BioTech Brief

Genome Editing

2 | 2016

Deutsche Industrievereinigung Biotechnologie

Genome Editing: Significant for Biotechnology

Genome editing methods are essential tools worldwide in research and development, inter alia, for medicinal products, plant varieties or micro-organisms which help produce bio-based chemicals and even bioenergy from renewable raw materials. Genome editing allows researchers to alter individual DNA components more precisely than ever before. The European Commission is currently addressing the legal classification of genome editing methods. In Germany the Central Committee on Biological Safety (ZKBS) has legally classified the methods quite some time ago.

MORE PRECISE THAN EVER

Genome editing refers to a set of new molecular biology methods derived from nature which can be used as highly accurate tools to precisely alter DNA components. They are equivalent to a microsurgical procedure in which genes can be turned on or off, and inserted or removed. The major advantage of genome editing is that it produces the exact same changes as can be found in nature or are produced by traditional plant breeding. There are no physical, chemical or biological differences. The most widespread method at the moment is CRISPR/Cas9. When mentioned in conjunction with plant breeding, genome editing refers to "New Breeding Techniques" (NBTs).

BALANCED APPLICATION OF THE PRECAUTIONARY AND INNOVATION PRINCIPLES

A debate is currently taking place in Europe about how legislators should assess the "New Breeding Techniques" for plants. Some from the world of politics want to sweepingly prohibit NBTs or classify them as genetic engineering. As an example, the German Ministry for the Environment (BMUB) announced that the entirety of new breeding methods should be declared as genetic engineering in the future. At the same time, the BMUB acknowledged that a change made to genetic material

GMO/NON GMO

The German Association of Biotechnology Industries (DIB) believes that it is easily possible to legally classify all methods within the scope of the current EU GMO legislation and in national implementations.

ORGANISMS FALL WITHIN THE SCOPE OF GENETIC ENGINEERING LAW IF...

...traceable and thus identifiable foreign DNA has been stably integrated. These organisms will be officially regulated and approved according to the requirements of current Genetic Engineering Law.

ORGANISMS DO NOT FALL WITHIN THE SCOPE OF GENETIC ENGINEERING LAW IF...

...foreign DNA was not stably inserted into the genome of the end product. These products are i.a. covered by Biological Agents Ordinance, Occupational Safety and Health Act, Medicinal Products Act or by the Federal Immission Control Act for production facilities.

using CRISPR-Cas9 cannot be distinguished from naturally occurring mutations or from changes by means of traditional plant breeding.

Why, then, should new molecular biology methods, such as for plant breeding, be subject to a sweeping ban or classified as genetic engineering if what they produce is indistinguishable from traditionally bred plants?

Genome editing is an important key technology of the future. The assessment of its opportunities (innovation principle) and risks (precautionary principle) should therefore not be generalised, but instead should be based on scientific, case by case assessments. Some methods may result in genetically modified organisms (GMOs), whilst others may not. If a product is a GMO, it falls under the Genetic Engineering Law. If the product is not a GMO, it might be regulated e.g. under the Chemicals Act, Occupational Safety and Health Act, Medicinal Products Act or by the Federal Immission Control Act for production facilities.

Accordingly, many professionals proceed in a differentiated manner. Thus, a dedicated EU Member States expert working group on New Breeding Techniques, concludes that some genome editing methods lead to GMOs, whilst others do not. The ZKBS in Germany, an expert panel responsible for evaluating GMOs with regard to the potential risks posed to humans, animals and the environment, found that the majority of the new methods do not fall within the scope of the current EU GMO legislation. For example, if CRISPR-Cas is used to make a targeted mutation in a plant and not stably inserts foreign DNA into the genome, then the result is not a genetically modified plant. That is because this kind of modification of the properties of plants can equally occur spontaneously in nature or be produced by using conventional breeding methods.

Consequently, the Federal Office of Consumer Protection and Food Safety as well as the authorities from five other EU Member States have classified a type of oilseed rape as "not genetically modified". This type of oilseed rape was bred using a new method of molecular biology and has been equated to products produced with conventional breeding.

A BROAD FIELD OF APPLICATION

The methods of genome editing play a crucial role, not only in plant biotechnology but also particularly in medicine and the production of bio-based products. The latter is of significant importance in the development of a circular economy. The methods are applied worldwide in basic research, biotechnology and biomedicine – among other things, they can contribute to deciphering previously incurable diseases such as multiple sclerosis, Alzheimer's or HIV infections in order to heal them or help to disable antibiotic resistance.

Further development of a bio-economy also requires molecular biology methods in order to remain sustainable and to both gain and maintain a foothold in international competition. Biotechnology is a cross-cutting technology: If one aspect of an application is restricted – for example, green biotechnology – then red and white biotechnology will be immediately harmed.

In a position statement, the Union of the German Academies of Sciences and Humanities classifies genome editing as a quantum leap in molecular biology research. It further states that Germany should be involved in the entire spectrum of this important development and to actively shape the safe and responsible use of genome editing.

SAFEGUARD AND EXPAND RESEARCH AND PRODUCTION SITES

Whether genome editing and future molecular biology methods have long-term prospects in Europe and Germany or not, should decisively depend upon benefits generated by these methods for humans, animals and the environment. It should not depend on the technological origin of the methods, but solely on whether their products are safe or not.

A blanket and not science-based regulation that categorizes all methods of genome editing as genetic engineering, would particularly put small and medium sized enterprises in Europe and Germany at a serious disadvantage compared to international competition. Outside of Europe, the use of biotechnology – which also includes genome editing – for agriculture, medicine and the production of bio-based products from renewable raw materials will continue to be a priority. A differentiated approach in the EU and Germany that aims at balancing the precautionary and innovation principles would therefore contribute significantly to safeguarding and expanding Germany as a location for investment, innovation and production.

Field of application: from cancer treatment to biofuels

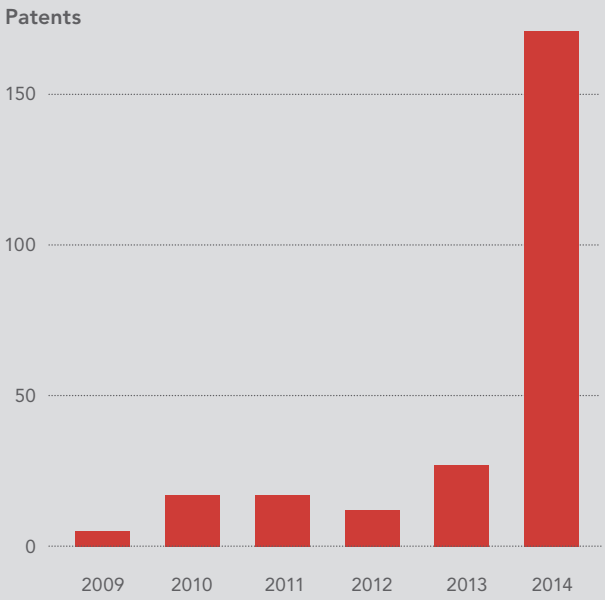
Medical applications: Millions of people around the world suffer from hereditary genetic diseases that are caused by a single mutated gene. One example is sickle cell anaemia, which leads to severe renal disease, or beta thalassemias, which are associated with weakness, anaemia and developmental delay. Genome editing could help to develop new treatments to fight these kinds of diseases. Specific objectives exist in cancer research as well – the first clinical trial is being planned for performing genome editing on immune cells ex vivo, which specifically attack and turn off tumour cells.

Industrial biotechnology: With genome editing, the metabolic processes of production organisms can be selectively improved to achieve the desired final products with increased productivity, selectivity and substrate efficacy. For example, yeast could be modified in such a way that it degrades xylose for use as feedstock in the production of biofuel. This would make a significant contribution to the bio-economy.

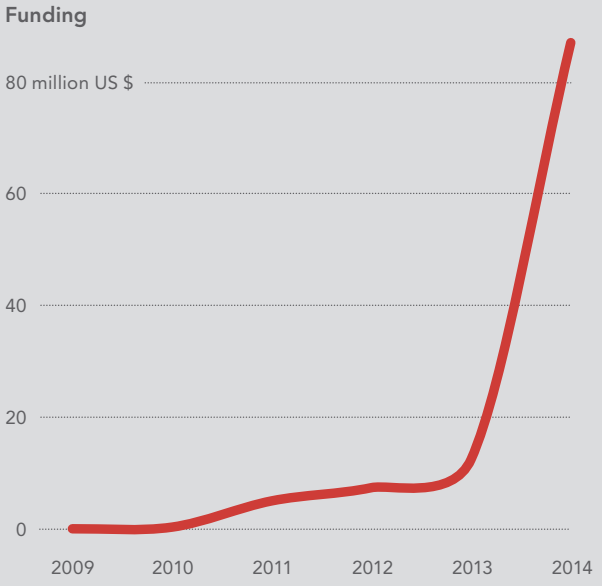
Agriculture: Genome editing can be used to improve crop plants in a number of ways. For example, the procedures could be used to remove allergens from edible plants, cows' milk or hens' eggs or to stimulate nutrient production. Furthermore, because they are inexpensive, their use is worthwhile even for minor crops of regional or even local varieties. This could give an important impetus to conserve and safeguard bio-diversity.

THE RISE OF CRISPR

DNA sequences called CRISPRs (clustered regularly interspaced short palindromic repeats) are part of a bacterial defence system. After researchers showed in 2012 that CRISPRs could be used for genome editing, their application increased significantly – as reflected by sharp rises in publications, patent applications and funding.



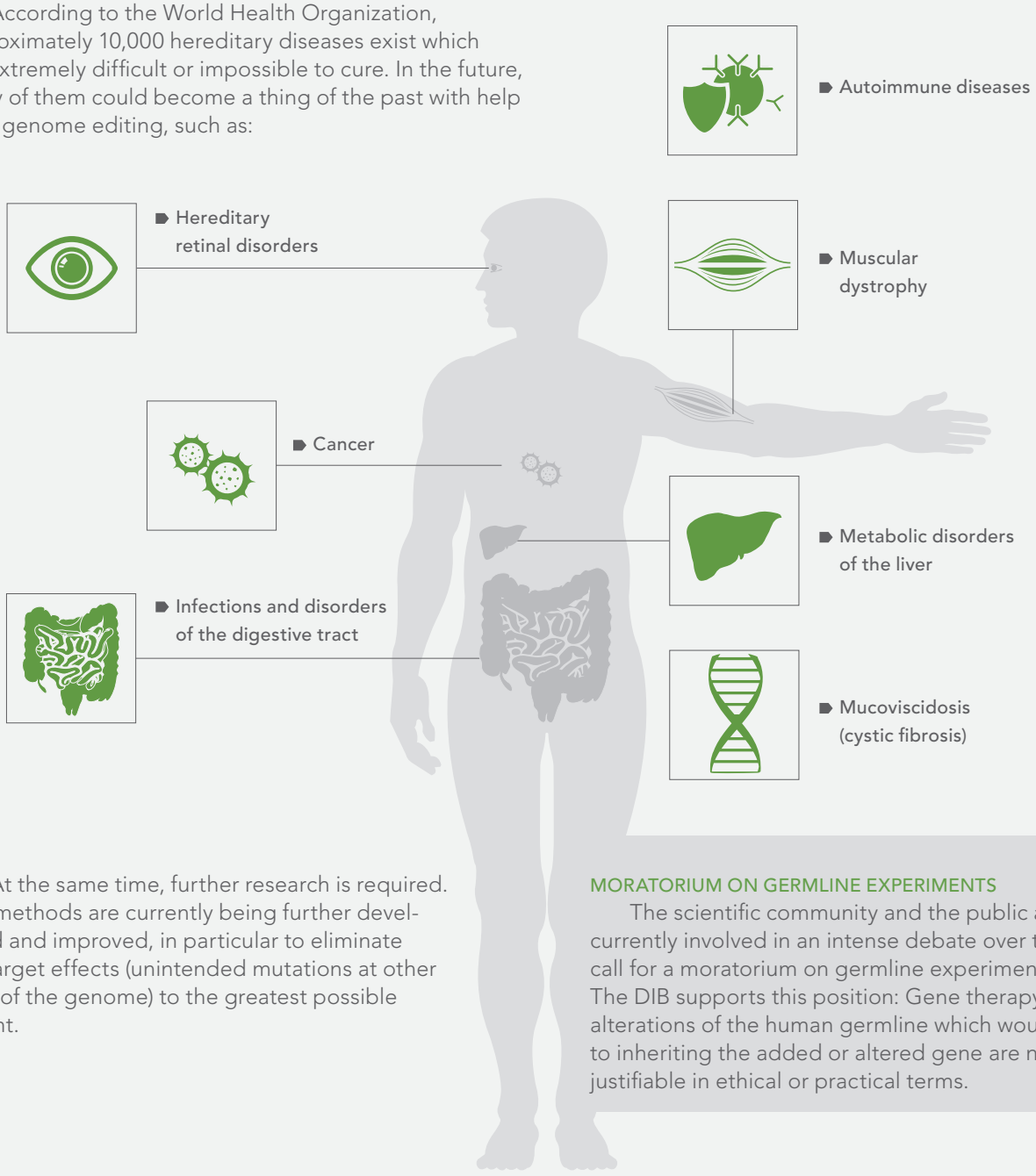
Patent applications increased many times over in 2014 worldwide.
Source: Nature



The marked increase in research funding from US institutions of health for CRISPR projects is an indicator of further progress in the future.
Source: Nature

Genome Editing: Potential fields of application in medicine

According to the World Health Organization, approximately 10,000 hereditary diseases exist which are extremely difficult or impossible to cure. In the future, many of them could become a thing of the past with help from genome editing, such as:



At the same time, further research is required. The methods are currently being further developed and improved, in particular to eliminate off-target effects (unintended mutations at other sites of the genome) to the greatest possible extent.

MORATORIUM ON GERMLINE EXPERIMENTS

The scientific community and the public are currently involved in an intense debate over the call for a moratorium on germline experiments. The DIB supports this position: Gene therapy alterations of the human germline which would lead to inheriting the added or altered gene are not justifiable in ethical or practical terms.

Imprint:
German Association of Biotechnology Industries (DIB)
within the German Chemical Industry Association (VCI)
Mainzer Landstraße 55
60329 Frankfurt

Press Date: December 2016

Managing Director:
Dr. Ricardo Gent
Phone: +49 69 2556-1459
Telefax: +49 69 2556-1620
E-mail: gent@dib.org
Internet: www.dib.org