Call for Grant Applications: Strategic Research Areas

Background

The Government bill on research and innovation proposed increased support for strategic research areas. More specifically, during 2009 to 2012 the additional resources for the 24 strategic research areas will mean an increase of 1800 million Swedish kronor (SEK) to Sweden's higher education institutions (HEIs in the following). This call for grant applications includes 20 of these areas, and the level of increase in grants for the areas during the period will reach SEK 1315 million per year see table. Normally, at least two HEIs will be chosen for targeted initiatives in the respective areas.

The Government used three criteria in prioritising the strategic areas. Strategic initiatives should address:

- research that, in the long term, has the prerequisites to be of the highest international quality,
- research that can contribute towards fulfilling major needs and solving important problems in society,
- research in areas that have a connection to the Swedish business sector.

During the spring of 2009 the Swedish Research Council (Vetenskapsrådet), the Swedish Council for Working Life and Social Research (FAS), the Swedish Research Council for Environment, Agricultural Sciences, and Spatial Planning (Formas), the Swedish Energy Agency (Energimyndigheten), and the Swedish Agency for Innovation Systems (VINNOVA) will manage the call for, and review of, grant applications from Sweden's HEIs in all of the strategic research areas announced by the Government. Decisions concerning funding of the 20 areas covered by this call for applications will be made by the Government.

The agencies can make recommendations to the Government to allocate resources for large national infrastructures within the framework of the strategic research initiatives.

Who can apply?

Applicants for these grants should be one or more collaborating Swedish HEIs. Each HEI can be the main applicant for only one grant application per strategic area. The main applicant bears the overall responsibility for the initiative's construction. The HEI may also be involved with specified parts of one or more other applications in the same area. Collaborating research institutes can be financed from the grants. Researchers may be involved in several applications.

Application deadline

The call for applications will be issued in mid January 2009. The application deadline is March 16, 2009.

Motivation

The Swedish Government finds a need for long-term funding of research in special strategic areas of importance to society and the business sector. Hence, the Government bill addresses initiatives for a range of research areas that have, or may achieve, the **highest quality in an international comparison** and that **concurrently are of strategic importance for society and the business sector**. Several of the strategic research areas mentioned are also suitable for collaborative programmes involving the business sector, where HEIs, public agencies, corporations, and/or institutes take joint initiatives.

Grant recipients and terms of the grants

Applications for funding of strategic research areas should be submitted from the HEI (the main applicant) to the responsible research-funding agency. The HEIs that are chosen to receive grants from the Government's initiative for strategic research areas will receive this funding as an increase to their basic budget appropriation. Two or more HEIs can jointly form constellations and submit joint applications. One HEI is the main applicant, and the co-applicant's share of the application is indicated as a percentage. If the application receives funding, the percentages specified in the application will be used to allocate funds to the respective HEI.

Collaborative projects may include corporations, public organisations, and industrial research institutes. Industrial research institutes may receive part of the funding if this is specified in the grant application.

The increase in funds received by a HEI is coupled with a mission that the institution will develop research in the strategic research area that is of the highest international standard. The mission should be clearly profiled and able to be developed from work that is already in progress. It should be possible for the strategic research area to become one of the most important profiles of the HEI. Striving for scientific excellence should be the foundation for all proposed initiatives.

Implementation of the proposal and how it reflects the intentions expressed in the application will be followed up annually by the responsible research-funding agency. The work will be evaluated after 5 years, which can lead to redistributing the funding among the grant holders in the respective strategic research area. The evaluation will be based on the fundamental goals for the strategic research areas.

Infrastructure aspects

In many areas, access to competitive research infrastructures is decisive for conducting research of the highest quality. In December 2007, the research councils and VINNOVA published *The Swedish Research Council's Guide to Infrastructure*. The criteria for an infrastructure are that it should be of broad national interest, offer the potential for world leading research, and be openly accessible to researchers.

Some infrastructures provide essential conditions for research of the highest quality in several different research areas. These include, for example, the MAX IV synchrotron radiation facility, high-performance computing resources, biobanks, bioinformatics, and national databases and archives in social sciences, medicine, and climate and environmental research.

Criteria, review, and decision

Submitted applications will be judged based on two categories of criteria: 1) that the research should achieve the highest quality in an international comparison, and 2) concurrently it should be of strategic importance for society and the business sector. The fundamental criterion, however, is scientific excellence (existing capacity or the potential to achieve scientific excellence in international comparison).

Based on the criteria in the two categories an overall assessment is made concerning which proposal or proposals that will, within 5 years in the respective areas, be expected to generate the greatest effects in Sweden in terms of:

1. **Highest scientific quality in an international comparison**
   - scientific quality
   - potential for development of the scientific environment
   - how the area is prioritised among the applicant's activities to generate the conditions for scientific excellence
   - strategies to increase Sweden's international scientific competitiveness in the research area.

2. **Strategic importance for society and the business sector**
   - why, and in what way, the research area is, or can become, strategically important for the business sector and society
   - strategies and plans to generate benefits from research findings in the research area
   - capacity and supportive activities to generate benefits from research findings in the research area
   - engagement and participation of the business sector, industrial research institutes, and other community organisations in problem formulation and implementation.

The responsible funding agency along with identified consulting partners (see table) evaluate the grant applications. Panels that evaluate the applications in a strategic research area should be comprised mainly of international expertise. Recommendations from the agencies will be submitted to the Government no later than mid June 2009. The Government will take the decisions on funding and divide the appropriation among the respective grant recipients.

Application contents

(Applications shall be written in English. Font size: 12-point)

1) Executive summary (max. 2 pages).

2) Research programme (max. 15 pages) describing:
   a. the HEI's plans to develop leading-edge research in the area
   b. current quality of the research in international comparison
   c. how the potential for development of the scientific environment is promoted in the research area
   d. career opportunities for young researchers via the initiative
   e. how the area is prioritised in the applicant's activities
   f. in the grant application, the HEI should indicate the need of infrastructure for the proposed research programme. In particular, it should indicate in what way the above-mentioned infrastructures or other infrastructures included in the *Guide* constitute prerequisites for execution, or can contribute to raise research quality and competitiveness in the long term. Furthermore, the HEI should indicate how it would like to be involved in planning, constructing, using, or further developing the infrastructure, or contribute towards building up relevant expertise. The HEI should indicate whether it would like to take special responsibility for all or part of certain infrastructures.
   g. need for expensive equipment
   h. how research will be linked to advanced education and research training
   i. how gender equality and diversity are taken into consideration in the proposed initiative.

3) The application should also describe (max. 10 pages):
   a. why and in what way the research area is or can become of strategic importance for the business sector and society
   b. strategies and plans to generate benefits from research results
   c. capacity and supportive activities to generate benefits from research results
   d. engagement and participation of the business sector, industrial research institutes, and other community organisations in problem formulation and implementation of research results when it is relevant to the strategic research area.

4) When the grant application addresses collaboration with other HEIs, corporations, industrial research institutes, public services, and other community organisations it should also describe (max. 5 pages):
   a. national and international partners to be involved in collaboration
   b. forms and conditions for collaboration between collaborating partners
   c. desired distribution of funds between the HEIs applying for grants via the proposed initiative
   d. how collaboration is expected to affect the development of the research environment.

5) The grant application should include a budget covering the first 5 years (max. 1 page). The budget should specify the sum applied for and related resources needed to implement the research programme,

as well as possible contributions by collaborating partners. If the collaboration includes research institutes, the institutes' share of the total grant must be specified.

6) The application should also describe the research constellation, which can include several principal investigators. Their curriculum vitae (max. 10 CVs of max. 2 pages) and publication lists (max. 50 publications) should be attached. Other attachments should include relevant (from an implementation standpoint) presentations (max. 1 page) of external collaborators (e.g. corporations). The management of the initiative should be described, and the person in charge of this function should be named.

The 20 strategic research areas are:

- Energy (p 7)
- Sustainable use of natural resources * (p 9)
- Effects on natural resources, ecosystem services, and biodiversity (p 11)
- Climate models (p 12)
- Marine environment (p 13)
- Cancer (p 14)
- Diabetes (p 15)
- Epidemiology (p 16)
- Molecular biosciences (p 18)
- Neurosciences, including diseases of the brain and nervous system (p 20)
- Stem cells and regenerative medicine (p 21)
- Care sciences (p 22)
- Nanoscience and nanotechnology (p 23)
- eScience (p 24)
- Materials science, including functional materials * (p 25)
- IT and mobile communication, including future solutions for communication and control systems * (p 26)
- Manufacturing engineering * (p 27)
- Transport research * (p 28)
- Security and emergency management * (p 30)
- Politically important geographic regions (p 32)

Vinnova is the agency responsible for the call and for the evaluation of the applications in the areas marked with *.

Table. Strategic Research Areas 2009-2012 (million Swedish kronor, SEK)

Area	Funding to HEIs 2009-2012				Total	Responsible agency	Consulting partners
	2009	2010	2011	2012	2009-2012		
Politically important geographic regions	15	15	15	20	65	Swedish Research Council	
Energy		50	100	160	310	Swedish Energy Agency	Swedish Research Council
Sustainable use of natural resources		20	30	50	100	Vinnova	Formas
Effects on natural resources, ecosystem services, and biodiversity		25	35	50	110	Formas	Swedish Research Council
Climate models		10	20	30	60	Formas	Swedish Research Council
Marine environment		10	15	20	45	Formas	
Molecular biosciences		65	115	190	370	Swedish Research Council	
Stem cells and regenerative medicine		25	35	65	125	Swedish Research Council	
Diabetes		25	40	70	135	Swedish Research Council	
Neurosciences, incl. diseases of the brain and nervous system		25	40	70	135	Swedish Research Council	FAS
Epidemiology		15	15	25	55	Swedish Research Council	FAS
Cancer		25	40	70	135	Swedish Research Council	
Care sciences		25	40	50	115	Swedish Research Council	FAS
Nanoscience and nanotechnology		30	45	80	155	Swedish Research Council	Vinnova
eScience		25	40	70	135	Swedish Research Council	Vinnova
Materials science, including functional materials		25	35	65	125	Vinnova	Swedish Research Council
Manufacturing engineering		25	35	50	110	Vinnova	Swedish Research Council
IT and mobile communication, incl. future solutions for communication and control systems		45	55	80	180	Vinnova	Swedish Research Council
Transport research		25	50	80	155	Vinnova	
Security and emergency management		5	15	20	40	Vinnova	Swedish Research Council
Total	15	515	815	1315	2 660		

Strategic Research Areas

Energy

In the area of Energy, the Government has identified three strategic sub-areas that can contribute to strengthening the international competitiveness of Sweden and Swedish industry.

These are:

1. *Large-scale renewable electricity production and its integration into the electricity network*
2. *Electric propulsion systems and hybrid vehicles*
3. *Energy combines, research on alternatives to fossil fuels and environmentally sound and climate-sound production of biomass for raw materials and biofuels, including industrial biotechnology*

Research and development in these sub-areas is of significant relevance to the development of industry and is suitable for collaboration with companies, industrial research institutes and other higher education institutions. An application in the strategic area of Energy may contain one or more of the three sub-areas; synergistic effects may also be attainable between the sub-areas.

Large-scale renewable electricity production and its integration into the electricity network

The initiatives cover technology and knowledge which, in the short and medium terms, may lead to an increase in the proportion of renewable electricity production, adaptation of the electricity network to such electricity production, and systems-based knowledge. This sub-area contains bioenergy and wind power but also other renewable electricity production technology that can quickly become more extensive and contribute to attaining energy policy goals. These production techniques are normally amenable to limited regulation, and the area therefore also includes research on how a sharp increase in the proportion of intermittent generation affects the electricity network and how transmission and distribution networks can be adapted to new circumstances. Research on hydropower as a regulating resource and improved control and monitoring functions also falls within this area. This sub-area covers both technical and non-technical research, for example systems-based knowledge of sustainable use of resources and the mutual interaction of systems.

Electric propulsion systems and hybrid vehicles

The overarching aim of this sub-area is the development of electric propulsion systems for commercially competitive electricity-based vehicles such as plug-in hybrid vehicles. This area of research covers several applied disciplines, such as batteries or other energy storage technology, electric motor technology, power electronics, control systems at various levels from battery monitoring to control of electric vehicles, and working with the electricity network in the recharging phase. This must be coupled with fundamental development of materials, mathematical models, production technology for new electric

propulsion systems and testing and demonstration of prototypes with the aim of creating competitive products and production units.

Energy combines, research on alternatives to fossil fuels and environmentally sound and climate-sound production of biomass for raw materials and biofuels, including industrial biotechnology

This sub-area principally relates to research on, and technical development of, cost-effective and energy-efficient simultaneous production in industrial processes that entail refining of the renewable raw material into different products. These products can, besides second-generation biofuels, be paper, heat and renewable industrial raw materials. This sub-area also encompasses research with results that may affect the availability and price of fuel raw material, as well as how raw-material availability can be increased without an unacceptable impact on the environment. The research should focus on topics with strong industrial interest. Sweden is very well placed to play a leading role in the development of both vehicle biofuels and materials based on renewable raw materials due to the availability of raw materials and outstanding research in areas such as energy technology, chemical biology, biological chemistry, bionanotechnology, microbial biotechnology, plant biotechnology and process and manufacturing technology.

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Sustainable use of Natural Resources

A large proportion of Swedish industry depends on natural resources, mainly from forests and mines. Long-term research focusing on innovative and sustainable use of these natural resources is important in mitigating climate change and strengthening Sweden's competitive edge in the global marketplace. Strategic research is important in bringing about new business opportunities in the face of climate change and increased global competition.

Mineral resources

Sweden's long tradition of mining and quarrying, development of production technology and resource efficiency linked to high environmental standards implies that we should play a leading role in the European and global development and disseminate technology in various forms. Earth sciences and engineering are crucial to maintain and develop world-leading expertise for that role. The challenge is to develop technology that gives priority to low-resource production of raw materials, innovative products with high added value and minimal impact on health and the environment.

Ongoing, long- term collaboration with industry is needed in order to define the national and regional potential for developing domestic resources. Efforts should focus on technologies, including finding new deposits, plus new extraction and production methods to increase resource efficiency whilst minimising environmental impact. These should include waste management and research which aims to reduce energy consumption in mining. In the context of finding, using and preserving resources, groundwater for water supply is also an important natural resource to consider.

National and international collaborations and the recruitment of undergraduate and graduate students, PhD students and foreign researchers are prerequisites for high quality research and long-term value-creation. This is especially important for relatively small nations like Sweden.

Forests and other plant material

Forests and sustainable forest management play a key role in the work of reducing greenhouse gas emissions to the atmosphere and providing renewable raw materials for industry. Research efforts are therefore needed for more efficient production methods, including tree breeding and mass propagation of plants, forest regeneration, improved forest management systems and a more efficient, customer-orientated supply of forest raw materials including logging on non-frozen land. This research must be integrated with research efforts on trees with tailor-made characteristics and the efficient conversion of raw materials into innovative, high value added products.

Further research is also needed on sustainable forestry with multiple objectives and increased knowledge on forest ecosystems in the realm of climate change. In this context, it is important to secure data from longer time series, including ensuring the maintenance of permanent and long-term research plots. Increased use of biomass also means a greater impact on ecosystems. There is a need for more in-depth research on the impact of removing the biomass from forested

land and how this affects biodiversity, greenhouse gas emissions and nutrients. Other important aspects include the forest ecosystem, its resilience and the role of forests in recreation.

Stimulating the development of biomass production on Swedish agricultural land requires coordinated R&D efforts to develop non-food agricultural crops by plant breeding and green biotechnology. Using modern biotechnology, genetically improved and modified plants can be developed faster and their cultivation may become common in Sweden. Thus, basic knowledge is needed on the breeding and production of non-food crops including new cultivation systems, as well as consequences of using new plant varieties on biodiversity and conventional forms of cultivation.

In this strategic field, needs for building up infrastructure have been identified. See link.

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Effects on Natural Resources, Ecosystem Services, and Biodiversity

Climate change impacts greatly on natural resources, biodiversity, and ecosystem function, dynamics, and services. This also changes the conditions for agricultural sectors. Substantial gaps exist in the body of knowledge needed for adaptation and mitigation. Extensive research is needed on the possible effects on natural resources and ecosystems as well as consequences for the agricultural sectors. This research should preferably use a multi- or interdisciplinary approach.

Research of high priority:

- How natural resources and ecosystems have previously been affected by major climate changes
- The adaptability of species and ecosystems in a long-term perspective
- Short- and long-term effects of climate change on natural resources, biodiversity, ecosystem function, dynamics, and services
- Adaptation and mitigation for sustainable management of natural resources, biodiversity, ecosystem function, dynamics, and services
- Consequences of climate change for the agricultural sectors, principally agriculture, forestry, and reindeer herding
- Adaptation and development of production systems in the agricultural sectors, e.g. cultivation systems, silviculture, and control of pests and diseases
- How emissions of greenhouse gases and loss of plant nutrients can be reduced without negative environmental impact.

In this strategic field, needs for building up infrastructure have been identified. See link.

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Climate Models

There is an urgent need for increased knowledge in the area of future climate change and its scope, causes, and effects. Global and regional climate models are increasingly important instruments for describing possible future scenarios. Future climate models need to be expanded and improved to provide more reliable and more detailed predictions. We must better understand the natural climate system, couplings between different parts of this system, and what is happening and might happen in the different regions, such as the Arctic, where changes appear to be occurring most rapidly. In other words, we need to learn more about both the causes and effects in the complex interaction between different processes in the climate system.

The models must describe possible fluxes of greenhouse gases and climate effects on, e.g. the biosphere, the cryosphere, and the hydrosphere. The purpose is to gain greater insight into the regional and global effects of climate change as well as inherent feedback mechanisms.

To accomplish all of this we need more reliable data, both meteorological and geological, with better geographic coverage and greater knowledge and techniques to interpret these data. Development and fine adjustment of new generations of models is urgent, as is development and stronger positioning of international cooperation, including EU and the Nordic region. Swedish climate research is strong, and Swedish contributions to international debate and research have been accorded great respect. The ambition is that Swedish research should remain successful within this rapidly growing international field of research.

The future scenarios and their consequences must be communicated to society so that appropriate action can be taken to adapt to climate change and to create policy instruments that help reduce emissions of climate gases.

In this strategic area, needs for building up infrastructure have been identified. See link.

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Marine Environment

Our knowledge of marine ecosystems is generally inferior to our knowledge of terrestrial ecosystems. The sea has many functions in terms of aesthetic values and recreation, provision of ecosystem services, and production of fish and shellfish. The impact of climate change on these functions is poorly understood, but is expected to be significant. A thorough understanding of the processes that control fluxes, e.g. in nutrients and pollutants, is crucial for sustainable management of ecosystems and natural resources and to adopt measures that have the effects intended. Knowledge concerning the sustainable management of fish stocks, as well as effective and informative monitoring of the sea, will also be of utmost importance for sustainable management.

Research of high priority:

- Research on complex interactions and processes in the marine environment
    - Structure and function of the ecosystems, cycling and transport of e.g. nutrients and pollutants
    - How processes on land affect the sea
    - How different environmental changes interact

- Research on remedial measures and recovery, and research to support management decisions
    - Measures to reduce the impact of eutrophication in the Baltic Sea and the Kattegat-Skagerrak area
    - Support to achieve environmental objectives
    - Support for a national strategy to implement the Baltic Sea Action Plan

- Research to support environmental monitoring
    - Development of programmes, methods and technologies for environmental monitoring, and analysis of environmental monitoring data
    - Identification of new environmental threats

- Research on fishing and aquaculture
    - Effects of different management measures for fishing, and the impact of fishing on marine ecosystems
    - Increased knowledge for development of aquaculture

In this strategic field, needs for building up infrastructure have been identified. See link.

Contact

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Cancer

In Sweden, cancer is the most common disease-related cause of death in age groups up to 75 years. Development of targeted drugs with high specificity and a focus on individual-based therapy are important trends in the medical treatment of cancer. Parallel with new treatment methods, a focus on preventive aspects is crucial for reducing cancer incidence in the future. This includes environmental and lifestyle factors as well as the development of better diagnostic and screening methods for early detection of malignant tumours.

The mapping of the human genome and the rapidly increasing understanding of different cell functions provide new insight into the uncontrolled growth and invasive characteristics of cancer cells. Combined with clinical and translational cancer research, this knowledge can lead to more effective treatment and better cancer prevention. Epidemiological cancer research plays an important role in this context.

Swedish cancer research is on the forefront in several areas, e.g. molecular studies on uncontrolled growth of tumour cells, tumour immunology, and genetic and epidemiological studies to identify associations between heredity and environment in cancer incidence. There is also a major potential for research on radiation biology and development of precision instruments in radiation therapy. Clinically oriented cancer research of correspondingly high international quality is essential to convert new knowledge into preventive care and new treatment methods in the health services.

It is also essential to assure long-term development of expertise in all areas of Swedish cancer research. In established environments where prevention, care, high-quality research, and education are integrated, clinical cancer research can contribute with new aspects concerning the disease course and therapeutic options. In parallel, the results of basic research can be more rapidly applied within diagnostics, therapy, and patient care. Access to a solid infrastructure including advanced technical platforms, well-developed biobanks, health data registers, and patient material is of utmost importance. Given these conditions, improving the efficacy of Swedish cancer research can lead to substantial benefits within health services and the business sector, along with better public health and reduced suffering for the individuals affected.

In this strategic field, needs for building up infrastructure have been identified. See link.

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Diabetes

The prevalence of diabetes is increasing in large parts of the world, and increasingly younger individuals are being affected. This is largely due to the increases in overweight and obesity, which are directly associated with development of type 2 diabetes and the metabolic syndrome. Although drugs and lifestyle changes are used to treat type 1 and type 2 diabetes and the complications associated with both diseases, neither a cure nor fully satisfactory medical treatment are currently available. Additional and more effective treatment options are needed.

Swedish research groups have made major contributions to current knowledge about diabetes and lifestyle-related diseases. Continued investment in this field can secure the standing of Swedish researchers and further increase Sweden's international competitiveness.

Diabetes research ranges from basic research in cell and molecular biology and near-patient clinical research to areas such as public health, health care sciences, and food. It is also an area that includes several therapeutic disciplines.

Research in recent years has revealed new, potential opportunities to prevent, cure, and treat diabetes. These include transplantation biology, where the hope is to replace or restore dysfunctional insulin-producing beta cells with cells harvested from donated organs or developed from stem cells. Other possibilities include identifying new targets for pharmacotherapy, both as regards diabetes itself and its commonly occurring complications, e.g. damage to the cardiovascular system, kidneys, eyes, and nerves. Identifying risk factors and improving treatment of the underlying causes of the disease linked to, e.g. lifestyle and genetics, could also present new opportunities for preventing the disease and its complications. A particular strength in Sweden is the opportunity for long-term follow-up through various registers and biobanks, as well as clinical and epidemiological studies.

In summary, there is a need for improved treatment methods and better possibilities of preventing diabetes and its complications. This can be achieved through basic studies of molecular mechanisms as well as near-patient clinical research.

In this strategic field, needs for building up infrastructure have been identified. See link.

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Epidemiology

The overriding goal in epidemiological research is to monitor and prevent disease and ill health. By identifying disease causes and transmission pathways, research can build a foundation for analysing the scope, distribution, trends, and risk factors concerning different health problems in the population. Sweden has unique opportunities to conduct this type of research because of access to certain infrastructures, e.g. the system of personal identification numbers linked to various registries, databases, and biobanks.

Epidemiological research has gained increasing attention internationally and is of major importance to strong areas in Swedish research, e.g. public health and community medicine. Causal factors involving the environment and living habits have been successfully studied through epidemiological research for some time, and in pace with the rapid advancements in molecular biology more genetic factors are being studied in relation to disease prevalence. Inequality in health, and the social determinants of public health, comprise other important aspects of epidemiological research. Epidemiological methods have also been used successfully in clinical and pharmacological research, e.g. to study treatment outcomes, prognoses, and side effects. Epidemiological research is an important tool for reducing the prevalence of many major problems in public health and community medicine. Epidemiological concepts, measures, and methods have come to play an important role for social considerations in evaluating health problems, in many health economic analyses, in decisions on prioritising interventions, and in assessing the effects of interventions.

Epidemiological research is also important in addressing threats to global health, e.g. in analysing a new disease panorama of pandemics and the spread of resistant bacteria or new types of virus. Hence, there is a need for research aimed at creating new, more sensitive, and more rapid systems to identify outbreaks or trends in infectious diseases and to evaluate the effects of different interventions. An important part of combating infectious diseases and pandemics involves the development of new vaccines, where epidemiology is needed to assess the effectiveness of various vaccines. Another rapidly growing problem concerns the increased use of antibiotics and the increase in resistant microorganisms, where epidemiology will be important in selecting the most effective countermeasures.

Epidemiological research depends heavily on well-functioning infrastructures, and the combination of Swedish biobanks, registers, databases, and scientific expertise represents a unique and invaluable resource for Swedish research in this field. In recent years, strategic investments have been made in computing through developing biostatistics, bioinformatics, and systems biology. Goal-oriented investments have also been made in informatics, e.g. biobanks. However, much remains to be done to create the integrated infrastructure necessary to handle and analyse data from different sources that concern molecules, cells, patients, and populations. Also, it is of critical importance for Swedish medical research that biobanks in Sweden can develop at a pace and in a direction that enables Swedish research to remain competitive internationally.

In this strategic field, needs for building up infrastructure have been identified. See link.

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Molecular Biosciences

Mapping of the genetic material in animals, humans, and plants represents a qualitatively new step in biological research. It has led to new methods of studying genetic activity in healthy and diseased tissue. Unique model organisms have been used to gain deeper understanding of basic functions and disease mechanisms. Advancements in methodology offer an enormous potential for both basic biological research and applications in biotechnology. The latter includes possibilities to modify genes, rectify tissues in plants, animals, and humans, and produce new products for diagnostics, pharmaceuticals, and plant and forest protection.

The basic goal of research on genes and protein functions is to understand how gene expression is regulated in normal and pathological states and to map where, when, and how RNA and proteins are expressed. This research offers great potential to discover new disease markers for diagnosis. Understanding the role of individual proteins requires extensive knowledge about their structure and how they interact with other molecules. Most proteins are modified, which often regulates their biological activity. New knowledge in these areas makes it possible to understand physiological and pathological processes at a molecular level.

Systems biology builds on two types of knowledge; in part concerning genes, proteins, and metabolites in cells and in part concerning information technology. Research in genetics, molecular biology, and cell biology generates a tremendous volume of data, which cannot be interpreted without multidisciplinary advancements. This involves systems analyses of the complex networks behind sophisticated functions in biological systems under normal conditions or in disease. In the long term it will enable the development of new forms of treatment and individualised pharmacotherapy.

Globally, infectious diseases claim many lives. Multiresistant bacteria and new virus types constitute rising threats that require ongoing research, e.g. in microbiology and immunology. State-financed research should address diseases with a weaker commercial potential that primarily affect poor countries. Greater understanding of pathogenic mechanisms, virulence factors, and the immune system can lead to new approaches towards combating infectious diseases. This will require collaboration among different disciplines, and there will be a continuing need for both basic and applied research in this field.

Sweden is prominent in research concerning molecular biosciences and also has a strong potential to secure a leading position in the future. In this respect, Sweden has an advantage by virtue of its large biobanks and extensive disease registers. Continued investment in molecular biosciences, in combination with clinical research, is needed for the country to extend its leading international position in development of diagnostics and new pharmaceuticals. Such investment could possibly include new laboratories of national interest that would serve as a base for research in the field, also at other universities and university colleges. Given the importance of the field and the magnitude of the total investment in this strategic area, several higher education institutions should come under consideration, depending on the results of the evaluation.

In this strategic field, needs for building up infrastructure have been identified. See link.

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Neurosciences, including Diseases of the Brain and Nervous System

Disease and injury of the brain and nervous system affect people of all ages and in all parts of the world. For the individuals affected, this often means a lower quality of life, severe functional impairments, long periods of rehabilitation, and fewer opportunities to function in the labour market. The growing percentage of elderly, and hence the increasing number of people in Sweden with dementia and neurodegenerative diseases, places a greater strain on society and its care institutions. Likewise, neuropsychiatric disorders, neurological diseases and injuries that occur early in the development of the individual, and substance abuse and dependence generate costs not only for society but also for the individual and the family.

Research in neurosciences aims at understanding the development and function of the nervous system and the diseases and injuries that affect it. This knowledge can enable advancement towards new, more effective drugs and other treatment methods and tools to facilitate research and treatment. In these areas, Swedish research in both basic and clinical neurosciences has achieved major success and holds a strong position internationally.

Despite the expansion of knowledge, many of the normal functions of the brain and nervous system remain relatively unknown, and diseases and other disruptions in the functions of these organs are among the major challenges facing medical research. Recent findings, e.g. in basic research, offer hope that great advances are possible and can lead to improved clinical treatment. Important advancements have also been achieved in research on learning and higher cognitive function.

Diseases of the brain and nervous system constitute areas where a major initiative to achieve reciprocal exchange between basic research, clinics, patients, need, and innovation could result in substantial social and economic benefits. Therefore, applications should encompass research ranging from basic levels to clinical applications and should describe activities aimed at strengthening the connection between basic research, clinical application, and innovation.

In this strategic field, needs for building up infrastructure have been identified. See link.

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Stem Cells and Regenerative Medicine

Basic stem cell research leads to knowledge of how different cell types are developed, which contributes towards understanding how stem cells can be used in new therapies and towards explaining the incidence of diseases. Hence, stem cell research has potential applications in treating many different morbid conditions. More knowledge is needed, however, to direct stem cell differentiation to various tissues and make it possible to treat diseases and injuries.

Sweden is far advanced in research on different types of stem cells and in cell therapy for treating certain patient groups. It is essential to prioritise and support research, based on new knowledge, concerning whether stem cells can prevent, ameliorate, and possibly cure serious, widespread diseases. This also applies to producing specific cells to counteract deficiencies in organs for transplantation as well as for other applications in health care.

Swedish research has established and developed human embryonic stem cell lines, and Sweden is one of the countries having the most such lines in the world. Many other types of stem cells, of both adult and embryonic origin, have been characterised in Swedish laboratories and clinics. Swedish researchers have developed refined culturing systems for stem cells, which enables their use in treating patients. Mapping of the different stages, from stem cells to different precursors of specialised cells, opens new opportunities to develop drugs that can regulate the formation of specific cells. An area of application is regenerative medicine, where stem cells can potentially be expected to replace cells, or repair or regenerate damaged tissue in the body. Stem cells and related technologies can also be used to assess drug candidates, e.g. as regards toxicity.

Stem cell research in Sweden has attracted international attention, and investment in the field can be expected to give large groups of patients greater hope for new treatment methods in regenerative medicine.

In this strategic field, needs for building up infrastructure have been identified. See link.

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Care Sciences

The demand for health services will continue to increase in the future, in part due to the increasing share of elderly in the population. The challenge is to effectively prevent ill health through efforts in health promotion and prevention while assuring that medical interventions, care, and rehabilitation are of the highest quality. Not least it is important to expand the opportunities for care outside of hospitals, e.g. by developing IT-supported health services, long-distance care, and home health services.

Care sciences research has a broad appropriation to meet this challenge. The research issues focus on the concept of health, with three basic orientations: health promotion/prevention, care services, and rehabilitation. Research concerning health promotion and prevention of ill health may, for instance, be oriented towards helping people change their habits and lifestyle, or acquiring knowledge to form the foundation for community planning projects. Such research also includes questions on how to help groups of individuals, e.g. the elderly and people with functional disabilities, remain active and involved in the community. The second basic orientation addresses questions on how to reduce suffering through care and support of patients and their families. The third orientation addresses questions on rehabilitation of the sick and injured, where the goal is for individuals to regain activity, involvement, and health. Broad research addressing these three orientations, with health in focus, concerns questions on the organisation and practical delivery of care, which affects health care costs and outcomes. There is a need for research at all levels in health care, including studies of care systems and health economics.

In summary, research in care sciences includes studies of problems and interventions in a context of health care as it relates to human health, quality of life, activity, and involvement, as well as care and social services for people in different contexts and environments.

Care sciences research is a practical field, and the association between research and practice is a central challenge. Care sciences research has developed strongly in Sweden and maintains good quality by international standards. However, many researchers in this field will retire during the next decade, and continued development of expertise will be required to maintain and strengthen Sweden’s competitive position internationally.

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Nanoscience and Nanotechnology

Nanoscience and nanotechnology constitute a rapidly growing research field that has already given rise to several new technical and scientific concepts. Nanoscience and nanotechnology involve many different activities that span across physics, chemistry, biology, technology, and medicine and include both more fundamental basic and more applied research. Research in nanoscience and nanotechnology concerns basic study, understanding, and control of phenomena and processes that arise when the spatial dimensions of materials and components are on the scale of a few nanometres. Examples of such activities include nanostructured materials, nanoelectronics, nanosensors, nanomagnetism, nanooptics, nanoparticles for targeted drug release, carbon nanotubes with their diverse areas of application, and quantum computers. An important component in the research field is the development of new and advanced methods for analysis, measurement, and processing.

The higher education institutions that can be considered for grants in the strategic area of nanoscience and nanotechnology must demonstrate:

- Good in-house resources for activity in the areas of analysis, modelling, and methods of measurement, characterisation, synthesis, and processing
- Examples of in-house development of advanced methods of analysis, measurement, and processing.

In addition, the higher education institution should specify whether it intends to conduct the research in collaboration with other Nordic countries within the framework of the proposed Nordic research programme on climate, energy, and environment.

In this strategic field, needs for building up infrastructure have been identified. See link.

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eScience

The development of eScience has given the research community an opportunity to pursue scientific questions that, due to their complexity, cannot be studied without powerful computer-based resources. Furthermore, eScience plays a decisive role in the development of several areas of application, e.g. astro- and particle physics, biological and medical research, ecosystem research, complex technological systems, climate research, and material science. Also, eScience is important in research that employs large, often distributed databases, e.g. in bioinformatics, health care informatics, epidemiology, social science studies grounded in demographic databases, and linguistics.

In different areas of application, a wide variety of methods and tools are needed to make it possible to utilise computer-based research tools. The toolbox of eScience is developing rapidly and is dependent on fundamental research in a wide range of subjects, primarily within computing and computer science.

The basis for eScience is the infrastructure (eInfrastructure) that comprises resources for high-performance computing, large-scale storage resources, and local and global computer networks. Also, eInfrastructure involves the development and maintenance of large-scale databases.

Higher education institutions that can be considered for grants in the strategic area of eScience must have documented strengths in the following areas: Research in one or more of the areas that develop methods and tools for eScience applications. The research areas that are primarily referred to are computer architecture, algorithms and database techniques, numerical analysis, advanced parallel programming, visualisation, research concerning the use of distributed resources, development of grid technology, and e-security and integrity. Also information and IT architecture, in close connection with the above-mentioned areas, can be relevant to the grant application. The relevance of the research as regards its applications is of central importance for evaluating the grant application, and documentation of implementations carried out is a merit.

Research in one or more of the application areas of eScience. In the assessment for awarding a grant, substantial importance is attached to collaboration between the research activities within an application area and one or more of the above-mentioned areas of method development.

In this strategic area, needs for building up infrastructure have been identified. See link.

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Materials Science, including Functional Materials

Developed societies and industry with a capacity for development and adaptation to new circumstances are always associated with excellent research into materials science. This research has many different focuses and often involves close collaboration between different disciplines, such as electronics, physics, chemistry, medicine and mechanical engineering.

The materials of the future should contribute to societal goals such as reduced climatic impact and reduced dependence on fossil oil and other non-renewable resources. They thus need to be functional, safe, recyclable, energy-efficient and increasingly based on renewable raw materials to contribute to a reduced environmental impact in terms of life-cycle. Key areas for materials research along these lines are the characterisation of materials' structure and properties and the relationship to functions during use.

The interaction between research and industry is crucial to the development of materials with tailor-made properties which address the needs for strategic functions as well as relevant societal and environmental goals. For such an interaction to be efficient, the research must be set in a context. The context may include everything from identifying strategic needs to development of production methods to establishment of mechanisms for the transfer of knowledge and ideas on the design of new materials and components.

In this strategic area, needs for building up infrastructure have been identified. See link.

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IT and Mobile Communication, including future solutions for communication and control systems

IT and mobile communication (also called Information and Communication Technology or ICT) is enabling development within the majority of Swedish industries: telecommunications, automation, transportation, defence, security, environment, energy, health and nursing, trade including the financial sector and food production. The ICT industry is also in itself a central part of Swedish industry.

ICT is a major but still rapidly growing research field which has given rise to a number of new technological and scientific concepts. ICT comprises many different aims, spanning research into materials, components and systems solutions for future IT infrastructure and IT applications and products and services. This concerns on the one hand explorative research driven by inspiration and curiosity and on the other hand research based on a development approach related to needs and practicalities. Overall research areas include computer science, computer technology, electronics, photonics, signals and systems. Specific examples include photonics, nano- and microelectronics, semiconductor engineering, radio engineering, sensor engineering, automatic control engineering, systems design, systems integration, software-intensive systems, mobile radio systems and IT and information security.

In this strategic area, needs for building up infrastructure have been identified. See link.

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Manufacturing Engineering

The ever-increasing globalisation and new environmental and sustainability conditions are bringing pressure on creating new knowledge in manufacturing technologies, materials processing and product development methods as well as the ability to develop, handle and optimise increasingly complex production systems. The wide area of manufacturing engineering is highly applied and research is often carried out in cooperation between relevant actors from academia, research institutes and industry. Research fields benefit a multitude of sectors and results are often verified and implemented in existing industrial structures. Universities play a vital role in delivering state-of-the-art-knowledge and skilled people, especially in Sweden with its emphasis on manufacturing complex, high added value, engineering-based products as well as running advanced processes. New manufacturing technologies, processes and methods can be the foundation of future successful business areas through research based on new ideas and radical innovation.

Specific criteria

The proposal must address one or more of the following sub-areas:

1. Manufacturing technologies and methods.
2. Product development technologies and methods.
3. Production systems development.

If the proposal has a strong base in area 1) Manufacturing technologies and methods, it must address how the proposal relates to the “Swedish National Research Agenda” jointly proposed in 2008 by the Association of Swedish Engineering Industries, the Swedish Production Academy and Swerea IVF.

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Transport Research

An efficient transport system and good reliability are necessary prerequisites for welfare and economic growth. At the same time, the negative impacts of transport on health, climate and environment must be reduced. This involves a major challenge but also good business opportunities for environmentally-orientated proactive Swedish industry.

Swedish transport research is of good quality. However, one deficiency is the lack of holistic thinking in which different research disciplines collaborate in order to find cost-effective solutions for the needs of society and industry. In addition, there is no comprehensive climate-oriented research based on an inter-modal approach and the creative and innovative perspective we need to solve the challenges we face. It may be a question of developing radical new technological solutions for things like city traffic, railway traffic, flights and shipping. In the long-term such research is required in order to complement the technical research within the vehicle and vessel systems being conducted in Sweden today.

Improving the circumstances of internationally competitive transport research needs reinforcement to complement the existing expertise and agreed measures and benefit from them. Three areas covering all forms of transportation have been given priority: transport policy, efficient transport systems and traffic safety.

Transport policy

Transport policy influences all transport activity. If environmentally adapted technology is to gain a market, there has to be an effective control system which is also market-driven. Of major importance to the development are demand aspects and other market-related issues. Furthermore, innovative solutions are required for energy-efficient construction, and usage and maintenance of infrastructure. Increased knowledge about the interaction between infrastructure and the transformation of society is needed in order to clarify the circumstances under which new infrastructure contributes to sustainable growth.

Transport systems for efficient and long-term sustainable transportation and customer-adapted logistics

The transport system must be improved in order to meet increased environmental requirements and costs, and increased complexity. More knowledge is required to contribute to the development of an efficient and long-term sustainable transportation system. Achieving transport efficiency requires new knowledge which creates progress within technology, vehicle concept, systems and products and supporting data for regulation and organisational changes. This provides the conditions for more attractive and efficient solutions relating to passenger traffic and public transport as well as goods transport and logistics systems, plus a more optimised utilisation of the transport systems for all forms of transport modes. The reliability, predictability and robustness of the infrastructure are other important areas which facilitate efficient transport systems adapted to future climate change and requirements for environmental, social and economic sustainability.

Traffic safety

Traffic safety has major socioeconomic and industrial importance. There has been increased attention in recent years on new automotive technological systems to prevent accidents. However, vehicle-based solutions are not enough. The effectiveness of the systems requires a multidisciplinary approach. When the cities are renewed, they must become more attractive and offer a safer and healthier living environment. Many of the problem areas in traffic safety have potential to be generally applicable to all forms of transport. There are the fundamental conditions for an increased transfer of knowledge between different modes of transport. Innovation is needed to find solutions which cannot be achieved by traffic safety as a one-dimensional issue of automotive engineering. A further challenge is integrating several different perspectives in which traffic safety is one of a number of quality aspects.

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Security and Emergency Management

The overall objective of research and innovation within the field of security and emergency management is to bring about a safe, secure, open and democratic society with well-functioning institutions on a national, regional and local level as well as internationally. There have always been risks, threats and crises, but globalisation brings new challenges and a requirement for flexible preparedness; being ready for and preventing a wide range of crises, managing serious events as they occur and acting effectively during the subsequent reconstruction phase.

Successful security and emergency management relies on a broad knowledge of technology, methods and processes. Further research is needed into a number of areas so that "old" as well as new knowledge can be utilised and applied in civilian and military contexts. The following are examples of such vital areas:

- *Communication of threats and risks, including sociocultural conditions and human behaviour*. Surveys and analysis are required in order to understand and predict the causes of risks and threats, reduce vulnerabilities, maintain the function of society and prevent and manage serious events (such as climatic and antagonistic threats as well as pandemics).
- *Efficient collaboration in a crisis or disaster.* Managing defence, rescue, evacuation and health care requires knowledge of a range of areas and the interaction between them.
- *A relevant and coherent status report in the event of crises or disasters*. This requires technology and knowledge of such things as warning, decision-making and other systems supporting actors at various levels and in different sectors of society.
- *Identification of risks associated with human behaviour and capability to detect and prevent antagonistic threats, crime or terrorism*. The required knowledge may relate to systems, methods and technology required to detect weapons and chemical, biological, radiological, nuclear and explosive substances (CBRNE), e-terrorism etc.
- *Protection of critical infrastructure.* This relates to the physical infrastructure as well as infrastructure types such as a functioning economic flow and decision-making structure etc.

The field requires an interdisciplinary and multi-faceted approach since it embraces many aspects such as the development of new knowledge on which cultural, ecological, climatological, socioeconomic and other conditions in society pose risks and threats. It also requires interdisciplinary and multi-faceted approaches in order to generate technology, services, models and methods to prepare for, prevent and manage crises and reconstruction following serious events. Research and innovation in the area are strongly promoted by a broad collaboration between academia and industry, the state, local authorities, county councils and the Swedish emergency services. The fundamental purpose of the collaboration is to raise the quality of research and enable knowledge to spread and be utilised.

Research to enhance emergency management and bolster security should tackle a broad spectrum of risks, threats, crises and disasters. This means that it should be interdisciplinary or multi-faceted and aim to increase the use of knowledge in terms of how society can prepare for and prevent crises, how society may deal with these, if and when they arise and how security can be restored and society reconstructed after a crisis.

Further requirements of the research are that:

- it should be sufficiently broad so that its results can meet overall sector needs from private as well as public activities
- it should relate to the systemic and organisational level as well as the individual level
- it should be clearly set in a global context.

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Politically Important Geographic Regions

The Swedish Research Council is issuing a call for basic research addressing regions that have become politically and economically important in the global economy. Regions intended in this call are Russia and the Middle East. Research on such regions requires integrated knowledge of the cultural, social, religious, and political conditions in the region, including the region's geography and economy.

Research of the highest scientific standard is eligible for funding. We welcome research that takes a broad perspective as well as systematic comparisons and comparisons with a longer time perspective. There is a need for greater knowledge concerning how historical, religious, political, and secular motives interact. This could involve, e.g. trends in foreign policy, welfare development and welfare policy models, cultural dynamics in relation to globalisation and modernisation processes, or regional changes, e.g. in economic and political structures.

Funding can be provided to research groups that include senior researchers (professors), junior researchers (research assistants and postdoctoral researchers), and doctoral students.

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Infrastructure for Strategic Research Areas

In the strategic area of ***sustainable use of natural resources*** and ***effects of climate change on natural resources, ecosystem services, and biodiversity,*** infrastructure building for climate and environmental data (climate and environment SND), the European infrastructures for greenhouse gas measurements (ICOS), biodiversity (LifeWatch), and deep seafloor observations (EMSO) are particularly relevant to provide conditions for research of the highest quality. The existing infrastructure in the area is scattered and often run on a small scale by individual research groups. National, Nordic, or European coordination of existing and new infrastructure would be desirable.

In the strategic area of ***marine environment*** the European infrastructures for deep seafloor observations (EMSO) and biodiversity (LifeWatch), and infrastructure building for climate and environmental data (climate and environment SND), are particularly relevant to provide conditions for research of the highest quality. Open and quality-driven availability of current and future infrastructures for marine environment measurements is also desirable for research in this area.

In the strategic area of ***climate models***, the development of high-performance computing resources in SNIC and PRACE, infrastructure building for climate and environmental data (climate and environment SND), the European infrastructure to measure greenhouse gas (ICOS), and infrastructure to characterise the upper atmosphere (EISCAT) are particularly relevant to provide conditions for research of the highest quality.

In the strategic area of ***material sciences, including functional material***, the MAX IV and ESRF synchrotron radiation facilities, the ILL neutron source, the MyFab cleanroom network, and the SNIC and PRACE computing resources are particularly relevant in providing the conditions for research of the highest quality.

In the strategic area of ***nanoscience and nanotechnology***, the MyFab cleanroom network and the MAX IV synchrotron radiation facility are particularly relevant in providing the conditions for research of the highest quality.

In the strategic area of ***eScience***, the development of high-performance computing resources in SNIC and PRACE is an important prerequisite. Managing large data volumes, e.g. through using GRID, is essential in several areas such as high-energy physics (LHC-Grid), bioinformatics (BILS and ELIXER), and biobanks (national infrastructure and also the European BBMRI). The same applies to the data archives in several areas, such as social sciences and medicine (ESS, SND, CESSDA), climate and environmental research (SND-KM), and biodiversity (LifeWatch).

In the strategic area of ***cancer***, the national and international infrastructures for bioinformatics (BILS and ELIXER), biobanks (BBMRI), animal research activities (SweImp and Infrafrontier), national technical platforms, and

translational research (EATRIS) are particularly relevant in providing the conditions for research of the highest quality.

In the strategic area of ***diabetes,*** the national and international infrastructures for bioinformatics (BILS and ELIXER), biobanks (BBMRI), animal research activities (SweImp and Infrafrontier), national technical platforms, and translational research (EATRIS) are particularly relevant in providing the conditions for research of the highest quality.

In the strategic area of ***epidemiology,*** the national and international infrastructures for bioinformatics (BILS and ELIXER), biobanks (BBMRI), animal research activities (SweImp and Infrafrontier), national technical platforms, and translational research (EATRIS) are particularly relevant in providing the conditions for research of the highest quality.

In the strategic area of ***molecular bioscience,*** the national and international infrastructures for bioinformatics (BILS and ELIXER), biobanks (BBMRI), animal research activities (SweImp and Infrafrontier), the MAX IV synchrotron radiation facility, national technical platforms, translational research (EATRIS), and high-performance computing resources in SNIC and PRACE are particularly relevant in providing the conditions for research of the highest quality.

In the strategic area of ***neurosciences, including disorders of the brain and nervous system,*** the national and international infrastructures for bioinformatics (BILS and ELIXER), biobanks (BBMRI), animal research activities (SweImp and Infrafrontier), national technical platforms, and translational research (EATRIS) are particularly relevant in providing the conditions for research of the highest quality.

In the strategic area of ***stem cells and regenerative medicine,*** the infrastructures for bioinformatics (BILS and ELIXER), biobanks (BBMRI), animal research activities (SweImp and Infrafrontier), national technical platforms, and translational research (EATRIS) are particularly relevant in providing the conditions for research of the highest quality.

In the strategic area of ***IT and mobile communication, including future solutions for communication and management systems,*** the MyFab cleanroom network is particularly relevant in providing the conditions for research of the highest quality.