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Brief Description of the Link Between DNA Bio-engineering and Human Health

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Abstract: As genetic engineering develops step by step, some methods of curing diseases that were thought impossible to be cured have been invented, but still, there will be more possibilities of creations we could bring by this technology. In the following report, the close relationship between genetic engineering and modern medical science would be illustrated.
Keywords: Cancer; Diagnosis; Medicine; Treatment; Inheriting diseases; Ethical issues

1. Historical events

In 1909, Johansson of Denmark named the genetic factor "gene". Then Thomas Hunt Morgan and his students published The Material Basis of Inheritance and Gene Theory, proved that genes are the genetic units on chromosomes.

Thirty five years later, Oswald Theodore Avery proved that genetic inheritance is in DNA. Watson and Crick, published a paper about their discovery in double helix structure of the DNA molecule on Nature, which laid the foundation for the development of subsequent genetic technology.

Then, in 1956, Arthur Kornberg isolated DNA polymerase from E.coli, as the start of DNA replication technology in vitro. Then came the genetic central dogma, the operon theory, and the successful deciphering of the genetic code, bringing the development of biology to another stage.

By 2000, scientists had published a working draft of the human genome, marking an important step forward in the process of interpreting our own “book of life”.

2. Body

2.1 Gene diagnosis

Genetic diagnosis is the application of using DNA recombination technology to detect human diseases, also known as DNA diagnosis. Since the sequence of the human genome is formed as early as the beginning of the germ cell, it is possible to identify the defective genes at any point in human phase by obtaining the genetic DNA of the subject and applying the appropriate DNA analysis techniques.

A good example of how genetic diagnosis can be more accurate is profiling DNA methylation for the adrenal tumor diagnosis. “Methylation patterns were distinctly different and could distinguish normal, benign, primary malignant and metastatic adrenocortical tissue samples,” said by senior investigator Electron Kebebew of the National Cancer Institute, Bethesda, Maryland, USA.[1]

Now, genetic testing, the simultaneous detection of thousands of gene loci by a new generation of sequencing technology, makes predicting the susceptibility of tumors and a variety of polygenetic diseases became possible. This new technology could also provide targeted guidance for clinical treatment.[2]

2.2 Genetic therapy

The first approved targeted medicine is Herceptin, which is for breast cancer. The traditional way to cure cancer is chemotherapy, which will cause huge negative side effects. While targeted therapies only affects targeted cells but have no influence on normal human cells.

The principles of different targeted drugs are different. Take passive targeting principle for an example, passive targeting works by using characteristics of tissues and organs to get natural distribution differences, mostly depends on the size of drug molecules. Particles larger than 7μm are usually trapped by the small capillary in the lung by filtration. In addition, the specific pH value of some parts of the body, can also be used to achieve the purpose of targeted drug delivery.

Targeted drugs are widely used to cure various types of cancer, including cerebral cancer, renal cancer and leukemia by killing cancer cells and stopping cancer cell division.[3]

2.3 Gene pharmacy

Biological gene technology can be used to treat gene defects that cannot be cured by general drugs through the method called animal pharmaceutical factory, which means that people can gain drugs from transgenic animals. These transgenic animals are the

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equivalent of mobile pharmaceutical factories.

The most significant application of animal medicine factory is synthetic insulin. Since 1958, people began to explore the chemical method to synthesize insulin on the basis of previous studies on insulin structure and peptide chain synthesis, and thus determined the procedure of synthesizing bovine insulin. Natural insulin is first split into two chains and then recombined. In the second step, after the synthesis of the new double chain, the synthetic B chain was linked with the natural A chain. Then, combining the semi-synthesized A chain with B chain. In 1965, with the joint efforts of scientists all over the world, the synthesis of crystalline bovine insulin was successful. In 1979, the University and the gene technology companyof California in San Francisco successfully transferred human growth hormone into E. coli by using gene engineering technology. Growth hormone affects the growth of the body. However, it can work in patients only if it is obtained from other people. In this way, it can only be gained from the pea sized pituitary gland of a dead person. Therefore, human growth hormone is extremely expensive and its use is limited. According to the data, the treatment of a child with hypophyseal dwarfism requires the removal of human growth hormone from 50 corpses. Therefore, the production of human growth hormone by bacteria will be more effective. This is the beginning of a new era of hormonal medicine. In 1997, a British company used the nuclear transformation, which is used in cloned sheep, to breed 200 sheep carrying human gene, and successfully extracted α - 1 antitrypsin from mammary gland of the sheep. Firstly, the gene of antitrypsin was recombined into a new plasmid to construct the expression vector, and then the vector was inserted into sheep cells to extract human antitrypsin from sheep mammary gland.

Using genetic engineering technology to develop new therapeutic drugs is the most active field in pharmaceutical industry. [4] Since the advent of genetic engineering drugs, it has become a miracle in the pharmaceutical industry. Every year, an average of 3-4 new drugs or vaccines come out, and more than 50 drugs have been successfully developed. They have been widely used in the treatment of cancer, hepatitis, dysplasia, diabetes, cystic fibrosis and some genetic diseases. In many fields, especially in difficult diseases, they play a role that traditional chemical drugs can not achieve.

2.4 Application in creating “perfect baby”

There is a film named Gattaca, which considers that in the near future, people born through genetic engineering are normal, and without this procedure, children born naturally are treated as “patients”. People who want to have a baby could simply choose the zygote with desirable characteristics through transferring one egg cell into another, so that the gene which causes unwanted diseases could be “repaired”. Via genetic technology, the child will have the genetic material of three people - the child will have a “second mother”. That is the ethical controversy of this technology.

2.5 Evaluation

With the rapid development of biological gene technology in the medical field, people are increasingly concerned about potential issues arising from it. Ethical and cost problems are the main concerns.

Among the ethical issues, the safety of genetic engineering is the most concerned. The safety problems brought by biological gene technology can not be ignored. At present, retroviral vectors are mostly used in gene therapy for genetic diseases, which may result in malignant transformation of cells, leading to cancer and other lethal diseases.

It is also a controversial field to try to correct the genetic defects of germ cells or to change the genetic characteristics of normal people by means of genetic engineering. Babies born through genetic technology may be prejudiced and discriminated against by people. People will doubt whether it is reasonable to give birth to babies with dominant traits by unnatural means, and whether it is unfair to the poor. Moreover, the variability of genes will be greatly reduced. As a result, a global pandemic could lead to catastrophic damages to human (hard to survive due to lack advantageous alleles under particular conditions)

High medical expenses also lead to low accessibility to the public. Zolgensma, a gene therapy drug for spinal muscular atrophy priced at 2.1 million dollars, becoming the most expensive drug ever put on the market.[5] Targeted drugs are relatively expensive compared to normal methods to treat cancer and the drugs are only accessible in sophisticated hospitals instead of small clinics.

3. Prospect

Breakthrough in the field of genetic engineering probably could help people gain a longer life expectancy. In some developed countries, the average live span has already exceeded 80 years. Some scientists suggest that as new methods found to cure cancer, cardiovascular diseases and other intractable diseases,100 years old could be the average life expectancy in most developed countries somedays between 2020 and 2030. Future decoding genes to promote human health and prolong life is predictable. [6]What’s more, the techniques of decipher genetic codes not only can be applied to boost crop production but also play an indispensable role in innovating new technology in the field of bio-pharmaceuticals and medical science.

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