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CRISPR TECHNOLOGY AND ITS BENEFITS FOR AGRICULTURAL ECONOMY AND NOT ONLY

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CRISPR is one of the most promising technologies in recent years, and in the coming years its role will only grow. However, not everyone understands exactly how gene editing works. In short, CRISPR is more accurate, CRISPR / Cas9 is a powerful genome editing tool. It is based on an element of the bacterial defense system that biologists have adapted to make changes in the DNA of plants, animals and even humans. The technology allows you to make changes in just a few days, not weeks or months. Never before has mankind had such an accurate tool for gene manipulation. Bacteria must constantly repel the attacks of viruses – their natural enemies. To do this, they produce special enzymes. Each time a bacterium manages to kill a virus, it cuts off the remnants of its genetic material and stores them inside the CRISPR sequences [1, 2]. This information is then used in the event of a new virus attack. During the attack, the bacterium produces Cas9 proteins, which carry a fragment of the genetic material of the virus. If this area and the DNA of the attacking virus match, Cas9 cuts the genetic material of the latter and neutralizes the threat. For some time, this discovery was interesting only to microbiologists. However, things changed in 2011 when biologists Jennifer Dudna and Emmanuel Charpentier decided to take a closer look at the CRISPR mechanism. They found that the Cas9 protein could be tricked into giving it artificial RNA. A protein carrying such RNA will look for genetic fragments that match what it carries. Finding a match from someone else's DNA, he will start shredding it, regardless of who it belongs to – a virus, plant or animal. In February 2013, it was shown that CRISPR / Cas9 can be used to edit DNA in mouse and human cell culture. Moreover. it turned out that the technology allows not only to delete unnecessary genes, but also to insert others in their place. To do this, simply add enzymes that repair DNA [3-5]. The idea of genetic modification is not new, and its various methods have existed for many years. However, CRISPR surpasses all hitherto known technologies due to its availability and accuracy. Editing one gene will cost only $ 75 and will take several hours. And, importantly, technology works with any organism on Earth [6, 7].

There are almost an infinite number of potential applications of the technology. First, CRISPR allows scientists to elucidate the function of various genes. It is enough to simply cut out the studied gene from DNA and see which functions of the body were affected. However, the public is much more interested in practical applications. They can be divided into several points:

1) Changes in agriculture. CRISPR allows you to make crops more nutritious, tastier and resistant to heat and stress. You can give plants and other properties: for example, cut out of peanuts allergen gene, and in bananas to introduce resistance to the deadly fungus. The technology can also be used to edit the genome of pets - such as cows.

2) Fighting hereditary diseases. Scientists intend to use CRISPR to cut out from the human genome mutations responsible for a number of diseases, such as sickle cell anemia. The technology will also cut out Huntington's chorea genes or BRCA-1 and 2 mutations associated with breast and ovarian cancer. Theoretically, a CRISPR attack can even stop the development of HIV.

3) New antibiotics and antiviral drugs. Bacteria develop resistance to antibiotics, and developing new ones is expensive and difficult. CRISPR technology makes it possible to destroy certain types of bacteria with high accuracy, although a specific technique has yet to be developed. A number of researchers are also working on CRISPR systems targeting viruses.

4) Genetic drive. With CRISPR, you can change not only the genome of an individual animal and plant, but also the gene pool of an entire species. This concept is known as the "genetic drive". Usually any organism passes half of its genes to offspring. However, the use of CRISPR can increase the probability of gene inheritance by almost 100 %. This will allow the desired trait to spread rapidly throughout the population. Using this technology, you can, for example, modify mosquitoes so that only females are born in their population. After a while the population will disappear. In a more gentle version, you can make mosquitoes resistant to Plasmodium infection. They will not be able to transmit the parasite to humans, and malaria will be put to an end. However, the implementation of such projects requires overcoming the doubts of skeptics who protest against such a large-scale invasion of nature.

5) Creating «designer babies». This item attracts the most public attention. However, according to scientists, our technological capabilities do not allow us to create children with predetermined properties. For example, thousands of genes are responsible for the level of intelligence, and it is impossible to adjust them all. It is possible that in the future the technology will reach the desired level, but so far there is nothing to worry about.

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MEMORY ANALYSIS OF MICROCONTROLLER PROGRAMS

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There are three main types of memory used in microcontrollers. Program memory is a non-volatile memory designed to store program code and constants. This memory does not change its contents during program execution. Data memory is used to store variables during program execution. Microcontroller registers This type of memory includes internal registers of the processor and registers used to control peripheral devices [1,2]. Program memory. One of the types of non-volatile memory is usually used to store programs: ROM (disposable software ROM), EPROM (electrically programmable ROM with ultraviolet erasure), EERROM (ROM with electric recording and erasure, this type also includes modern Flash-memory chips' or ROM (reusable ROM). All of these types of memory are non-volatile, which means that the contents of the memory are stored after the microcontroller is turned off. This memory is necessary because the microcontroller does not contain any mass storage devices (magnetic disks) from which the program is downloaded to computers. The program is constantly stored in the microcontroller [3].

During execution, the program is read from this memory, and the control unit (command decoder) provides its decoding and perform the necessary operations. The contents of the program memory cannot be changed (reprogrammed) during program execution. Therefore, the functional purpose of the microcontroller cannot be changed until the contents of its program memory are erased (if possible) and reprogrammed (filled with new commands).