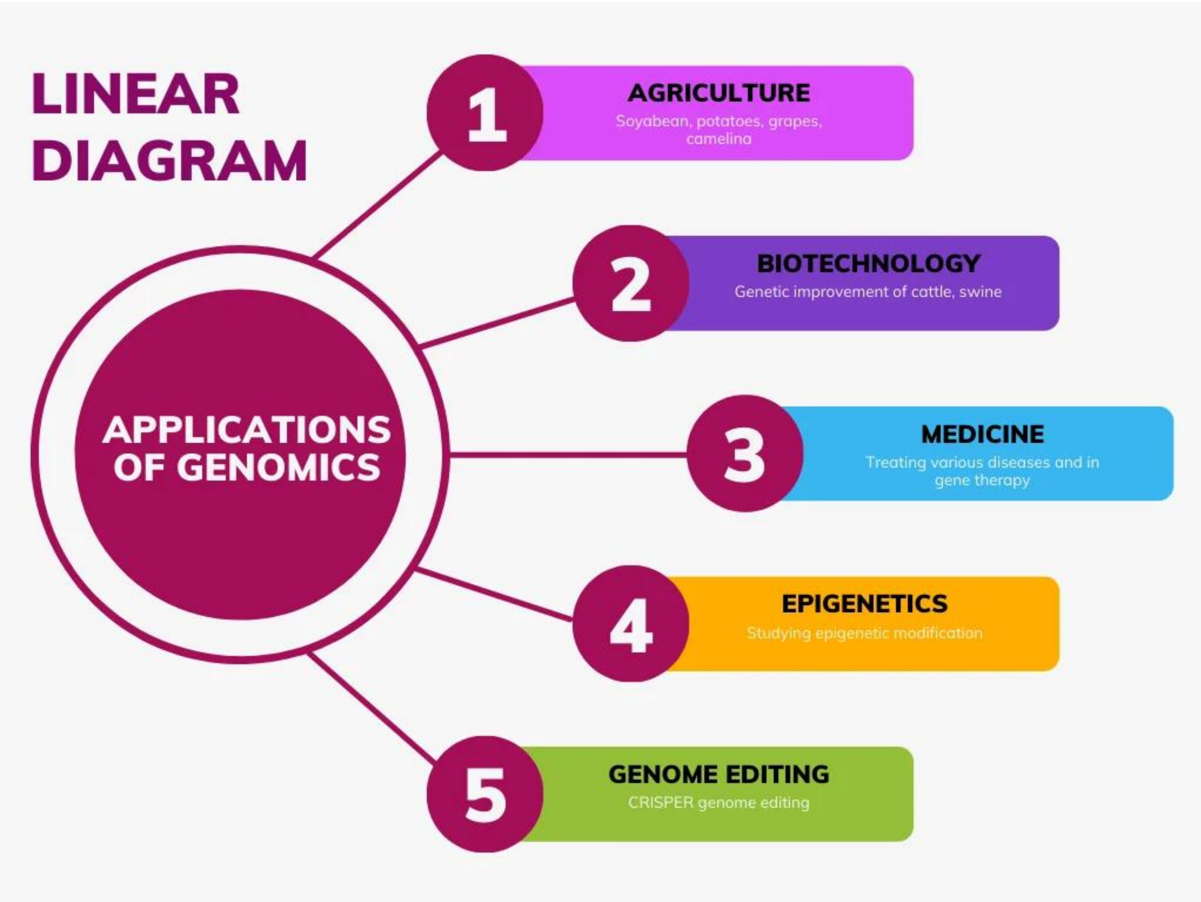
Genomics and its Applications: 5 Modern Applications

The field of genomics and its applications offer solutions to the growing global population and changing climate patterns are placing increasing pressure on current farming practices. By using genomics, scientists can develop crop strains and livestock breeds that are capable of producing more food while also being resistant to pests and diseases. Moreover, this technology can help reduce the environmental impact of conventional farming by decreasing the use of harmful chemicals and lowering carbon emissions.



Applications of Genomics in Agriculture

The application of genomics to crop enhancement holds the possibility of improving crop quality and yield while consuming less water, fertilizer, and pesticides. Selective breeding is becoming more targeted and two to three times faster to DNA tests based on plant genome sequences. Some plant strains with novel traits that increase productivity and nutritional value are being developed through genetic manipulation.

1. SOYBEAN

The soybean is a key source of food for both humans and livestock because to its high protein and oil content, and it is the focus of extensive research of Genomics and its applications. It was the first legume whose entire genome has been sequenced in 2010. In order to create strains with disease and drought resistance, healthier food-oil content, higher oil yield for biofuel generation, and even to minimize polluting phosphorous in the manure of cattle that are fed soybean meal, this new information is being employed in genomics-directed breeding.

By inserting a gene that imparts resistance to the potent herbicide, glyphosate, soybean was one of the first crops to be genetically modified to be "Roundup Ready." The food business prioritizes oleic and stearic acid, so DuPont is conducting additional research on genetically altering soybeans with these two acids in mind.

2. POTATO

The potato is the largest non-grain food crop in the world, and research is being done extensively to create new varieties with higher disease and insect resistance as well as better production and quality features. While several genetically modified plant varieties have been created with advantageous traits like resistance to the potato pest, these potato cultivars have not been produced because of opposition to the fast-food industry's use of genetically modified foods. Genetically engineered potatoes have showed great promise in producing pharmaceutical items like vaccines, and they do not face the same hostility as food crops.

Many production varieties with desired traits, such as higher resistance to pests and viruses and superior appearance, have been produced through traditional selective breeding. Research to uncover the genes that regulate significant potato features has been sparked by the publishing of the potato genome's full DNA sequence in 2011. This information will substantially facilitate and speed up selective breeding of superior varieties that have these advantageous genes.

3. GRAPES

The wine-making sector in Canada generates an estimated $6.8 billion in revenue from the world's largest fruit crop, grapes. The age-old process of breeding better wine grapes entered a new phase with the revelation of the grape genome's entire DNA sequence in 2007. The genomic data is being used by researchers in Canada and around the world to determine which genes are responsible for critical features including sweetness and colour, flowering time, frost and pest resistance, and ripening.

The objective of genomics-assisted selective breeding is to find the ideal combination of features for use in various growing environments and for various wine drinking preferences because each of these contributes a little different element to the final product.

4. Camelina

Camelina sativa, a plant that belongs to the mustard family, is gaining attention for its potential in numerous industries. Camelina is a strong candidate for usage as a source of biofuel, a supplement to feed for poultry, fish, and other animals, and a nutritious source of oil in our meals due to its high oil content and nutritional value.

While its DNA sequence has not yet been identified, researchers, including a project here in Atlantic Canada, are examining the genes responsible for a number of its hardy traits in order to use this knowledge to develop varieties that are most suitable for various growing conditions as well as various industrial and food applications.

Application of Genomics in Biotechnology

Using genomics can hasten the genetic improvement of cattle qualities like milk production, meat quality, and reproductive success.

The method is quite straightforward: we may utilize DNA markers connected to the required qualities to identify the animals with the highest potential and choose those for breeding and production. Breeders and producers have used this type of genomic selection to boost productivity of their herds across a variety of species while lowering expenses.

Cattle:

The meat and dairy sectors now have access to the bovine genome, which was finished in 2009. strong tools to carry out the genomic selection to enhance desirable features, including complicated traits like fertility and health that could not be examined using conventional approaches. A new class of genomics evaluation tests were made mandatory for all bulls offered as sires for artificial insemination within two years of the bovine genome's completion (AI).

This greatly enhanced the accuracy of genetic forecasts of attributes over traditional progeny-based evaluations, which are based on performance data on hundreds to thousands of AI daughters, and significantly decreased the time and cost of bringing AI bulls to market.

The improvement of breeds could be as great in the next 50 years thanks to genomic testing as it has been in the 8000 years since dairy and beef cattle were domesticated. Around $180 million in yearly benefits have already been brought to Canada through the usage of these instruments.

Swine:

It costs money to raise livestock. For farmers, increasing the value of each animal they grow can alter everything. A Genetic marker test that allows producers to selectively breed pigs that have larger litters and longer progeny lifespans has been developed as a result of genomic research, with clear financial advantages. Because to the high concentration of phosphorus in their excrement, pigs are also recognized as significant polluters.

Yet, some recent genomics research has shown pigs who appear to do well on diets that are reduced in phosphorus. This could result in selective breeding, producing pigs that are healthy, productive, and have a smaller environmental impact.

Application of genomics in medicine:

Medical professionals and researchers now have additional options thanks to recent advancements in the technology used to collect genomic data because data can now be gathered more effectively than in the past. This has improved our knowledge of genetics and the role that genes play in either causing or avoiding disease.

Oral plant vaccines, which use DNA and transgenes to build surface antigens that trigger immunity when ingested, show promise in the effort to immunize people against hepatitis B.

• **Heterologous prime-boost malaria vaccine:** Two-part injections containing DNA from P. falciparum and modified Ankara virus are anticipated to lower the risk of contracting malaria by up to 80%.

• **Anti-malarial medications:** The pharmaceuticals fosmidomycin and FR-900098 are being examined for their ability to specifically inhibit the body's DOX reductoisomerase, a step in P. falciparum's life cycle, the most harmful of the parasites that can cause malaria.

• **Testing for thalassemia:** Polymerase chain reaction (PCR) tests have been developed to look for gene mutations that cause the hemoglobin molecule's structure. Due to genetic counselling, Sardinia's thalassemia prevalence has decreased from 1 in 250 to 1 in 4000 live births as a result of the screening test.

Precision medicine is a use of genomics in the medical industry that enables individualized knowledge of a patient's genetic profile to guide the kind of therapy they receive. While some targeted cancer medicines and other treatments that concentrate on specific genomic data have already been implemented in medical practice, there is tremendous potential for this technology to spread to all other fields of medicine.

Genomics in gene therapy:

There are several manageable methods for administering gene therapy after the pathophysiology of a genetic mutation that causes disease has been identified. Delivering genetic material to replace, correct, or regulate the expression of a defective gene in the cell type(s) involved in the relevant disease is the main goal of gene therapy. With the enormous variability of the different cell types that make up the nervous system and the difficulty of crossing the blood-brain barrier, this is a particularly challenging topic for neurology.

Nonviral and viral delivery methods for gene therapy are the 2 main methods. Both strategies have had great success, and numerous additional clinical trials are currently being conducted. Antisense oligonucleotides (ASOs) are brief nucleotide sequences that have been chemically changed to enter cells undamaged.

They are one of the most promising nonviral gene therapy methods. Research is ongoing in the domain of chemical modification of ASOs, which has the potential to significantly alter bioavailability and, in certain circumstances, give tissue specificity.

Applications of genomics in industry

Enterprise-Scale Sequencing Businesses:

The physical mapping of genes and their intervening regions, followed by their sequencing, took place in the early stages of the human genome project. A number of businesses were established specifically with the goal of identifying genes, sequencing them, and figuring out their functions in order to develop novel medications and diagnostics. Incyte, Human Genome Sciences, and Celera Genomics are a few of these businesses. This group of businesses has added millions of bases of sequence data from several microbes as well as the human genome to both public and private databases.

Gene Mining Businesses:

Companies have been established to "mine" the data, that is, to analyse the genomic sequences to find genes, their function, and their connections to health and disease processes, now that the sequencing data is accessible and in the public domain. Among the businesses that led the way in this field were Sequana and Millennium Pharmaceuticals (although Sequana did not survive as an independent company).

In search of drugs that will target the effects of the defective gene or dysregulated pathways, some of the companies in this sector concentrated on discovering and developing small molecules, antibodies, proteins, or a combination of the three after genes were found to be relevant to particular disease processes.

Applications of Genomics in Bioinformatics:

Genome editing, also known as gene editing, refers to a range of scientific techniques that enable the modification of an organism's DNA. At specific sites in the genome, these technologies enable the addition, removal, or modification of genetic material.

There are several methods for genome editing that have been developed. CRISPR-Cas9, which stands for clustered regularly interspaced short palindromic repeats and CRISPR-associated protein 9, is a well-known example. Because it is quicker, less expensive, more precise, and more effective than existing genome editing techniques, the CRISPR-Cas9 system has sparked a lot of interest in the scientific community.

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