

THEMES

1. Health

Objective

Improving the health of European citizens and increasing the competitiveness of European health-related industries and businesses, while addressing global health issues including emerging epidemics. Emphasis will be put on translational research (translation of basic discoveries into clinical applications), the development and validation of new therapies, methods for health promotion and disease prevention, diagnostic tools and technologies, as well as sustainable and efficient health care systems.

Approach

This research will advance our understanding on how to more efficiently promote good health, to prevent and treat major diseases and to deliver health care. It will help integrate the vast amount of genomics data to generate new knowledge and applications in medicine and biotechnology. It will foster translational health research, which is essential to ensure practical benefits from biomedical research. It will allow Europe to contribute more effectively to international efforts combating diseases of global importance, as illustrated by the ongoing programme on “European and Developing Countries Clinical Trials Partnership” (EDCTP) for combating HIV/AIDS, malaria and tuberculosis (Article 169)^{1,2}. It will reinforce health policy-driven research at the European level and especially the comparisons of the models, systems and data of national databases.

This research will help improve the competitiveness of European health care biotechnology and medical technology sectors, where SMEs are the main economic drivers, and pharmaceutical industries. In particular, it is envisaged to support a European Technology Platform³ on innovative medicines, aiming at overcoming the research bottlenecks in the drug development process. Special attention will be given to bridging the gap between research activities and exploitation by providing support for demonstrating proof of concept and clinical validation. This research will also contribute to the development of norms and standards for new advanced therapies (e.g. regenerative medicine) needed to help EU industry face worldwide competition.

Gender aspects in research will be considered and integrated in the projects⁴ whenever appropriate. Special attention will be given to communicating research outcomes and engaging in dialogue with civil society, in particular with patient groups, at the earliest possible stage, of new developments arising from biomedical and genetics research. A wide dissemination and use of the results will also be assured.

Two strategic issues, child health⁵ and the health of the ageing population will be addressed across the three main blocks of activities set out below, with priorities highlighted in the work programme. Other multi-disciplinary areas will also be included. This will ensure a visible and coherent approach to these issues across the Theme, whilst avoiding duplication.

¹ Other new important initiatives regarding the co-ordination of national research programmes may be supported where needed.

² Other new important initiatives regarding the co-ordination of national research programmes may be supported where needed.

³ Strategic research agendas of other European Technology Platforms may be supported where they are of major importance for health-related industries.

⁴ Risk factors, biological mechanisms, causes, clinical manifestation, consequences and treatment of disease and disorders often differ between women and men. Therefore, all activities funded within this Theme must reflect the possibility of such differences in their research protocols, methodologies and analysis of results.

⁵ Support will in particular be given to specific clinical studies to provide evidence for the appropriate use of off-patent products currently used off-label in paediatric populations.

Activities

• Biotechnology, generic tools and technologies for human health

This activity aims at developing and validating the necessary tools and technologies that will make possible the production of new knowledge and its translation into practical applications in the area of health and medicine.

– *High-throughput research*: to develop new research tools for modern biology that will enhance significantly data generation and improve data and specimen (biobanks) standardisation, acquisition and analysis. The focus will be on new technologies for: sequencing; gene expression, genotyping and phenotyping; structural genomics; bioinformatics and systems biology; other “omics”.

– *Detection, diagnosis and monitoring*: to develop visualisation, imaging, detection and analytical tools and technologies for biomedical research, for prediction, diagnosis, monitoring and prognosis of diseases, and for support and guidance of therapeutic interventions. The focus will be on a multidisciplinary approach integrating areas such as: molecular and cellular biology, physiology, genetics, physics, chemistry, nanotechnologies, microsystems, devices and information technologies. Non- or minimally- invasive and quantitative methods and quality assurance aspects will be emphasised.

– *Innovative therapeutic approaches and interventions*: to consolidate and ensure further developments in advanced therapies and technologies with broad potential application. The focus will be on gene and cell therapy, regenerative medicine, transplantation, immunotherapy and vaccines, and other medicines. Related technologies, such as advanced targeted delivery systems, advanced implants and prosthetics, and non- or minimally-invasive technology-assisted interventions will also be addressed.

– *Predicting suitability, safety and efficacy of therapies*: to develop and validate the parameters, tools, methods and standards needed for bringing to the patient safe and effective new biomedicines [for conventional medicines⁶, these issues will be addressed through the proposed Joint Technology Initiative on Innovative Medicines]. The focus will be on approaches such as pharmacogenomics, in silico, in vitro (including alternatives to animal testing) and in vivo methods and models.

• Translating research for human health

This activity aims at increasing knowledge of biological processes and mechanisms involved in normal health and in specific disease situations, to transpose this knowledge into clinical applications, and to ensure that clinical data guide further research.

– *Integrating biological data and processes: large-scale data gathering, systems biology*.

- *Large scale data gathering*: to use high-throughput technologies to generate data for elucidating the function of genes and gene products and their interactions in complex networks. The focus will be on: genomics; proteomics; population genetics; comparative and functional genomics.
- *Systems biology*: the focus will be on multidisciplinary research that will integrate a wide variety of biological data and will develop and apply system approaches to understand and model biological processes.

– *Research on the brain and related diseases, human development and ageing*.

- *Brain and brain-related diseases*: to better understand the integrated structure and dynamics of the brain, and to study brain diseases and search for new therapies. The focus will be to explore brain functions, from molecules to cognition, and to address neurological and psychiatric diseases and disorders, including regenerative and restorative therapeutic approaches.

⁶ Pharmaceuticals and bio-pharmaceuticals.

Extras din “Proposal for a COUNCIL DECISION concerning the Specific Programme “Cooperation” implementing the Seventh Framework Programme (2007-2013) of the European Community for research, technological development and demonstration activities” Brussels, 21.09.2005

- *Human development and ageing*: to better understand the process of life-long development and healthy ageing. The focus will be on the study of human and model systems, including interactions with factors such as environment, behaviour and gender.
- *Translational research in major infectious diseases: to confront major threats to public health.*
 - *Anti-microbial drug resistance*: the focus will be on combining basic research on molecular mechanisms of resistance, microbial ecology and host-pathogen interactions with clinical research towards new interventions to reduce the emergence and spread of multi-drug resistant infections.
 - *HIV/AIDS, malaria and tuberculosis*: the focus will be on developing new therapies, diagnostic tools, preventive vaccines and chemical transmission barriers such as HIV microbicides. Research efforts will confront the three diseases at global level, but will also address specific European aspects. Preclinical and early clinical research activities will be emphasised, and where relevant (e.g. for HIV/AIDS vaccines) collaboration with global initiatives is foreseen.
 - *Emerging epidemics*: the focus will be on confronting emerging pathogens with pandemic potential including zoonoses (e.g. SARS and highly pathogenic influenza). Where appropriate, provisions will be made for rapidly initiating collaborative research aimed at expediting development of new diagnostics, drugs and vaccines for efficient prevention, treatment, and control of infectious disease emergencies.
- *Translational research in other major diseases.*
 - *Cancer*: the focus will be on disease aetiology; identifying and validating drug targets and biological markers that aid in the prevention, early diagnosis and treatment; and assessing the effectiveness of prognostic, diagnostic and therapeutic interventions. □ *Cardiovascular disease*: the focus will be on diagnosis, prevention, treatment and monitoring of heart and blood vessel diseases (including vascular aspects of stroke) using broad multidisciplinary approaches.
 - *Diabetes and obesity*: for the former, the focus will be on aetiologies of the different types of diabetes, and their related prevention and treatment. For the later, the focus will be on multidisciplinary approaches including genetics, life style and epidemiology.
 - *Rare diseases*: the focus will be on Europe-wide studies of natural history, pathophysiology and on development of preventive, diagnostic and therapeutic interventions. This sector will include rare Mendelian phenotypes of common diseases.
 - *Other chronic diseases*: the focus will be on non-lethal diseases with a high impact on the quality of life at old age such as functional and sensory impairment and other chronic diseases (e.g. rheumatoid diseases).

- **Optimising the delivery of health care to European citizens**

This activity aims at providing the necessary basis both for informed policy decisions on health systems and for more effective strategies of health promotion, disease prevention, diagnosis and therapy.

– *Enhanced health promotion and disease prevention*: to provide evidence for the best public health measures in terms of life styles and interventions at different levels and in different contexts. Focus will be on the wider determinants of health and how they interact at both the individual and community level (e.g. diet, stress, tobacco and other substances, physical activity, cultural context, socio-economic and environmental factors). In particular, mental health will be addressed in a life-course perspective.

– *Translating clinical research into clinical practice* including better use of medicines, and appropriate use of behavioural and organisational interventions and health therapies and technologies. Special attention will be given to patient safety: to identify the best clinical practice; to understand decision making in clinical settings in primary and specialized care; and to foster applications of evidence-based medicine and patient empowerment.

Focus will be on the benchmarking of strategies; investigating outcomes of different interventions including medicines, taking into consideration pharmacovigilance evidence, specificities of the patient (e.g. genetic susceptibility, age, gender and adherence) and cost benefits.

– *Quality, solidarity and sustainability of health systems*; to provide a basis for countries to adapt their health systems in the light of experience of others, taking into account the importance of national contexts and population

characteristics (ageing, mobility, migration, education, socioeconomic status and the changing world of work etc). Focus will be on organisational, financial and regulatory aspects of health systems, their implementation and their outcomes in terms of effectiveness, efficiency and equity. Special attention will be paid to investment issues and human resources.

International cooperation

International cooperation is an integral part of the Theme and is of particular importance for areas addressing global health problems, such as anti-microbial resistance, HIV/AIDS, malaria, tuberculosis and emerging pandemics. This may also involve priority setting in the context of international initiatives, such as the Global HIV Vaccine Enterprise. Subject to the consolidation of a long-term sustainable partnership in clinical research between Europe and Developing countries, further support will be provided⁷ to the European and Developing Countries Clinical Trials Partnership (EDCTP) in response to its achievements and future needs. The EDCTP programme will remain focused on advanced clinical testing for the development of new vaccines, microbicides and drugs against the three diseases in sub-Saharan Africa. Specific cooperation actions will be implemented in the areas formulated through bioregional dialogues in third Countries/Regions and international fora, as well as within the context of Millennium Development Goals. Such priority areas adapted to local needs and through partnerships may include: health policy research, health systems and health care service research, maternal and child health, reproductive health, control and surveillance of neglected communicable diseases and emerging unforeseen policy needs in those regions.

An annual subscription to the international Human Frontier Science Programme Organisation (HFSP)⁸ will be made jointly with the “Information and Communication Technologies” theme. This will allow EU non-G8 Member States to fully benefit from the Human Frontier Science Programme (HFSP) and provide increased visibility for European research.

Responding to emerging needs and unforeseen policy needs

Research on emerging needs will be implemented on the basis of “bottom up” and “focussed” initiatives, in coordination with other Themes and this will include a broad and inter-disciplinary research portfolio. Support for unforeseen European Union policy needs may address, for example occupational health and safety, health impact assessment, risk assessment, statistical indicators, management and communication in the public health domain, as well as obligations under international health treaties including the Framework Convention on Tobacco Control⁹ and the International Health Regulations¹⁰. This will complement the health policy-driven research supported above.

2. Food, Agriculture and Biotechnology

Objective

Building a European *Knowledge Based Bio-Economy*¹¹ by bringing together science, industry and other stakeholders, to exploit new and emerging research opportunities that address social and economic challenges: the growing demand for safer, healthier and higher quality food, taking into account animal welfare and rural contexts; the sustainable production and use of renewable bio-resources; the increasing risk of epizootic and

⁷ E.g. a grant to the EDCTP European Economic Interest Grouping.

⁸ The European Community is a member of the HFSP Organisation (HFSP) and has funded HFSP under previous Framework Programmes

⁹ Framework Convention on Tobacco Control, 2004/513/EC

¹⁰ International Health Regulations 2005 – Resolution 58.3 of the 58th World Health Assembly, 23 May 2005.

¹¹ The term “bio-economy” includes all industries and economic sectors that produce, manage and otherwise exploit biological resources (and related services, supply or consumer industries), such as agriculture, food, fisheries, forestry, etc.

zoonotic diseases and food related disorders; threats to the sustainability and security of agricultural and fisheries production resulting in particular from climate change.

Approach

This theme will strengthen the knowledge base, deliver the innovations and provide policy support for building and developing a European Knowledge Based Bio-Economy (KBBE).

Research will focus on the sustainable management, production and use of biological resources, in particular through life sciences and biotechnology and the convergence with other technologies, to provide new, eco-efficient and competitive products from European agriculture, fisheries, aquaculture, food¹², health, forest based and related industries. Research will make important contributions to the implementation and formulation of EU policies and regulations and specifically address or support: the Common Agricultural Policy; agriculture and trade issues; food safety regulations; Community Animal Health Policy, disease control and welfare standards; environment and biodiversity; EU Forestry Strategy; and the Common Fisheries Policy aiming to provide sustainable development of fishing and aquaculture. Research will also seek to develop new and existing indicators supporting analysis, development and monitoring of these policies.

Agro-food industries, of which 90% are SMEs, will particularly benefit from many research activities, including targeted dissemination and technology transfer activities, in particular as regards the integration and uptake of advanced eco-efficient technologies, methodologies and processes and the development of standards. High-tech start-ups from the bio-, nano and ICT are expected to provide important contributions to the areas of plant breeding, improved crops and plant protection, advanced detection and monitoring technologies for ensuring food safety and quality, and new industrial bioprocesses.

Several European Technology Platforms, covering the areas of plant genomics and biotechnology, forestry and forest based industries, global animal health, farm animal breeding, food, aquaculture and industrial biotechnology, will contribute in setting common research priorities for this theme, in identifying possible future large scale initiatives such as demonstration projects for the production of bulk chemicals from biomass (plant cell wall, biofuels, biopolymers) and help ensure broad participation and integration of all stakeholders. Actions to enhance the co-ordination of national research programmes will be pursued wherever appropriate, in close co-ordination with ERA-Net projects, Technology Platforms and other relevant actors, such as the Standing Committee on Agricultural Research (SCAR) or any future European maritime research co-ordination structure. Consideration of the social, ethical, gender, legal, environmental, economic and wider cultural aspects and potential risks and impacts (foresight) of the scientific and technological development will form a part of the activities, where relevant.

Activities

• **Sustainable production and management of biological resources from land, forest, and aquatic environments¹³**

– Enabling research on the key long term drivers of sustainable production and management of biological resources (micro-organisms, plants and animals) including the exploitation of biodiversity and of novel bioactive molecules within these biological systems. Research will include 'omics' technologies, such as genomics, proteomics, metabolomics, and converging technologies, and their integration within systems biology approaches, as well as the development of basic tools and technologies, including bioinformatics and relevant databases, and methodologies for identifying varieties within species groups.

¹² Food includes seafood.

¹³ Complementary research relating to sustainable management and conservation is addressed under “Environment including Climate Change”. Research on other tools and technologies that support sustainable production and management will be done under the relevant themes.

– Increased sustainability and competitiveness, while decreasing environmental impacts, in agriculture, forestry, fisheries and aquaculture through the development of new technologies, equipment, monitoring systems, novel plants and production systems, the improvement of the scientific and technical basis of fisheries management, and a better understanding of the interaction between different systems (agriculture and forestry; fisheries and aquaculture) across a whole ecosystem approach. For land based biological resources, special emphasis will be placed on low input and organic production systems, improved management of resources and novel feeds, and novel plants (crops and trees) with improved composition, resistance to stress, nutrient use efficiency, and architecture.

This will be supported through research into biosafety, co-existence and traceability of novel plants systems and products. Plant health will be improved through better understanding of ecology, biology of pests, diseases and other threats and support to controlling disease outbreaks and enhancing sustainable pest management tools and techniques. For biological resources from aquatic environments, emphasis will be placed on essential biological functions, safe and environmentally friendly production systems and feeds of cultured species and on fisheries biology, dynamics of mixed fisheries, interactions between fisheries activities and the marine ecosystem and on fleet-based, regional and multi-annual management systems.

– Optimised animal production and welfare, across agriculture, fisheries and aquaculture, *inter alia* through the exploitation of genetic knowledge, new breeding methods, improved understanding of animal physiology and behaviour and the better understanding and control of infectious animal diseases, including zoonoses. The latter will also be addressed by developing tools for monitoring, prevention and control, by underpinning and applied research on vaccines and diagnostics, studying the ecology of known or emerging infectious agents and other threats, including malicious acts, and impacts of different farming systems and climate. New knowledge for the safe disposal of animal waste and improved management of by-products will also be developed.

– Providing the tools needed by policy makers and other actors to support the implementation of relevant strategies, policies and legislation and in particular to support the building of the European Knowledge Based Bio-Economy (KBBE) and the needs of rural and coastal development. The Common Fisheries Policy will be supported through the development of adaptive approaches supportive to a whole ecosystem approach for the harvesting of marine resources. Research for all policies will include socio-economic studies, comparative investigations of different farming systems, cost-effective fisheries management systems, the rearing of non-food animals, interactions with forestry and studies to improve rural and coastal livelihoods.

• **Fork to farm: Food, health and well being**

– Understanding consumer behaviour as a major factor in the competitiveness of the food industry and the impact of food on the health, and well-being of the European citizen.

The focus will be on consumer perception and attitudes towards food, understanding societal trends, and identifying determinants of food choice and consumer access to food.

– Understanding dietary factors and habits as a major controllable factor in the development and reduction of occurrence of diet-related diseases and disorders. This will involve the development and application of nutrigenomics and systems biology, and the study of the interactions between nutrition, physiological and psychological functions. It could lead to reformulation of processed foods, and development of novel foods, dietetic foods and foods with nutritional and health claims. The investigation of traditional, local, and seasonal foods and diets will also be important to highlight the impact of certain foods and diets on health, and to develop integrated food guidance.

– Optimising innovation in the European food industry through the integration of advanced technologies into traditional food production, key process technologies to enhance the functionality of food, the development and demonstration of high-tech, eco-efficient processing and packaging, smart control applications and more efficient management of by-products, wastes and energy. New research will also develop sustainable and novel technologies for animal feed, including safe feed processing formulations and for feed quality control.

- Assuring chemical and microbiological safety and improving quality in the European food supply. This will include understanding the links between microbial ecology and food safety; developing methods and models addressing the integrity of the food supply chains; new detection methods, and technologies and tools for risk assessment, management, and communication, and enhance the understanding of risk perception.
- Protecting both human health and the environment through a better understanding of the environmental impacts on and of food/feed chains. This will involve study of food contaminants and health outcomes, developing enhanced tools and methods for the assessment of impacts of food and feed chains on the environment. Assuring quality and the integrity of the food chain requires new models for commodity chain analysis and total food chain management concepts, including consumer aspects.

- **Life sciences and biotechnology for sustainable non-food products and processes**

- To strengthen the knowledge base and develop advanced technologies for terrestrial or marine biomass production for applications in energy and industry. This will include plant, animal and microbial genomics and metabolomics to improve the productivity and composition of raw materials and biomass feedstocks for optimised conversion to high added value products, while exploiting natural or enhanced terrestrial and aquatic organisms as novel sources. This will fully incorporate life cycle analysis of farming practices, transportation, and storage and market deployment of bio-products. Accordingly the application of industrial biotechnologies within the whole crop chain to realise the full potential of the bio-refinery approach, including socioeconomic, agronomic, and ecological and consumer aspects will be addressed. This will be enhanced by an increased understanding and control of plant and microbial metabolism at the cellular and sub-cellular level, in the production of high value commodities deploying bio-processes with increased yield, quality and purity of conversion products, including biocatalytic process design. Furthermore, biotechnologies for novel and improved high quality, high added value and renewable forest-based products and processes will be used or developed to increase sustainability of wood and wood production, including timber and renewable bioenergy stocks. Finally, the potential of biotechnology to detect, monitor, prevent, treat and remove pollution with an emphasis on maximising the economic value of waste and by-products through new bio-processes, alone or in combination with plant systems and/or chemical catalysts will be addressed.

International cooperation

International co-operation is a priority aspect for Food, Agriculture and Biotechnology research and will be strongly encouraged throughout the entire area. Research of specific interest for developing countries will be supported, taking into account Millennium development goals and already ongoing activities. Specific actions will be undertaken to foster co-operation with priority partner regions and countries - particularly those involved in bi-regional dialogues and bilateral S&T agreements as well as neighbourhood countries and emerging economies and developing countries. Furthermore, multilateral co-operation will be carried out to address either challenges requiring broad international efforts, such as the dimension and complexity of systems biology in plants and micro-organisms, or to address global challenges and EU international commitments (security and safety of food and drinking water, global spread of animal diseases, equitable use of biodiversity, the restoration of world fisheries to Maximum Sustainable Yield by 2015 and the influence of/on climate change).

Responding to emerging needs and unforeseen policy needs

Research on emerging needs may address, for example, the development of new concepts and technologies, such as on crisis management systems and the integrity of the food chain. A flexible response to unforeseen policy needs will take particular account of relevant policies for building a European Knowledge Based Bio-Economy.

3. Information and Communication Technologies

Objective

Improve the competitiveness of European industry and enable Europe to master and shape the future developments of Information and Communication Technologies (ICT) so that the demands of its society and economy are met. Activities will strengthen Europe’s scientific and technology base and ensure its global leadership in ICT, help drive and stimulate innovation through ICT use and ensure that ICT progress is rapidly transformed into benefits for Europe’s citizens, businesses, industry and governments.

Introduction

Information and communication technologies (ICT) play a unique, proven role in fostering innovation, creativity and competitiveness of all industry and service sectors. They are essential for addressing key societal challenges and modernising public services and they underpin progress in all science and technology fields. Europe must therefore master and shape the future developments of ICT and ensure that ICT-based services and products are taken up and used to deliver the maximum possible benefits for citizens and businesses.

These are the targets of the Union’s Information Society policy, as highlighted in the i2010 initiative, aiming at a competitive convergent information economy in Europe, a significant rise in European investment in ICT research and innovation and a very high level of accessibility in the Information Society.

New ICT technologies will open up many new opportunities for higher-value products and services, many of which are in areas where Europe already enjoys industrial and technological leadership. Partnering at European level is the optimal approach to ICT investment. More than ever before, such efforts are needed to keep pace with soaring research costs in an era of global competition, and increasingly complex and interdependent technologies.

The ICT theme prioritises strategic research around key technology pillars, ensures end-to-end integration of technologies and provides the knowledge and the means to develop a wide range of innovative ICT applications. The activities will leverage industrial and technological advance in the ICT sector and improve the competitive edge of important ICT-intensive sectors – both through innovative high-value ICT-based products and services and from improvements of organisational processes in businesses and administrations alike. The theme will also support other policies of the European Union, by mobilising ICT to meet public and societal demands.

Activities will cover collaboration and networking actions, support to Joint Technology

Initiatives – including selected aspects of research in the areas of Nanoelectronics Technologies and Embedded Computing Systems – and national programme co-ordination initiatives – including in the area of Ambient Assisted Living. The priorities of the activities will include topics relying, among other sources, on the work of European Technology Platforms. Thematic synergies will also be developed with related activities in other Specific Programmes.

The active participation of small and medium-sized enterprises and other small entities in the activities is essential given their role in promoting innovation. They play vital roles in the development and nurturing of new visions in ICT and their applications and in transforming them into business assets.

Activities

- **ICT Technology Pillars:**

- *Nano-electronics, photonics and integrated micro/nano-systems*: process, device and design technologies to improve size, density, performance, energy efficiency, manufacturing and cost-effectiveness for components,

systems-on-a-chip, systems-in- package and integrated systems; basic photonic components for wide range of applications; high-performance/high-density data storage systems; very large area/highly integrated display solutions; sensing, actuating, vision and imaging devices; ultra low power systems, alternative energy sources/storage; heterogeneous technologies/systems integration; multi-functional integrated micro-nano-bio-info systems; large-area electronics; integration in different materials/objects; interfacing with living organisms; (self) assembly of molecules or atoms into stable structures.

– *Ubiquitous and unlimited capacity communication networks*: cost-effective mobile and broadband network technologies and systems including terrestrial and satellite networks; convergence of different fixed, mobile, wireless and broadcasting networks spanning from the personal area to the regional and global area; interoperability of wired and wireless communications services and applications, management of networked resources, service reconfigurability; complex networking of ad-hoc intelligent multimedia devices, sensors and microchips.

– *Embedded systems, computing and control*: more powerful, secure, distributed, reliable and efficient hardware/software systems that can perceive, control and adapt to their environment while optimising the use of resources; methods and tools for system modelling, design and engineering to master complexity; open composable architectures and scale-free platforms, middleware and distributed operating systems to enable truly seamless collaborative and ambient intelligent environments for sensing, actuation, computing, communication, storage, and service delivery; computing architectures incorporating heterogeneous, networked and reconfigurable components including compilation, programming and run-time support; control of large-scale, distributed, uncertain systems.

– *Software, Grids, security and dependability*: technologies, tools and methods for dynamic and trusted software, architectures and middleware systems that underpin knowledge-intensive services, including their provision as utilities; service-oriented, interoperable and scale-free infrastructures, grid-like virtualisation of resources, network-centric operating systems; open platforms and collaborative approaches for development of software, services and systems; composition tools; mastering emergent behaviours of complex systems; improving dependability and resilience of large-scale, distributed and intermittently connected systems and services; secure and trusted systems and services, including privacy-aware access control and authentication, dynamic security and trust policies, dependability and trust meta-models.

– *Knowledge, cognitive and learning systems*: methods and techniques to acquire and interpret, represent and personalise, navigate and retrieve, share and deliver knowledge, recognizing the semantic relationships in content for use by humans and machines; artificial systems that perceive, interpret and evaluate information and that can cooperate, act autonomously and learn; theories and experiments that move beyond incremental advances benefitting from insights into natural cognition, in particular learning and memory, also for the purpose of advancing systems for human learning.

– *Simulation, visualisation, interaction and mixed realities*: tools for modelling, simulation, visualisation, interaction, virtual, augmented and mixed reality and their integration in end-to-end environments; tools for innovative design and for creativity in products, services and digital audio-visual media; more natural, intuitive and easy-to-use interfaces and new ways to interact with technology, machines, devices and other artefacts; multilingual and automatic machine translation systems.

New perspectives in ICT drawing on other science and technology disciplines (physics, materials, biotechnologies, life-sciences, cognitive and social sciences etc) are provided in the whole of the ICT theme. These are bringing breakthroughs that lead to innovation in ICT and to entirely new industry and service sectors. They span from miniaturisation of ICT devices to sizes compatible and interacting with living organisms (like novel ICT components and computing systems based on synthetic biomolecular structures), to new computing and communication sciences inspired by the living world, to fully eco-compatible ICT devices inspired by natural systems, and to modelling and simulation of the living world (like simulation of human physiology across several biological levels).

- **Integration of Technologies:**

- *Personal environments*: integration of multimodal interfaces, sensing techniques and micro-systems, personal communication and computing devices, ICT systems embodied in personal accessories, wearable systems and implants and their connection to services and resources, placing emphasis on integrating all facets of a person’s presence and identity.

- *Home environments*: communication, monitoring, control and assistance of the home, buildings and public spaces; seamless interoperability and use of all devices taking account of cost efficiency, affordability and usability; new services and new forms of interactive digital content and services; access to information and management of knowledge.

- *Robotic systems*: flexible and dependable robot systems operating in human and unstructured environments and co-operating with people; networked and cooperating robots; miniaturised robots; modular design and modelling of integrated robotic systems.

- *Intelligent infrastructures*: ICT tools making critical infrastructures more efficient and user-friendly, easier to adapt and maintain, more robust to usage and resistant to failures; data integration tools; ICT for systemic risk assessment, early warning and automated alerts.

- **Applications Research:**

- *ICT meeting societal challenges*: To ensure that all European citizens can reap the maximum benefit from ICT products and services, to improve inclusiveness, seamless access and interactivity of services of public interest, and to strengthen the innovation role of public sector services, improving their efficiency and effectiveness.

- for *health*: personal non-obtrusive systems that enable citizens to manage their well-being such as wearable or implantable monitoring devices and autonomous systems for supporting a healthy state; emerging techniques such as molecular imaging for improved prevention and individualized medicine; health knowledge discovery and application in clinical practice; modelling and simulation of organ functions; micro- and nano-robotic devices for minimally invasive surgical and therapeutic applications;

- for *governments*: use of ICT in an interdisciplinary approach in public administrations combined with organisational change and new skills in order to deliver innovative, citizen-centric services for all; advanced ICT based research and solutions to improve democratic and participatory processes and the performance and quality of public sector services, interaction with and between administrations and governments, and support legislative and policy development processes in all stages of democracy;

- for *inclusion*: to empower individuals and their communities and improve equal participation of all citizens in the information society, while preventing digital divides due to disability, low skills, poverty, geographic isolation, culture, gender or age, inter alia through support to assistive technology, promoting independent living, increasing e-skills, and developing products and services designed-for-all;

- for *mobility*: integrated ICT-based safety systems for vehicles based on open, secure and dependable architectures and interfaces; interoperable cooperative systems for transport efficiency and safety, based on communication between vehicles and with the transport infrastructure and integrating accurate and robust location technologies; personalised, locationaware info-mobility and multi-modal services, including intelligent service solutions for tourism;

- in support of *the environment and sustainable development*: risk and emergency management; smart sensor networks to improve hazard forecasting, natural resources management including systems for reduction of pollutants; increasing energy efficiency; managing human response to environmental stresses and to sustain biodiversity; alert systems and timely and reliable public safety communication; assistive technologies and support systems for operation under harsh, hazardous or risky conditions; ecoefficient and sustainable

production of ICT: advanced data and information management for environmental monitoring and risk assessment, contributing to INSPIRE; GMES and GEOSS.

– *ICT for content, creativity and personal development:*

- novel forms of interactive, non-linear and self-adaptive content; creativity and enriched user-experience; cross-media content customisation and delivery; combining all-digital content production and management with emerging semantic technologies; user-oriented use, access to and creation of content;
- technology-enhanced *learning* systems, tools and services, adapted to different learners in different contexts; issues underlying human learning when the process is mediated by using ICT; improving people’s abilities to become active learners;
- intelligent services for access to *cultural* heritage in digital form; tools for communities to create new cultural memory based on living heritage; methods and tools for preservation of digital content; making digital objects usable by future users whilst keeping authenticity and integrity of their original creation and context of use.

– *ICT supporting businesses and industry:*

- dynamic, network-oriented *business* systems for product and service creation and delivery; decentralised control and management of intelligent items; digital business ecosystems, in particular software solutions adaptable to the needs of small- and medium-sized organisations; collaboration services for distributed *workspaces*; augmented group presence, group management and sharing support;
- *manufacturing*: networked intelligent controls for high-precision manufacturing and low-resource utilisation; wireless automation and logistics for rapid plant reconfiguration; integrated environments for modelling, simulation, presentation and virtual production; manufacturing technologies for miniaturised ICT systems and for systems interwoven with all kinds of materials and objects.

– *ICT for trust and confidence:*

- tools supporting the trust and confidence of ICT and its applications; multiple and federated identity management systems; authentication and authorization techniques; systems meeting privacy needs deriving from new technological developments; rights and asset management; tools to protect against cyber threats.

International cooperation

International cooperation will be encouraged in the ICT theme to address issues of common interest aiming at interoperable solutions with strategic partners with high mutual benefits, and to contribute to the spread of the information society in emerging economies and developing countries. Specific actions will be identified for the countries or regions with which Europe needs to focus collaboration, with a particular emphasis on cooperation with emerging economies and developing countries and neighbourhood countries.

A subscription will be made available jointly with theme 1 "Health" to the international Human Frontier Science Programme (HFSP) to promote interdisciplinary research and novel collaborations between scientists from different fields, and provide the possibility or non-G8 Member States to fully benefit from the programme.

Activities under this Theme support the Intelligent Manufacturing Systems (IMS) scheme, which allows RTD cooperation between its member regions¹⁴.

¹⁴ The agreement for scientific and technical cooperation in the domains of IMS is stipulated between the European Community and the United States of America, Japan, Australia, Canada, Korea and the EFTA States of Norway and Switzerland.

Responding to emerging needs and unforeseen policy needs

A *Future and Emerging Technologies* activity will attract and foster trans-disciplinary research excellence in emerging ICT-related research domains. Foci include: exploring the new miniaturisation and computing frontiers including for example the exploitation of quantum effects; harnessing the complexity of networked computing and communication systems; exploring new concepts of and experimenting with intelligent systems for new personalised products and services.

Research that aims at better understanding *trends and impacts of ICT* on society and the economy may include, for example: impacts of ICT on productivity, employment, skills and wages; ICT as a driver for innovation in public and business services; obstacles to wider and faster innovation and use of ICT; new business models and exploitation paths; usability, utility and acceptability of ICT-based solutions; privacy, security and trust of ICT infrastructures; ethical issues of ICT developments; links to ICT-related legal, regulatory and governance frameworks; analyses of ICT support to, and impact on, EU policies.

4. Nanosciences, Nanotechnologies, Materials and new Production Technologies

Objective

Improve the competitiveness of European industry and ensure its transformation from a resource-intensive to a knowledge-intensive industry, by generating breakthrough knowledge for new applications at the crossroads between different technologies and disciplines.

Approach

To enhance its competitiveness, European industry needs radical innovations. It must concentrate its capabilities on high-added-value products and technologies to meet customer requirements, as well as environmental, health and other societal expectations. Research is integral to meeting these competing challenges.

A key element of this theme is the effective integration of nanotechnology, materials sciences and new production methods so as to achieve and maximise the impacts for industrial transformation and, at the same time, supporting sustainable production and consumption. The theme will support all industrial activities operating in synergy with other themes. Applications in all sectors and areas will be supported and this includes materials sciences, high performance manufacturing and process technologies, nanobiotechnology or nanoelectronics.

The medium term approach is to focus on a convergence of knowledge and skills drawn from different disciplines exploiting application-driven scientific and technological synergies. In the long term the theme aims to capitalise on the enormous prospects of nanosciences and nanotechnologies for the creation of a true knowledge-based industry and economy. In both cases it will be essential to ensure uptake of the knowledge generated through effective dissemination and exploitation of the results.

Strong contributions to industrial needs and complementarities through initiatives and funded projects will be ensured in particular through European Technology Platforms (e.g. in the potential areas of sustainable chemistry, new manufacturing, industrial safety, nanomedicine, steel, forest-based sector etc) and support to Joint Technology Initiatives.

The theme is particularly relevant to SMEs due to their needs and role in advancing and using technologies. Areas of particular relevance include: nano-instruments, -tools, and – devices (due to the concentration of high-growth, high technology SMEs in this sector); technical textiles, (typical of a traditional sector undergoing a rapid transformation process affecting many SMEs); space systems; mechanical industries (e.g. machine tools- where European SMEs are

world leaders), as well as other sectors which involve many SMEs that will benefit from the introduction of new business models, materials and products.

Specific actions to coordinate programmes and joint activities conducted at national and regional level will be carried out through the ERA-NET and ERA-NET PLUS schemes so as to promote convergence of research programmes, and to reinforce critical mass and synergies within the European Technology Platforms. Industrial research will also benefit from the coordination of activities in areas such as metrology, toxicology, standards and nomenclature.

Activities

• Nanosciences and nanotechnologies

The objective is to create materials and systems with pre-defined properties and behaviour, based on increased knowledge and experience with matter at the nano scale. This will lead to a new generation of high added-value, competitive products and services with superior performance across a range of applications, while minimising any potential adverse environmental and health impacts. Interdisciplinarity, integrating theoretical and experimental approaches, will be promoted.

The focus will be new knowledge on the interactions of atoms, molecules and their aggregations with both natural and artificial entities. The research will also address the relevant instruments, tools, pilot lines and demonstration activities required for highly novel approaches to nanotechnology-based manufacturing in the most promising industrial sectors.

In addition, the activity will focus on related challenges and the societal context and acceptance of nanotechnology. This will include research on all aspects of risk assessment (e.g. nano-toxicology and -ecotoxicology), as well as safety, nomenclature, metrology and standards which are becoming increasingly important to pave the way for industrial applications. Specific actions will also be launched for establishing dedicated centres of knowledge and expertise as well as a focal point to implement the Commission’s integrated and responsible approach towards nanotechnology as outlined in the associated Action Plan¹⁵.

• Materials

New advanced materials with higher knowledge content, new functionalities and improved performance are increasingly critical for industrial competitiveness and sustainable development. According to the new models of manufacturing industry, it is the materials themselves which are becoming the first step in increasing the value of products and their performance, rather than the processing steps.

Research will focus on developing new knowledge-based materials with tailored properties. This requires an intelligent control of intrinsic properties, processing and production, and taking into account potential impacts on health and the environment throughout their entire life-cycle. Emphasis will be placed on new advanced materials obtained using the potential of nanotechnologies and biotechnologies and/or “learning from nature”, in particular higher performance nano-materials, bio-materials and hybrid materials.

A multidisciplinary approach will be fostered, involving chemistry, physics and increasingly the biological sciences. Materials characterisation, design and simulation are also essential to better understand materials phenomena, in particular the structure–property relationships at different scales; to improve materials assessment and reliability, and to extend the concept of virtual materials for materials design. The integration of nanomolecular-macro levels in chemical and materials technologies will be supported for developing new concepts and processes such as in catalysis, and process intensification and optimisation.

¹⁵ Commission Communication, Nanosciences and Nanotechnologies: an action plan for Europe 2005-09 - COM(2005) 243.

- **New Production Technologies**

A new approach to manufacturing is required for the transformation of EU industry from a resource intensive to a knowledge-based industrial environment and will depend on the adoption of totally new attitudes towards the continued acquisition, deployment, protection and funding of new knowledge and its use, including towards sustainable production and consumption patterns. This entails creating the right conditions for continuous innovation (in industrial activities and production systems, including construction, devices, and services) and for developing generic production “assets” (technologies, organisation and production facilities) while also meeting safety and environmental requirements.

The research will focus on a number of strands: the development and validation of new industrial models and strategies covering all aspects of product and process life-cycle; adaptive production systems that overcome existing process limitations and enable new manufacturing and processing methods; networked production to develop tools and methods for co-operative and value-added operations at a global scale; tools for the rapid transfer and integration of new technologies into the design and operation of manufacturing processes; and the exploitation of the convergence of the nano-, bio-, info- and cognitive technologies to develop new products and engineering concepts and the possibility of new industries.

- **Integration of technologies for industrial applications**

The integration of knowledge and technologies of the three areas of research above is essential in order to speed up the transformation of European industry and its economy, while adopting a safe, socially responsible and sustainable approach.

The research will focus on new applications and novel, step-change solutions responding to major challenges, as well as to the RTD needs identified by the different European Technology Platforms. The integration of new knowledge and nano-, materials-, and production-technologies will be supported in sectoral and cross-sectoral applications such as health, construction, space industry, transport, energy, chemistry, environment, textiles and clothing, pulp and paper, and mechanical engineering, as well as in the generic subject of industrial safety.

International cooperation

The increasingly international dimension of industrial research requires a well-coordinated approach to working with third countries. International cooperation will therefore be important across the theme.

Specific actions may include: activities with industrialised countries and those having signed a S&T cooperation agreement in the fields of the Theme; specific initiatives with emerging economies and developing countries to secure their access to knowledge; dialogue with major countries on a “code of conduct” for the responsible and safe development of nanotechnology; and the Intelligent Manufacturing Systems (IMS) scheme, which allows RTD cooperation between its member regions¹⁶. Initiatives to coordinate and exchange research data will be encouraged (such as in environmental and health safety issues for nanotechnologies), paving the way for a common understanding of regulatory needs by policy makers across the world.

Responding to emerging needs and unforeseen policy needs

Research on emerging needs will be implemented notably to develop and consolidate European capabilities in specific emerging and interdisciplinary research areas with high potential for the future. Any unforeseen policy needs will be addressed in a flexible way and may, for example, relate to standardisation, to support the safe transformation towards a knowledge based industry, or to potential environmental and health impacts of nanotechnologies.

¹⁶ The agreement for scientific and technical cooperation in the domains of IMS is between the European Community and the United States of America, Japan, Australia, Canada, Korea and the EFTA States of Norway and Switzerland.