

A close-up photograph of a petri dish containing plant tissue culture. The dish is filled with a white, gelatinous medium. Several small, green, elongated plant tissue pieces are scattered across the surface. A prominent, thin, dark, curved structure, likely a root or stem, is visible in the center. The background is a soft, out-of-focus blue.

BIOTECHNOLOGY TREND ANALYSIS 2023

A CALL FOR VISION,
DECISION AND DIRECTION

SUMMARY

MARCH 2023

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The scientific and technological advances being made in biotechnology are proceeding at a rapid rate and the possibilities for modifying organisms have grown enormously. New products and applications are appearing in increasingly rapid succession, including Covid vaccines, biochemicals and proteins produced by microorganisms, and plant breeding techniques. As a result, biotechnology is becoming increasingly important. For this reason, the Minister for the Environment – also on behalf of four other ministries: Agriculture, Nature and Food Quality; Health Welfare and Sport; Economic Affairs and Climate Policy; and Education, Culture and Science – asked COGEM and the Health Council of the Netherlands to prepare a new trend analysis of developments in biotechnology. This *Biotechnology Trend Analysis 2023* describes the main developments, focusing specifically on three areas: the circular economy, food production and health.

Biotechnology is accelerating and becoming integrated into other fields

The advance of biotechnology is being driven by a combination of technological developments. The use of information technology, automation and robotisation is making techniques such as sequencing, gene editing (targeted mutagenesis) and genetic modification *simpler, quicker, cheaper and more accurate*. This applies to the complete spectrum of living organisms, from microorganisms, plants and animals to humans. These developments have led to a situation in which modifying living organisms to give them desirable functional capabilities or traits is taking place on an *increasingly large scale*. As a consequence, biotechnology is gaining momentum and influence, and its applications have found their way into numerous economic sectors and research fields. While these applications present new opportunities for innovation and for achieving the UN's Sustainable Development Goals, they also raise new questions and dilemmas about their desirability and safety, and concern about property rights.

Potential benefits for the circular economy, food production and healthcare

The trend analysis focuses on the opportunities that biotechnology provides in three areas:

1) Industrial biotechnology can contribute to creating a fully circular economy. Microorganisms are used to make products and chemicals that are now manufactured by the petrochemical industry, such as fuels and plastics. Whereas the petrochemical industry uses fossil fuels and is responsible for large CO₂ emissions, industrial biotechnology aims to use renewable raw materials from agriculture and waste streams. Considerable research is also being conducted into biotechnological processes in which CO₂ is used as a raw material, along with electricity or green hydrogen.

2) In the agro sector, biotechnology has a part to play in the progress towards sustainability and security of food production, as described in the EU's *Farm to Fork Strategy* and the Dutch National Protein Strategy (*Nationale Eiwitstrategie*). Gene editing can speed up the plant breeding process and produce plants that are tolerant of drought, extreme temperatures and salinisation or resistant to pests and diseases. There is a global research effort on creating microorganisms that can produce 'animal' proteins and on the production of cultured meat. The first products have already appeared on the market. In countries outside the EU, gene editing is also being used to increase the productivity of farm animals.

3) In healthcare, biotechnology is involved in the control of infectious diseases, the treatment of cancer, the prevention and treatment of genetic disorders and, in future, possibly the transplantation of animal organs into humans (xenotransplantation). The power of lar-

ge-scale sequencing was demonstrated during the COVID-19 pandemic, when this new technology was instrumental in the rapid development of diagnostic tools and vaccines.

New developments also raise new issues

Biotechnology not only holds the promise of benefits to society, but also raises complex ethical and social questions involving different, possibly conflicting values. Moreover, applications are not always without risks to human health and the environment. The legislation must ensure safety, but it must also allow room for innovation. It is therefore time to modernise the regulations surrounding biotechnology. Not only do EU regulations date from the previous century and are based on outdated scientific insights, but opinions differ on which applications are desirable and which are not, and on how to weigh up the potential benefits against the risks. Decisions on which applications should be encouraged and which should be prevented are therefore inherently ethical and political.

There is public resistance to genetic modification, particularly in food production. Moreover, the new technologies raise ethical questions, such as whether modifying human or animal embryos is acceptable or desirable. Cellular agriculture, which is mainly geared to producing alternatives to animal proteins (such as cell-cultured meat), may become a disruptive technology, especially for conventional forms of livestock farming. Finally, the competitive position of the Netherlands and the EU may be at risk because significant technological innovations, such as CRISPR-Cas, are taking place outside the EU and Dutch companies are becoming dependent on patent holders elsewhere, especially in China and the US.

Government must provide an integrated vision and direction

To exploit the opportunities, the 'biotechnological innovation ecosystem' must be in good shape. COGEM and the Health Council of the Netherlands are of the opinion that the system needs to be improved as the Netherlands is ill prepared for new developments and is missing out on opportunities to make full use of the economic and social potentials of biotechnology. Although the government does develop initiatives, these are piecemeal and lack clearly formulated goals. What is needed is an *integrated long-term vision* on the direction of advances in biotechnology that would benefit Dutch society, as well as steering by government to implement this vision. A government-wide approach is needed.

Elements that should be considered in such an approach include: improving the research infrastructure; ensuring fundamental research, partly with a view to developing new technologies and the associated intellectual property rights; parallel research into socially accountable biotechnological innovation; clear ethical principles, including a good balance between the protection of privacy and property rights and the exchange of information; a just distribution of costs and benefits; and future-proof biotechnology legislation. To this end, each chapter of this trend analysis, particularly the final chapter, contains a number of recommendations and possible courses of action.

Putting such a vision into practice requires the coordinated engagement of the various parties active in biotechnology, such as government agencies, scientific institutions, the business community, professional groups, NGOs and consumer and patient organisations, with government taking the lead. Essential for this is active communication about developments in biotechnology between government, stakeholders and the public, involving both participation and education.