

Work programme

In effect from 2018

Large-scale Programme
Biotechnology for Innovation – BIOTEK2021



**Large-scale
Programmes**

The RCN initiative
to meet national
research priorities

Work programme

In effect from 2018

Large-scale programme
Biotechnology for Innovation – BIOTEK2021

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1 Summary

Biotechnology is an enabling technology that is expected to play a vital role in societal development in the coming years. The number of areas in which modern biotechnology is being used is expanding, with applications ranging from health services to process industries. Major societal challenges call for new technology. Norway possesses a strong biotechnology knowledge base built up through long-term research initiatives over many years, but there is a need to strengthen innovation efforts in the research community for biotechnology to play a greater role in contributing to value creation in trade and industry and the public sector, and for research and innovation to yield benefits for society at large in the long term.

The primary objective of the programme on Biotechnology for Innovation (BIOTEK2021) is to promote the use and development of biotechnology that contributes to innovation needed to solve societal challenges in a responsible manner. This is to be achieved by promoting: i) the development and use of innovative biotechnology expertise and methodologies at top international level; ii) the development and use of biotechnology that leads to innovation and industrial development; iii) the responsible development of technology that addresses major societal challenges; and iv) cooperation, task distribution and highly focused research activity nationally and internationally.

Results from the programme's activities are expected to have long-term impacts on the development and application of biotechnological research in Norway. The programme will give priority to research projects that bridge the gap between basic research and innovation. The programme will attach importance to strengthening the framework conditions for research-based innovation, such as interdisciplinarity, high research quality, and collaboration between academic research and the business sector/health trusts.

The BIOTEK2021 programme places focus on the role of societal responsibility in technological advancement and will provide funding for activities in which technologies are developed in broad collaborative arenas with users and stakeholders involved in the research process.

Strategic programme collaboration nationally and internationally will make it possible to implement measures with greater impact. Programme collaboration also helps to minimise fragmentation of research funding for applicants and promotes effective utilisation of combined resources by avoiding duplication of efforts in different programmes.

2 Background and challenges

2.1 Background

The Government's long-term plan for research and higher education 2015–2024¹ highlights biotechnology along with nanotechnology and ICT as enabling technologies expected to play a vital role in societal development in the coming years. The enabling technologies are developed and applied in mutual interplay, and new technology areas are emerging in the interfaces between them. Technological convergence is the focus of a great deal of attention internationally.²

¹ Meld. St. 7 (2014–2015) *Long-term plan for research and higher education 2015–2024*, white paper from the Ministry of Education and Research, is a 10-year plan for the development of Norwegian research.

² OECD Science, Technology and Innovation Outlook 2016.

Biotechnological expertise and methods are being developed and applied within the agricultural, marine, industrial and health sectors in particular. Because biotechnology extends across such a wide range of applications, it is natural that this field is an integral part of many of the Research Council of Norway's programmes and activities. In 2016 the Research Council's total funding to biotechnology amounted to just over NOK 1 billion, of which NOK 184 million was allocated under the large-scale programme on Biotechnology for Innovation (BIOTEK2021). It is therefore important that the BIOTEK2021 programme cooperates closely with other programmes and that investments take the entire project portfolio adequately into account.

This document is a revised version of the BIOTEK2021 work programme and is applicable from 2018. The BIOTEK2021 programme is a strategic, long-term programme designed to further develop Norwegian biotechnological research to promote greater innovation in society and industry. The programme has been running since 2012 and follows up Norway's national strategy for biotechnology.³

Biotechnology is not an industry in itself, but an umbrella term for a broad spectrum of *technologies* that can be used to stimulate new industrial development, enhance the competitiveness of new and existing industrial activity, and promote innovation in the public sector.

In keeping with the OECD and Norway's National Strategy for Biotechnology, the programme employs the following definition of biotechnology: *The application of science and technology to living organisms, as well as to parts, products and models thereof, to alter living and non-living materials for the production of knowledge, goods and services.*

During its first period, the BIOTEK2021 programme has taken a number of steps to achieve its objective of expanding the range of biotechnology applications.

- Optimisation projects have been developed to provide support for early-phase commercialisation based on research results. Funding for optimisation of research results bridges the gap between basic research and innovation.
- Large-scale, industry-relevant Researcher Projects in biotechnology have been developed to promote collaboration between the research community and the business sector/public administration on addressing societal challenges. The scheme has been further targeted with the launch of the strategic initiative "Digital Life - Convergence for Innovation", which promotes transdisciplinary collaboration and technological convergence as a tool for increased innovation. The national Centre for Digital Life Norway (DLN) is expected to have a significant impact on national cooperation and distribution of tasks in the biotechnology field, as well as pave the way for closer cooperation between actors across scientific boundaries, institutions and sectors on the development and application of modern biotechnology expertise.
- Increased focus has been placed on the role of societal responsibility in technology development with the incorporation of activities relating to Responsible Research and Innovation (RRI). The development of enabling technologies is a double-edged sword in that technological development and innovation are necessary to address major societal challenges but may also be a contributing factor to those same problems. RRI efforts are an important part of technological development and extend across all activities under the programme. A framework for RRI efforts has been drawn up in cooperation with the Research Programme on Nanotechnology, Microtechnology and Advanced Materials (NANO2021), the Initiative for ICT and Digital Innovation (IKTPLUSS) and the Programme on

³ Norway's National Strategy for Biotechnology 2011–2020.

Responsible Innovation and Corporate Social Responsibility (SAMANSVAR). The BIOTEK2021 programme is also involved in international initiatives related to developing best practice and new innovation policy.⁴

The BIOTEK2021 programme was recently evaluated by Technopolis and an external group of international experts in order to determine whether the steps taken by programme to achieve its objectives have been constructive and in accordance with international best practice. The evaluation, including its analyses and recommendations, has been discussed by the programme board and the Research Council and has formed the basis for this revision of the work programme. For more information about the evaluation, please see the evaluation report.⁵

2.2 The need to increase the pace of innovation from biotechnology research

The number of areas in which modern biotechnology is being used is expanding, with applications ranging from health services to process industries. Norway's National Strategy for Biotechnology emphasises that research results must benefit the private and public sectors in Norway to a greater extent. Norway possesses a strong biotechnology knowledge base built up through long-term research initiatives over many years, but there is a need to strengthen innovation efforts in the research community to achieve the ambitions set out. This will require building new expertise in innovation and identifying bottlenecks that inhibit it. Processes for early-phase, research-based innovation need to be simplified.

The BIOTEK2021 programme will build upon types of support developed in its first programme period and take innovative steps to realise the strategy's ambitions for increasing the pace of innovation and strengthening value creation from Norwegian biotechnology research.

Separate sector strategies have been drawn up for the oceans, food, industry and health which define the main issues in these respective areas, and there are thematic programmes at the Research Council for specific follow-up of these areas. As an enabling technology, biotechnology provides a generic toolbox for helping to find solutions. The role of the BIOTEK2021 programme is to ensure that Norway builds the requisite expertise to develop and implement biotechnology tools for the benefit of society and trade and industry.

Activities under the programme are to be based on cooperation between leading knowledge environments and national and international users. Furthermore, the activities must be adapted to the knowledge base found within each of the sectors:

(i) In the marine sector, Norway has a leading role at the international forefront of research, with strong industrial actors and major potential for contributing to innovation and value creation.

(ii) In the agricultural sector, Norway is home to a number of dynamic research groups that should be further developed through national and international cooperation.

⁴ The programme participates in international cooperation on development of innovation policy, the Transforming Innovation Policy Consortium, with the Swedish Governmental Agency for Innovation Systems (Vinnova), the Finnish Funding Agency for Technology and Innovation (TEKES), the Science Policy Research Unit (SPRU), among others..

⁵ Evaluation of the RCN's BIOTEK2021 programme – Final report (Technopolis, 2017)

(iii) In the health sector, Norway has substantial research capacity and many strong academic research environments. Medical biotechnology is the largest area nationally, and one challenge is to create more innovation based on existing research results.

(iv) In the area of industrial production, research and technology in the other sectors will be implemented as new production technologies. There is great potential for value creation from industrial biotechnology related to the emerging bioeconomy, but the knowledge base must be expanded through national and international cooperation.

2.3 The emerging bioeconomy opens up major opportunities for biotechnology

The bioeconomy encompasses the sustainable production and processing of biomass for a variety of foods, health products, fibre, industrial products and energy.⁶ In recent years there has been a growing understanding that biotechnology is a basic prerequisite for the development of such a knowledge-based bioeconomy, characterised by circularity and sustainable use of bioresources. Biotechnology will also contribute to the development of new or improved products, services and industrial processes.

There are high political ambitions to promote a green transition in the Norwegian economy. This drive has gained momentum in recent years, and the Government recently drew up a national strategy for the bioeconomy.⁷ Biotechnology is a central, integral part of this transition and thus offers ample opportunities to contribute solutions.

Within the primary industries, companies based on biotechnology expertise have been developed, particularly in aquaculture and agriculture (feed, vaccines, selective breeding and biobanks). Industrial biotechnology is a relatively immature field in Norway but in recent years has been applied to biorefining various types of biomass.

Ambitions are also high for enhanced value creation and increased employment. The oceans have a high capacity for production of biomass, and Norway has access to abundant marine resources. Norway should therefore play a key international role in developing the marine bioeconomy. The modern bioeconomy will be the foundation for developing a circular economy with high utilisation and recycling of resources. This requires new value chains and innovation ecosystems where waste from one value chain is a resource for another. Links between different value chains and industries will become increasingly important.

2.4 The need for greater social responsibility regarding technology development and innovation

The world is changing at a rapid pace, driven in large part by technology and innovation. Major societal challenges related to climate change, overexploitation of Earth's resources and growing inequality are dominating political agendas the world over, and there are expectations that technology and innovation will play a greater role in finding the solutions.⁸ At the same time, there is increased global acknowledgment that technology is not only part of the answer but can also be a factor in creating or exacerbating these same problems. The Research Council's main strategy from

⁶ *Innovating for Sustainable Growth: a Bioeconomy for Europe*. European Commission, 2012. m

⁷ The Government's Bioeconomy Strategy, *Familiar resources – undreamt of possibilities* (2016)

⁸ See the Lund Declaration (2009); also, *Shared Space – Slow Science*, Jack Stilgoe (2016).

2015⁹ states that the Council must assume greater societal responsibility by promoting research and innovation activities that will yield benefits for society at large in the long term. This has been a focus under the BIOTEK2021 programme in the first programme period.

There is irreducible uncertainty about the long-term effects of technology development and innovation. For this reason, procedural dimensions are important for ensuring that research is more broadly aligned with a wide array of stakeholders. This understanding has significance for the activities of technology programmes and imposes new requirements for knowledge, competence and skills.

The BIOTEK2021 programme has established a framework for Responsible Research and Innovation (RRI) together with the IKTPLUSS initiative, the NANO2021 programme and the SAMANSVAR programme.¹⁰ RRI entails management of technology and innovation by including a broad cross-section of actors and perspectives in the planning and implementation of activities. To foster innovation and industrial development, it will be necessary to promote work forms and networks involving close cooperation between academia, research institutes, trade and industry, public innovation and funding agencies, and private capital. This means that the actors must acquire new competencies and skills.

RRI has had high impact internationally and is a cross-cutting issue under Horizon 2020. The evaluations of the BIOTEK2021 and NANO2021 programmes point out that both are at the international forefront in terms of RRI efforts.¹¹ Development efforts targeting socially responsible development of technology will be continued and enhanced in the next programme period.

3 Objectives for the programme

Biotechnology is one of the enabling technologies covered in the Norwegian Government's *Long-term plan for research and higher education 2015–2024* (LTP), and is vital to the development of the agricultural, marine, industrial and health sectors. Biotechnology extends across a wide range of applications, and many Research Council activities support projects that develop or use biotechnology expertise and methods.

3.1 Primary objective

The BIOTEK2021 programme will promote the use and development of biotechnology that contributes to innovation needed to solve societal challenges in a responsible manner.

3.2 Secondary objectives

The programme will:

1. promote the development and use of innovative biotechnology expertise and methodologies at top international level;
2. promote the development and use of biotechnology that leads to innovation and industrial development;

⁹ *Research for Innovation and Sustainability: Strategy for the Research Council of Norway 2015–2020.*

¹⁰ *A framework for Responsible Innovation – under BIOTEK2021, IKTPLUSS, NANO2021 and SAMANSVAR, v.1.0 (2015).*

¹¹ *Evaluation of the RCN's BIOTEK2021 programme – Final report (Technopolis, 2017).*

3. promote the responsible development of technology that addresses major societal challenges;
4. promote cooperation, task distribution and highly focused research activity nationally and internationally.

4 Thematic and scientific priority areas

Activities under the BIOTEK2021 programme will address challenges within each sector according to its specific needs and in a manner that activates synergies and fosters cooperation. Thus the programme does not have designated thematic priority areas for individual sectors. The programme will establish priorities in consultation with relevant programmes and external actors, and will present these in annual action plans. The programme will give priority to projects with the potential to lead to innovation based on cutting-edge research. Activities under the programme are to be based on cooperation between leading knowledge environments and national and international users and other stakeholders. Furthermore, the activities must also be adapted to the knowledge base found within each of the sectors.

Biotechnology as an area of expertise shares an interface with a number of subject areas such as biology, chemistry, physics, mathematics and engineering. To make practical use of biotechnology, expertise in the social sciences, the humanities and law is also needed. The development of biotechnology therefore requires a high level of interdisciplinarity.

The developing convergence across the life sciences, mathematics and engineering has laid the foundation for cutting-edge technologies such as systems and synthetic biology. The vast amounts of data generated by modern life science activities hold major innovation potential, but realising this potential will require enhanced expertise in biostatistics and mathematical sciences. There is great interest internationally in new technologies being developed in areas in the interface between existing technology areas. The optimal use of a given technology often requires the application of other technologies as well.¹² The interfaces between technologies are expanding and there are significant opportunities for synergies across established technology areas.

The BIOTEK2021 programme will therefore follow developments within these areas of interface and cooperate with the other programmes encompassing enabling technologies. Regardless of sector, activities under the BIOTEK2021 programme will be focused on thematic areas and associated research questions on which the development and use of biotechnology expertise and methodology will have a critical impact.

5 Priorities for structuring the research effort

5.1 Strategic initiative “Digital Life – Convergence for Innovation”

In order to orient Norwegian biotechnology according to international developments, the BIOTEK2021 programme launched the initiative “Digital Life – Convergence for Innovation”. This is a development project for Norwegian biotechnology as a whole and its objective is to create value for

¹² OECD Science, Technology and Innovation Outlook 2016.

society based on technological convergence and transdisciplinary cooperation¹³ on research, education and innovation across subject areas, technologies and societal stakeholders.

The Digital Life initiative builds on major investments in similar initiatives at the largest research institutions.¹⁴ The national Centre for Digital Life Norway is designed to spearhead the development of biotechnology in Norway and promote effective national cooperation and task distribution. As a national platform for cooperation, the centre will play a consolidating role for Norwegian research groups and can serve as a Norwegian node in international networks with leading centres in other countries.

The Digital Life initiative started up in 2016 and will be developed to become a national flagship that creates value for society and ensures strong support from the responsible institutions and other stakeholders. The Digital Life strategic initiative has been established to accommodate the broad ambitions of the BIOTEK2021 programme, from more innovation and value creation (see part 5.2 below) to socially responsible innovation (see 5.3). The initiative will be evaluated within a few years to provide input for adjustments to the initiative.

5.2 Measures to foster greater innovation in the private and public sectors

The scheme for optimisation funding has been very well received by the users, and has been revised multiple times in cooperation with them. The scheme will be continued and is to be considered together with new commercialisation instruments now being established.

New steps will be taken to foster greater innovation in the private and public sectors that is derived from strong academic research. Measures under consideration include:

- enhancing cooperation between academia and the private sector/health trusts;
- mobility programmes between academia and the private sector;
- mentor programmes, in which researcher projects have access to senior private-sector expertise for industry-oriented projects.

5.3 Responsible Research and Innovation (RRI)

New technologies have the capacity to change society in major ways and may solve as well as exacerbate societal challenges. RRI entails devising new work forms in which technologies are developed in broad collaborative arenas with users and a wide array of stakeholders helping to steer the innovation process.

The technology programmes have established a common framework for RRI that formulates new expectations not only for the research organisations but also for the Research Council itself as a responsible societal actor. The RRI framework establishes objectives for increasingly characterising the processes in the research and innovation system as:

- **Anticipatory:** Technologies may potentially have terrain-changing effects that are realised in complex, dynamic interplay with other societal forces. There is lack of knowledge and

¹³ Transdisciplinary cooperation entails collaboration with societal stakeholders in addition to interdisciplinary academic collaboration.

¹⁴ Examples include University of Oslo Life Science, NTNU Biotechnology, and Computational Biology at the University of Bergen.

understanding concerning how to realise this potential in relation to desired societal development.

- Reflexive: This involves employing expertise and capacity to better understand and discuss fundamental, often implicit, assumptions and frameworks of understanding for research and innovation activities, as well as irreducible uncertainty regarding long-term effects. A greater degree of reflexivity is vital in order to provide directionality in research and innovation processes.
- Inclusive: Societal dialogue has long been high on the agenda of the research and innovation system. After a period of seeking to develop various types of dialogue mechanisms, such as people's juries, lay public conferences, consensus conferences and focus groups, attention is now increasingly being directed towards the research environments themselves. What is being targeted are the skills needed to open up research and innovation processes, recognise the limits of one's own knowledge and competence, and the ability to cooperate with other competencies and actors.
- Responsive: Activities involving the first three dimensions are intended to provide continual input and substance to new governance practices. This entails the development of horizontal or distributed governance schemes that encourage collaboration with partners that may be affected by a research and innovation process. There is a need to open up different perspectives relating to dilemmas and irreducible uncertainty. This must take place via broad-based involvement, not only on the part of researchers from different disciplines, but also bringing on board policy actors, including research councils, trade and industry, interest organisations and society at large.

Together, these objectives mean that RRI places new demands on the knowledge base, expertise, capacities and skills at both the individual and institutional levels. Efforts to promote RRI will be enhanced in the next programme period.

5.4 International cooperation

The Research Council's Strategy on International Cooperation states that international activities under the Research Council are to be an integral part of the corresponding national activities. In other words, many ongoing and new biotechnology-related initiatives under the European Research Area (ERA) must be viewed as a part of the overall efforts in biotechnology. Bilateral cooperation with selected countries outside of Europe will be relevant as well.

Norwegian biotechnology research has a strong international footing. Most publication takes place in international journals and incorporates a high degree of international collaboration.¹⁵

The most important arena for international cooperation will be initiatives under the EU's Framework Programme Horizon 2020¹⁶ and its successor, as well as participation in various European Research Area Networks (ERA-NET). During the first programme period, the BIOTEK2021 programme has participated extensively in ERA-NETs, and roughly 30 per cent of the project portfolio is linked to ERA-NET calls for proposals. Participation in new ERA-NETs will be assessed on an ongoing basis. The BIOTEK2021 programme will continue to enable Norwegian R&D stakeholders and companies to build up the expertise and capacity they need to successfully compete in relevant calls.

¹⁵ See the new bibliometric analysis of Norwegian biotechnology research (NIFU Report 2017:5).

¹⁶ Horizon 2020 through the year 2020, to be succeeded by the Horizon Europe Framework Programme for Research and Innovation, under development.

Biotechnology plays a role in projects under many different parts of Horizon 2020, and the Leading and Enabling Industrial Technologies (LEIT) Biotechnology part of Horizon 2020 best mirrors the efforts under the BIOTEK2021 programme. Norway has an excellent return share of the EU contribution under LEIT. The BIOTEK2021 programme has not developed an active distribution of tasks with Horizon 2020/LEIT Biotechnology, but the activities under LEIT Biotechnology closely support the Digital Life strategic initiative.

Projects may use some of their funding under the BIOTEK2021 programme to procure research services or research collaboration outside of Norway. This assumes that the international partner's scientific contribution is essential to the project.

An important part of the BIOTEK2021 programme's activities will be to assess which international programmes and bilateral cooperation should be given priority and to what extent. The programme will continually assess the use of relevant forms of support such as funding for positioning, mobility schemes and institutional cooperation aimed at encouraging effective international collaboration.

6 Cooperation with related instruments

6.1 Unified support system

The BIOTEK2021 programme administers just 20 per cent of the Research Council's investments in biotechnology research. The application and development of biotechnological expertise is extensive within a number of other thematic programmes as well. In addition, the field of biotechnology figures widely in the open competitive arenas such as the FRIPRO funding scheme, the Programme for User-driven Research-based Innovation (BIA), the Centres of Excellence (SFF) and Centres for Research-based Innovation (SFI), as well as the National Financing Initiative for Research Infrastructure. Biotechnology also holds a prominent position in several of the joint international programmes in which Norway participates. To achieve maximum effect, the programme must therefore balance its grant allocations with other existing funding opportunities for biotechnology projects within the four sectors, as well as with the volume and quality of biotechnology research being conducted in each of these sectors.

The development of biotechnological innovation requires a unified support system where industry-oriented projects are systematically followed up based on milestones and with greater flexibility than is currently the case, in order to see fruitful projects to a successful conclusion. The transition to unified management of the Research Council's portfolio, in which new investments will be more closely linked to realising objectives and ambitions, will be constructive and pave the way for greater innovation.

During its initial programme period, the BIOTEK2021 programme has given priority to national and international programme cooperation related to achieving the programme's objectives. Effective cooperation and distribution of tasks promote the efficient utilisation of common resources. Cooperation with thematic programmes and the Programme for Commercialising R&D Results (FORNY2020) lays a foundation for an integrated system of public research and innovation agencies, and makes it possible to address sector policy challenges with larger funding amounts. International cooperation promotes quality in Norwegian research and facilitates efforts to deal with global societal challenges requiring joint action.

The new organisation of programme activities under the Research Council encourages greater focus on an overall perspective in the administration of activities, at the level of both the programme portfolio and the project portfolio. The Research Council's funding instruments are also being revised, and this will create the framework for further activities under the BIOTEK2021 work programme.

The BIOTEK2021 programme will help to achieve and develop more unified management of the biotechnology area at the Research Council. The benefits of organising biotechnology activities as a coordinated initiative across the Research Council, modelled on the IKTPLUSS initiative, should be considered. This would mean that all the Research Council's efforts in this field would form the basis for ambitions and activities in the technology area, and new investments would be governed by active portfolio analysis and management linked to realising agreed-on objectives. This will lead to more dynamic interaction across Research Council programmes, in which allocations under other programmes would exert greater influence on investment decisions under the BIOTEK2021 programme.

Figure 1 shows the BIOTEK2021 programme's role in relation to other Research Council instruments.



Figure 1: The BIOTEK2021 programme has a role between the open competitive arenas FRIPRO, BIA and FORNY2020.

Coordination with the FRIPRO funding scheme for independent projects

The FRIPRO funding scheme for independent projects plays a part in the Research Council's overall strategic funding on biotechnology by financing basic research in the field. The FRIPRO scheme awards funding solely on the basis of scientific merit. Further enhancing interaction between the programmes and FRIPRO and viewing the BIOTEK2021 and FRIPRO portfolios in connection with each other can lead to significant synergies.

Coordination with the Programme for User-driven Research-based Innovation (BIA)

The BIA programme provides funding primarily to Innovation Projects for the Industrial Sector and to some Knowledge-building Projects for Industry, but it does not fund knowledge-building projects in the field of medicine. The programme is a supplement to the thematic programmes and provides funding to companies and areas of specialisation that are not covered by these. Industries of relevance for biotechnology are biomedicine, the process industries and environmental technology. From the outset, the BIOTEK2021 programme has had a clear distribution of tasks with the BIA programme, so that the latter provides funding for Innovation Projects in the field, while the BIOTEK2021 programme provides funding for projects put forth by the research institutions.

Coordination with thematic programmes

A wide range of thematic programmes (e.g. the Research Programme on Sustainable Innovation in Food and Bio-based Industries (BIONÆR), the Large-scale Programme on Aquaculture Research (HAVBRUK) and health research programmes) provide funding for biotechnological research. Increasingly, the research questions being addressed under the BIOTEK2021 and other technology programmes have societal challenges as their starting point, and close, dynamic interaction with thematic programmes is essential. This will facilitate cooperation on larger, integrated projects and make it possible to address broader challenges, as well as provide input on the ability of the various technologies to contribute solutions targeted towards the sector strategies. Moving forward, it will be important to developing this interaction as part of the unified portfolio perspective.

Coordination with other enabling technologies

Biotechnology progresses in step with other enabling technologies, especially ICT but materials and nanotechnology as well. Greater efforts to promote technological convergence are therefore needed. Further developing the enabling technologies calls for constructive dialogue with relevant societal stakeholders, and it is vital to continue ongoing efforts in keeping with the established framework for RRI. It is important to seek more direct organisation of enabling technologies ahead to ensure effective management of boundaries and improved interaction between thematic areas for addressing societal challenges.

Coordination with the SAMANSVAR programme

In its first period, the BIOTEK2021 programme has collaborated with the SAMANSVAR programme on developing a common framework for Responsible Research and Innovation (RRI), and this collaboration will continue.

Coordination with the INFRASTRUKTUR initiative

Biotechnology has an ongoing, significant need for major investment in research infrastructure. The National Financing Initiative for Research Infrastructure (INFRASTRUKTUR) is primarily designed to provide funding for the establishment of infrastructure that supports strategically important research, while operating costs are generally to be covered by the research using the infrastructure (user financing). This creates a basis for effective cooperation between the INFRASTRUKTUR initiative and the BIOTEK2021 programme. Research programmes also have the opportunity to provide funding for establishing infrastructure provided it is of national importance, in keeping with the national strategy for research infrastructure. Research programmes may also fund infrastructure by covering costs related to depreciation of equipment procured by the institutions themselves.

Coordination with the Programme for Commercialising R&D Results (FORNY2020)

The BIOTEK2021 programme has developed close interaction with the FORNY2020 programme, particularly with regard to establishing the scheme for optimisation funding. This funding is designed to build bridges between basic research and proof-of-concept funding under the FORNY2020 programme, and the scheme has been developed in close collaboration with the FORNY2020 programme administration. The programmes have also issued joint calls for proposals to provide funding for innovation projects on cancer research (in cooperation with the Norwegian Cancer Society). There is a need in future to develop more integrated, unified instruments from the research phase to market, where commercially oriented projects are followed up systematically and flexibly in order to see fruitful projects to a successful conclusion. New instruments to support commercially oriented projects are being developed and will likely encompass funding for optimisation projects.

Coordination with the Industrial Ph.D. Scheme

The Industrial Ph.D. Scheme is a dedicated scheme under which companies may apply for funding for their employees to complete a doctoral degree in cooperation with an R&D institution. The scheme provides funding for all subject areas and addresses needs in the field of biotechnology.

7 Anticipated results, impacts and societal outcomes

Continual follow-up and monitoring are necessary to ensure that the programme is developing in keeping with its objectives. The follow-up measures will be set out in the programme's three-year action plans, which are to be revised annually. The programme will be monitored mainly through portfolio analysis and management, where new investments will be more closely linked to realising objectives and ambitions.

7.1 Results and performance indicators

The programme will fund activities and set priorities that lead to a wide range of results within the programme's sphere of responsibility. Below, anticipated results are linked with the programme's different secondary objectives, with suggestions on how to achieve the results.

7.1.1 Promote the development and use of innovative biotechnology expertise and methodologies at top international level

In relation to this secondary objective, the programme will give priority to funding announcements for Researcher Projects, further develop a national generic initiative in the field, and participate in international programme cooperation. Important results of these activities are:

- scientific discoveries and scholarly publications at top international level;
- the national Centre for Digital Life Norway (DLN);
- Norwegian partners in international projects.

Examples of performance indicators:

- quality of the publications as measured by citation frequency;
- proportion of publications at level 2;
- number of doctoral candidates;
- number and proportion of projects based on transdisciplinary collaboration;
- number of publications with authors from multiple subject fields;
- New, long-term networks across scientific boundaries, sectors and institutions.

Examples of performance indicators related to Norwegian participation in international cooperation:

- number of Norwegian partners in ERA-NET projects and other international calls for proposals;
- publications in level 2 journals based on international collaboration, including those with Norwegian partners as lead author and/or last author.

7.1.2 Promote the development and use of biotechnology that leads to innovation and industrial development

In relation to this secondary objective, the programme will give priority to funding announcements for optimisation funding, requirements for innovation expertise and commercial relevance in all projects awarded funding, and development of schemes that promote more collaboration and exchange between companies and R&D environments. These measures are expected to lead to a number of results, including:

- a greater number of high-quality grant applications for proof-of-concept funding;
- expanded and enhanced collaboration between the research community and the business sector as more researchers gain experience from trade and industry;
- project participants take part in competence-raising measures for research and innovation management, commercialisation, etc.;
- patents, licensing agreements and business start-ups.

Performance indicators related to a greater number of high-quality grant applications for proof-of-concept funding:

- higher quality biotechnology-related applications for proof-of-concept projects;
- higher number of biotechnology projects that are granted proof-of-concept funding.

Performance indicators related to expanded and enhanced collaboration between the research community and the business sector/health trusts:

- number of research projects with company participation;
- number of patent applications and patents with partners from research institutions and companies;
- number of publications with partners from both research institutions and companies.

Performance indicators related to project participants taking part in competence-raising measures:

- number of participants in courses, etc., that are funded by the programme;
- proportion of researchers who can document expertise in innovation.

Performance indicators related to patents, licensing agreements and business start-ups based on activities under the programme:

- higher number and quality of notifications from research groups to Technology Transfer Offices (TTOs);
- higher number of biotechnology projects at TTOs;
- higher number of patent applications;
- higher number of approved patents;
- higher number of new products and processes;
- higher number of licensing agreements;
- higher number of business start-ups.

7.1.3 Promote the responsible development of technology that addresses major societal challenges

In relation to this secondary objective, the programme has launched a number of activities, which will be continued and expanded. The programme has focused close attention on development and interdisciplinary collaboration, has set requirements for social responsibility in all its projects, and has established the national Centre for Digital Life Norway (DLN) (including a national graduate-level researcher school) as a strategic spearhead with RRI perspectives cross-cutting all activities. A framework for RRI has been developed in cooperation with other programmes, and all projects allocated funding under the programme must be attentive to the specified RRI dimensions. The programme has also focused considerable attention on the importance of developing the programme's own expertise and practice, and in this context participates in e.g. international cooperation on policy development related to restructuring processes.¹⁷ Performance indicators for desired results will be:

- quality of RRI content in grant applications submitted to the programme;
- proportion of projects with plans for building RRI expertise;
- proportion of projects with integrated RRI;
- new work forms developed within and between the actors.

7.1.4 Promote cooperation, task distribution and highly focused research activity nationally and internationally

Expanding cooperation is a key component of programme activities, and the programme has taken a variety of steps that pave the way for effective cooperation and sound utilisation of resources. These help to achieve the following results:

- The DLN has been established as a national initiative in the field, providing a platform for national cooperation and distribution of tasks for developing Norwegian biotechnology. Through the centre, institutions cooperate on development and utilisation of shared data, expertise and infrastructure.
- The programme has provided funding for many effective meeting places that facilitate dialogue on a common agenda and priorities.
- The programme has participated extensively in national and international programme cooperation to promote effective cooperation and counteract fragmentation.

Performance indicators will comprise:

- further developing the DLN into a sustainable platform for national cooperation on modern biotechnology;
- at least half of the project portfolio supporting highly focused research activity;

¹⁷ The Transformative Innovation Policy Consortium (TIPC) is an international cooperative initiative for developing new innovation policy related to restructuring. The initiative is headed by the Science Policy Research Unit (SPRU) of the UK, with partners including the Swedish Governmental Agency for Innovation Systems (Vinnova), the Finnish Funding Agency for Technology and Innovation (TEKES) and more.

- the range of national research infrastructures, national graduate-level researcher school, national networks, etc.

7.2 Impacts

Results from the BIOTEK2021 programme are expected to have long-term impacts on the development and application of biotechnological research in Norway. Anticipated impacts include:

- Enhanced interdisciplinarity, more Norwegian environments at the international forefront, and expanded collaboration between R&D institutions and the business sector/health trusts have led to a faster pace of innovation and more entrepreneurship. More focus on innovation activities at research institutions is expected in the long run to help to increase value creation as biotechnology is implemented in various segments of the Norwegian business sector and the health care system.
- The programme's RRI-related activity is important for developing the Research Council's practice as a technology investor. The long-term impact of these development projects will be a more responsible innovation system where technologies are developed in broad collaborative arenas and better address society's needs and expectations. This transition requires developing new practices and skills among researchers and research councils.
- Strategic programme collaboration nationally and internationally will make it possible to implement measures with greater impact. Programme collaboration also helps to minimise fragmentation of research funding for applicants and promotes effective utilisation of combined resources by avoiding duplication of efforts in different programmes.

7.3 Societal outcomes

Activities under the programme are targeted towards some results and impacts that will lead to different societal outcomes, assuming they come to pass.

Desired societal outcomes from the programme's activities are:

- Positive contributions from biotechnological research and innovation that solve societal challenges related to health, the oceans, agriculture and industrial processes.
- Biotechnology increasingly contributes to value creation in the Norwegian private and public sectors.
- Biotechnology promotes the transition to the bioeconomy.
- A more responsible innovation system is being developed, one that incorporates the RRI dimensions, where technology and innovation are developed in broad collaborative arenas that include a wide array of perspectives that help to ensure that technology and innovation are implemented in keeping with the interests of society.

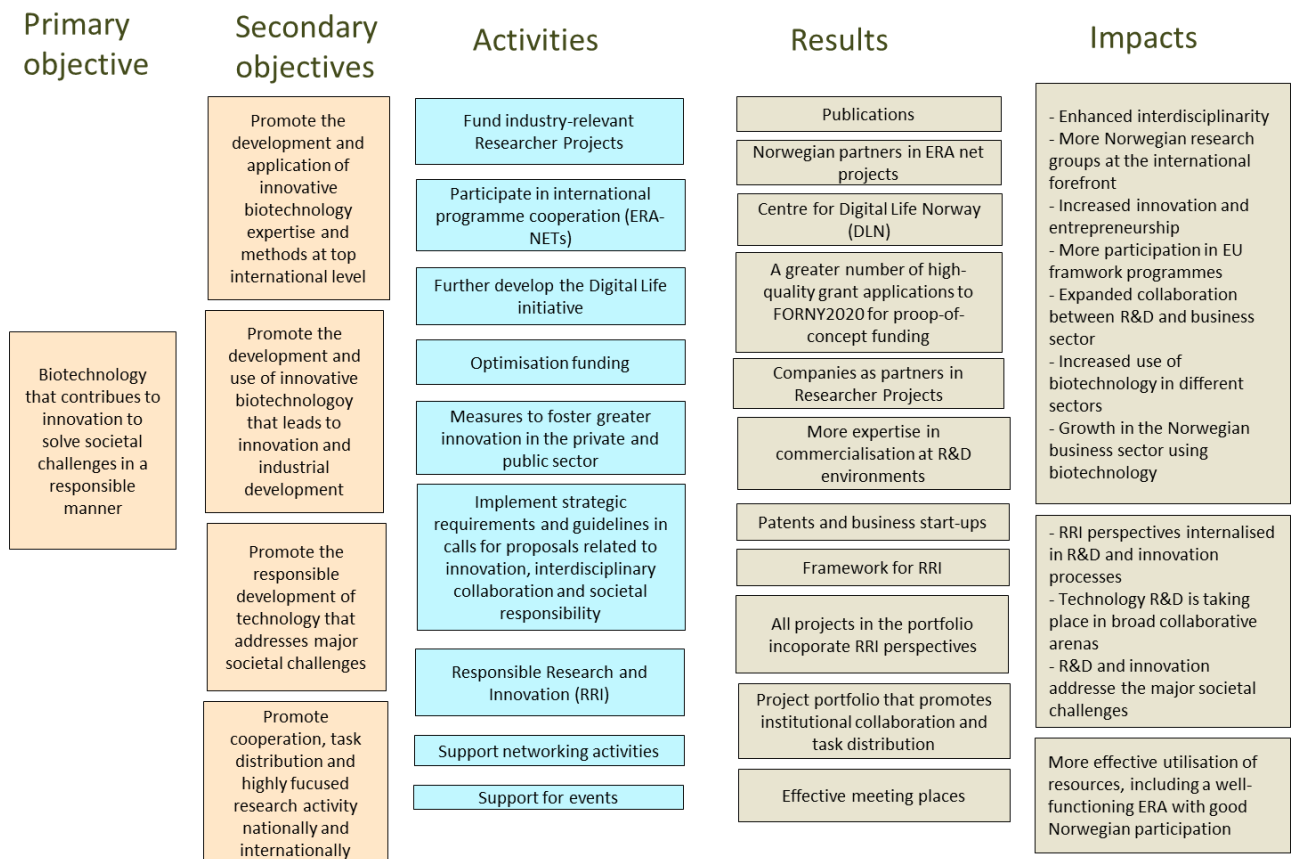


Figure 2: Schematic presentation of the BIOTEK2021 programme logic model.

8 Resources and budget

Allocations to the BIOTEK2021 programme's budget come from the Ministry of Education and Research, the Ministry of Trade, Industry and Fisheries, and the Ministry of Agriculture and Food. In 2018 allocations to the programme are approximately NOK 150 million.

9 Governance and organisation

The BIOTEK2021 programme board is appointed by and reports to the Research Board of the Division for Innovation. The programme will be governed in keeping with the general terms of reference for programme boards. The activities of the programme board must comply with the framework approved by the division research board, including the work programme, action plan, long-term budget and schedule for funding announcements. The programme board's activities must also be in compliance with the Research Council's overall principles and guidelines for the operation of research programmes.

The programme board will have nine members, and have the following profile:

- Five members with business experience, including at least one from the marine, agriculture, industry and health sectors. Members must have experience in establishing business activity based on biotechnological R&D and in late-phase/international market introduction of biotechnology products.
- Three members with experience in basic research/technology development.
- One member with experience in issues related to society and technology.

The day-to-day activities will be run by a programme administration under the direction of a programme coordinator. The size of the programme administration may vary over time, but will include a coordinator, advisers and an executive officer.



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