Nanoscience and nanotechnology; the EC

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Nanobiotechnology Research Group
EU/EC research funding

Grant/role	Amount (€)	Period
EU CRAFT Exploratory award	29,300	2000
EU RTD Project CHEMAG GRD2 - 2000 – 30122 (Project Coordinator)*	5.207 million	2001-2005
EU CRAFT Project CRAF-1999-70675 (Project Coordinator)#	1.427 million	2001-2004
EU FP6 Integrated project NACBO NMP4-CT-2004-500804 (Project Coordinator)	11 million	2005-2010
EU FP6 STREP project SELECTNANO NMP3-CT-2005-516922 (Project Partner)	270,000	2005-2009
EU FP6 Integrated project CHILL ON FOOD-CT-2005-016333 (Project Partner)	809,000	2006-2011

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* RTD Activities of a Generic Nature : materials and their technologies for production and transformation and new and improved materials and production technologies in the steel field

\# SME led collaborative research

Principal collaborations

Industry
Royal Dutch Philips (Medical Systems Division) (NL)
Sigma Aldrich (US)
Degussa AG/Evonik Industries (D)
Thermo Fisher Scientific (US/UK)

Governmental organisations
Health Protection Agency (Central Public health Laboratory) (UK)
Istituto Superiore di Sanita` (I)
National Institutes of Health/National Cancer Institute (US)

Universities/Research Institutes
The Hebrew University of Jerusalem (IL)
Bar Ilan University (IL)
Universita` degli Studi di Urbino (I)
Shemyakin-Ovchinnikov Institute of Bioorganic Chemistry
Russian Academy of Sciences (RU)
East China University of Science and Technology (PRC)

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Nano- and microparticulates

Silicon oxide

Crystalline
or
Amorphous

Porous
or
Nonporous

Iron oxide

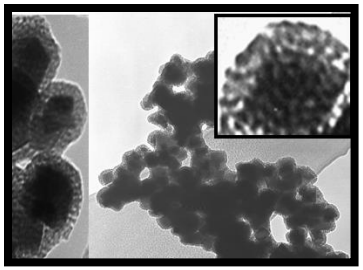
Superparamagnetic
with controlled size
and morphology

Polymeric

Agarose
Polystyrene
etc.

Nanocomposites

Semiconductors
(Quantum dots)



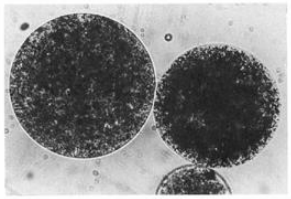
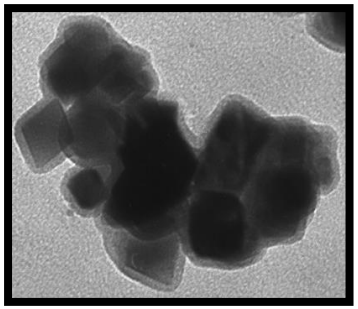
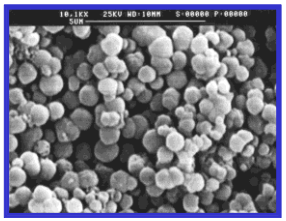
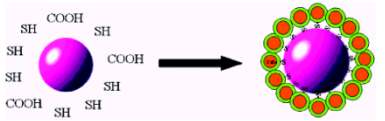


FIG. 2. MSPS beads examined under a light microscope set up for Köhler illumination.







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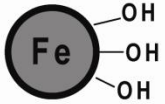
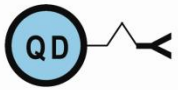
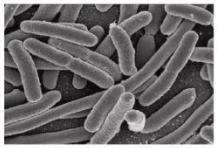
Other bio-materials and their applications

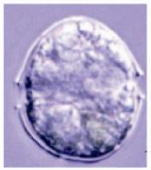




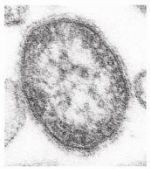
Bioseparation (DNA, RNA, protein)



B. cepacia strain 2a
P. aeruginosa PA01
L. monocytogenes
E. coli



A. minutum



Measles

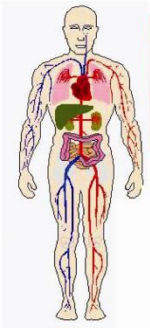
Soybeans

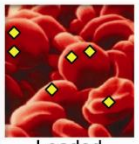
Contrasing agent

MRI

Magnetic RBC

Targeted drug delivery





Loaded Magnetic RBC

Detection of pathogens

Harmful algae

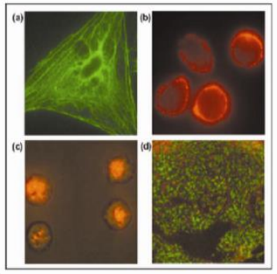
A. catenella

Food pathogens

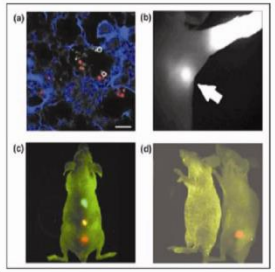
L. monocytogenes

Cellular imaging

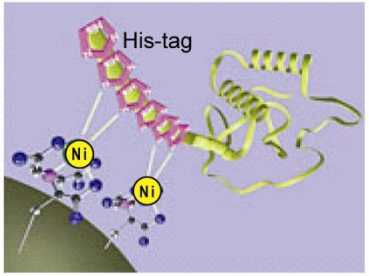
In vitro



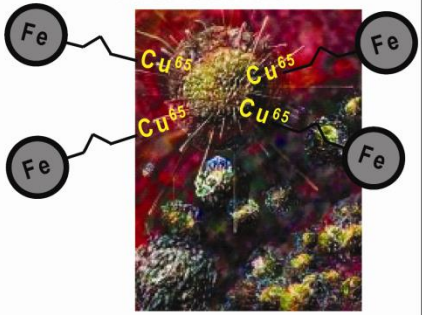
In vivo



Protein purification



Cancer treatment



Bruce IJ *et al* (2004) Aquaculture, 237, 391-405
Bruce IJ *et al* (2004) Food Microbiol., 21, 597-603
Bruce IJ *et al* (2005) J. Appl. Phycol., 17, 223-229
Bruce IJ *et al* (2006) Appl. Microbiol., 100, 375-383
Bruce IJ *et al* (2006) J. Appl. Microbiol., 101, 36-43
Magnani M, Galluzzi L and Bruce IJ (2006) J Nanosci. Nanotech. 6, 2302–2311
Bruce IJ *et al* (2007) Science Progress, *90 (1),* 29-50
Hertz A and Bruce IJ (2007) Nanomedicine 2(6), 899-918
Sebastianelli A, Sen T and Bruce IJ (2008) Letts. Appl. Microbiol. 46 (2008) 488–491
Bruce IJ *et al* (2009) J. Rapid. Meth. Auto. Micro., 17(2), 195-213
Bruce IJ *et al* (2010) Food Microbiol., 27(5):580-5.

Tissue engineering

Inorganic composite monoliths constructed from ordered meso- and macroporous siliates and TiO_2

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Nanoparticlate technology; what it's relevant to and why are we interested

A library of nanoparticulates based upon;

- Superparamagnetic iron oxide (magnetite- Fe_3O_4)
- Silicon oxides
- Magnetite and silica composites (core shell structures)
- Titanium dioxide
- Surface functionalised quantum dots

Bruce IJ et al (2004) J. Magn. Magn. Mater., 284, 145-16
Bruce IJ *et al* (2004) Chem. Commun,, 560-561
Bruce IJ *et al* (2005) J. Am. Chem. Soc., 127, 11998-12006.
Bruce IJ *et al* (2005) J. Magn. Magn. Mater., 293, 33-40
Bruce IJ and Sen T (2005) Langmuir, 21, 7029-7035
Bruce IJ *et al* (2006) J. Am. Chem. Soc., 128, 7130-7131
Sen T and Bruce IJ (2006) Micro Nano Lett., 1 (1), 39-42
Bagshaw SA and Bruce IJ (2008) Micropor. Mesopor. Mat., 109, 199–209
Sen T and Bruce IJ (2009) Micropor. Mesopor. Mat., 120 (3), 246-251
Bruce IJ *et al* (2010) Chem. Commun., 46, 6807-6809
Bruce IJ *et al* (2010) Micro Nano Lett., 5(5), 282-285
Bruce IJ *et al* (2011) Nanomedicine, 6(2), 211-223
Bruce IJ *et al* (2011) J. Colloid Inter. Sci., 357, 50-55
Bruce IJ *et al* (2011) Langmuir, 27, 13888–13896
Bruce IJ *et al* (2012) J. Colloid Inter. Sci., 367(1), 293-304
Bruce IJ *et al* (2012) Micropor. Mesopor. Mat., 156, 51–61
Bruce IJ *et al* (2012) Sci. Rep. 2, 564
Bruce IJ *et al* (2013) J. Magn. Magn. Mater. 328, 91-95

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Framework programmes

Framework Programme	Period	Budget (billions of €)
Brite* (First)	1984–1987	3.8
Brite-Euram+ I (Second)	1987–1991	5.4
Brite-Euram II (Third)	1990–1994	6.6
Brite-Euram III (Fourth)	1994–1998	13.2
Fifth	1998–2002	15.0
Sixth	2002–2006	17.9
Seventh	2007–2013	50.5 over 7 years + 2.7 for Euratom over 5 years
Horizon 2020 (Eighth)	2014–2020	80 (estimated)

http://ec.europa.eu/research/growth/competitive/pdf/competitive_en.pdf

- Basic Research in Industrial Technologies for Europe

\+ European Research in Advanced Materials

http://ec.europa.eu/research/brite-eu/impact2001/introduction_en.html

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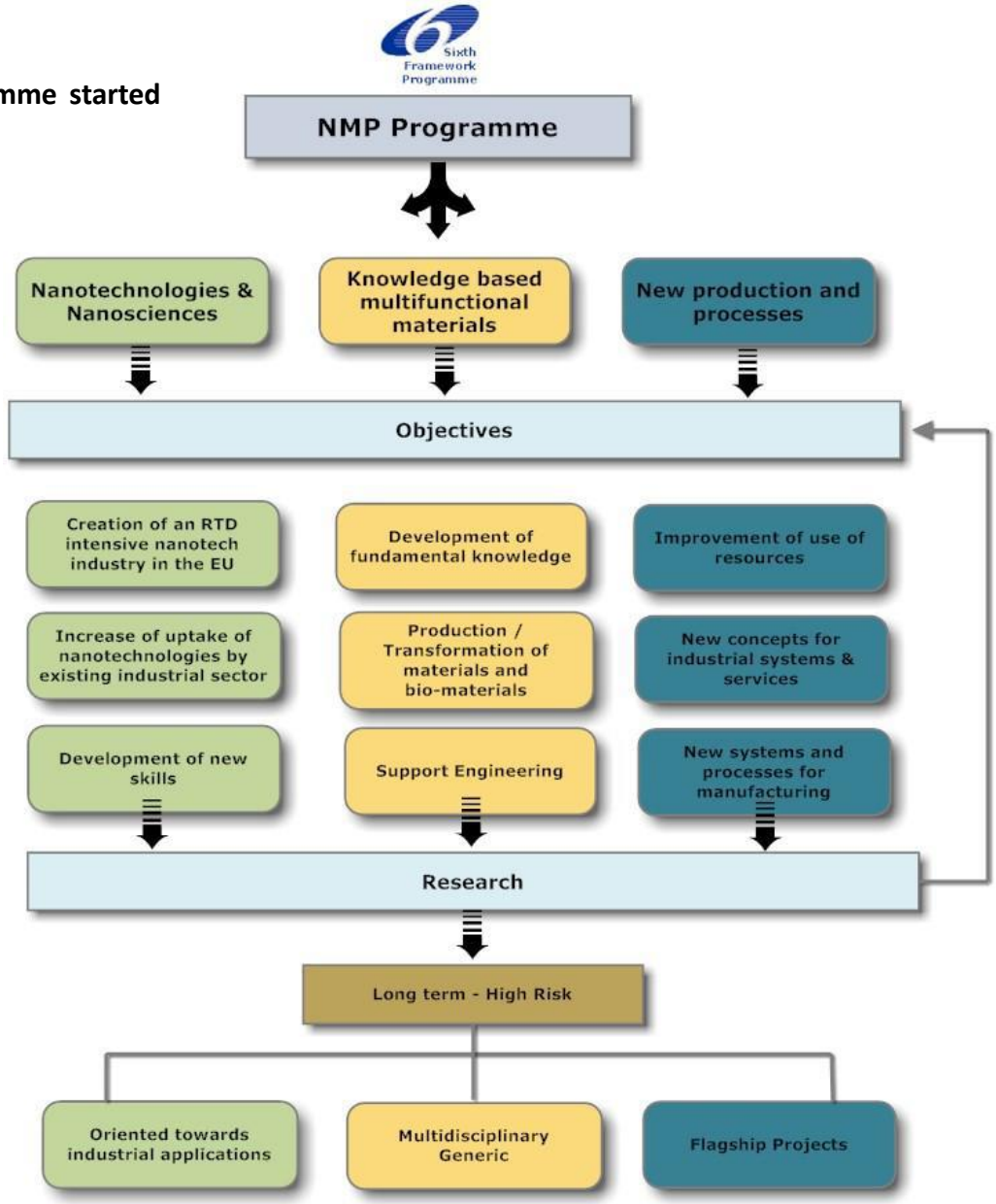
In 2003 the NMP programme started within FP6 (2002-2006)

Nanotechnology and nanosciences, knowledge-based multifunctional materials and new production processes and devices



FP6 NMP total budget €2348.77m (EC contribution €1,442.68m), 444 projects, 8.6% of total FP6 budget

FP7 activity areas

Capacities

1. International Cooperation
2. Regions of Knowledge
3. Research for the Benefit of SMEs
4. Research Infrastructures
5. Research Potential of Convergence Regions
6. Science in Society
7. Support to the Coherent Development of Research Policies

Cooperation

1. Energy
2. Environment (including Climate Change)
3. Food, Agriculture and Fisheries, Biotechnology
4. Health
5. Information and Communication Technologies
6. Nanosciences, Nanotechnologies, Materials & New Production Technologies
7. Security
8. Socio-economic Sciences and the Humanities
9. Space
10. Transport (including Aeronautics)

Ideas

European Research Council

People

Marie-Curie Actions

- Industry Academia
- Initial Training
- International Dimension
- Life-long Training
- Researchers' Night

ERA-NET

Joint Technology Initiatives

The Seventh Framework Programme of the European Atomic Energy Community (Euratom) for nuclear research and training activities (2007 to 2011)

Direct Actions

Indirect Actions

- Fusion Energy Research
- Nuclear Fission and Radiation Protection

Joint Research Centre

Other R&D Programmes

Research Fund for Coal and Steel

ETP - European Technology Platforms

ESTEP - European Steel Technology Platform

IMS - Intelligent Manufacturing Systems

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FP7 NMP total budget €4,658.44 (EC contribution €3,229.37m), 799 projects, 6.8% of total FP7 budget

EC research and innovation funding 2014-20

Direct funding

- **H2020**
- **Research Fund for Coal & Steel**

The Research Fund for Coal and Steel (RFCS) provides funding for high quality research projects which support the competitiveness of the European Coal and Steel industries. The programme covers core production processes; new products and applications, quality control, utilisation and conversion of resources, safety at work, environmental protection by reduction of emissions from coal use and steel production, and social issues

- **COSME**

COSME is the EU programme for the Competitiveness of Enterprises and Small and Medium-sized Enterprises (SMEs) planned budget of €2.3bn.

- **3rd Health Programme**

The Third EU Health Programme is the main instrument that the Commission uses to implement the EU Health Strategy.

- **Consumer Programme**

The Consumer Programme with a budget of EUR 188.8 million will support EU consumer policy. It aims to help citizens fully enjoy their consumer rights and actively participate in the Single Market.

Indirect funding

- Public-Public Partnerships by several Member States
- Public-Private Partnerships ("Joint Technology Initiatives")
- Co-funded activities (ERA-NETs; European Joint Programmes)
- Competitive calls published by consortia of FP7 projects
- Funding opportunities for innovation in other EU or national programmes

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Horizon 2020 (H2020)

- *"Horizon 2020 is the financial instrument implementing the Innovation Union, a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness ……..with nearly €80 billion of funding available over 7 years (2014 to 2020) – in addition to the private investment that this money will attract"* *http://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020*

- *"Funding opportunities under Horizon 2020 are set out in multiannual work programmes, which cover the large majority of support available".*
  http://ec.europa.eu/programmes/horizon2020/en/what-work-programme

- *"…preparation of work programmes involves the consultation of stakeholders". 19 Horizon 2020 Advisory Groups have been set up as consultative bodies representing the broad constituency of stakeholders from industry and research to representatives of civil society. Additional open and targeted consultation activities obtain further views and contributions, including the Enterprise Policy Group, European Innovation Partnerships and European Technology Platforms"*
  http://ec.europa.eu/programmes/horizon2020/en/what-work-programme

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Horizon 2020 (H2020)

'Horizon 2020 focuses resources on three distinct, yet mutually reinforcing, priorities, where there is clear Union added value. These priorities correspond to those of Europe 2020 and the Innovation Union'.

- **Excellent Science**. Raising the level of excellence in Europe's science base to ensure Europe's long-term competitiveness. Supporting the best ideas, developing talent within Europe, providing researchers with access to priority research infrastructure, and making Europe an attractive location for the world's best researchers.

- **Industrial Leadership**. To make Europe a more attractive location to invest in research and innovation (including eco-innovation), by promoting activities where businesses set the agenda. Representing a major investment in key industrial technologies, maximising the growth potential of European companies by providing them with adequate levels of finance and helping innovative SMEs grow into world-leading companies.

- **Societal Challenges.** Reflects the policy priorities of the Europe 2020 strategy and addresses major concerns shared by citizens in Europe and elsewhere. Brings together resources and knowledge across different fields, technologies and disciplines, including social sciences and the humanities. Covers activities from research to market with a focus on innovation-related activities, such as piloting, demonstration, test-beds, and support for public procurement and market uptake. Includes establishing links with the activities of the European Innovation Partnerships.

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H2020 Funding (1)

Excellent Science	€ million
European Research Council (ERC) Frontier research by the best individual teams	13 095
Future & emerging technologies (FETs) Collaborative research to open new fields of innovation	2 696
Marie Skłodowska-Curie actions (MSCA) Opportunities for training and career development	6 162
Research infrastructures (including e-infrastructure) Ensuring access to world-class facilities	2 488

Industrial Leadership	€ million
Leadership in enabling & industrial technologies (LEITs) (ICT, nanotechnologies, materials, biotechnology, manufacturing, space)	13 557
Access to risk finance Leveraging private finance & venture capital	2 842
Innovation in SMEs Fostering all forms of innovation in all types of SMEs	616

http://ec.europa.eu/research/participants/docs/h2020-funding-guide/grants/applying-for-funding/find-a-call/h2020-structure-and-budget_en.htm

Societal Challenges	€ million
Health, demographic change & wellbeing	7 472
Food security, sustainable agriculture and forestry, marine/maritime/inland water research and the bioeconomy	3 851
Secure, clean & efficient energy	5 931
Smart, green & integrated transport	6 339
Climate action, environment, resource efficiency & raw materials	3 081
Inclusive, innovative & reflective societies	1 310
Secure societies	1 695

*Additional funding for nuclear safety and security from the Euratom Treaty activities (2014-2018)

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Funding (2)

Joint Technology Initiatives (JTIs) (with industry)

- Innovative Medicines Initiative 2 (IMI2) http://www.imi.europa.eu/
- Clean Sky (Aeronautics) 2 (CS2) http://www.cleansky.eu/
- Fuel Cell and Hydrogen 2 (FCH2) http://www.fch.europa.eu/
- Bio-based Industries (BBI) http://biconsortium.eu/
- Electronic components & systems (ECSEL) (merger of the ARTEMIS embedded systems JTI and the ENIAC nanoelectronics JTI set up in 2008) http://www.ecsel-ju.eu/web/index.php
- Shift2Rail

Public public partnerships

- Through « ERA-Nets » for topping up individual calls/actions (replacing current ERA-Net, ERA-Net Plus, Inco-Net, Inno-net)
- Through participation in joint programmes between Member States (Art. 185)
- Supporting agendas of Joint Programming Initiatives when in line with Horizon 2020.

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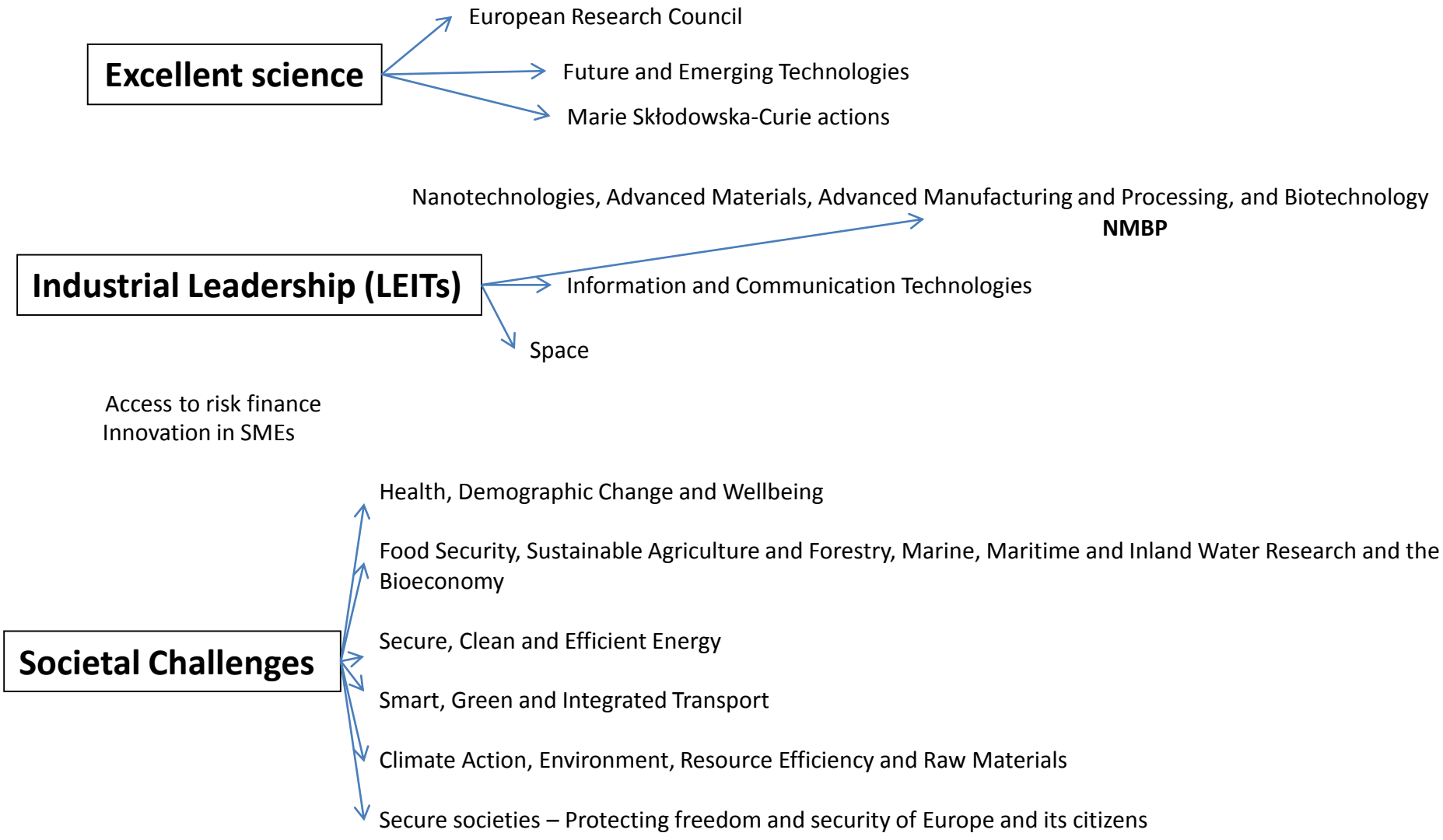
H2020 (work) programme sections with potential relevance to nano-



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Fast Track to Innovation Pilot (2015-2016)

European Research Council

Established by the European Commission

The European Research Council supports frontier research, cross disciplinary proposals and pioneering ideas in new and emerging fields which introduce unconventional and innovative approaches.

Principles

- 1 researcher; 1 host institution; 1 project; 1 selection criterion: scientific excellence
- No consortia, no networks, no co-financing
- Applications can be made in any field of research, including social sciences and humanities
- Independent researchers from anywhere in the world, of any age and career stage can apply
- Host institutions must provide conditions for the researcher to direct the research and manage its funding
- The grant is 'portable' to another host institution
- Research must be carried out in one of the 28 EU member states or associated countries

Funding streams

- **ERC Starting Grant** for young, early-career top researchers (2-7 years after PhD) -up to 2 million euro for a period of 5 years.
- **ERC Consolidator Grant** for already independent excellent researchers 7-12 years after PhD) -up to 2.75 million euro for a period of 5 years.
- **ERC Advanced Grant** for senior research leaders with significant research achievements in the last 10 years -up to 3.5 million euro for a period of 5 years.
- **ERC Proof of Concept Grants** for ERC grant holders who want to check the market and/or innovation potential of research results from ERC-projects -up to 150,000 euro for a period of 12 months.
- **ERC Synergy Grants** for small groups of individual researchers -up to 15 million euro for a period up to 6 years.

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Future and Emerging Technologies

Future and Emerging Technologies (FET) go beyond what is known! Visionary thinking can open up promising avenues towards powerful new technologies.

FET lines

- **FET Open** funds projects on new ideas for radically new future technologies, at an early stage when there are few researchers working on a project topic. This can involve a wide range of new technological possibilities, inspired by cutting-edge science, unconventional collaborations or new research and innovation practices.

- **FET Proactive** nurtures emerging themes, seeking to establish a critical mass of European researchers in a number of promising exploratory research topics. This supports areas that are not yet ready for inclusion in industry research roadmaps, with the aim of building up and structuring new interdisciplinary research communities.

- **FET Flagships** are 1-billion, 10-years initiatives where hundreds of excellent European researchers unite forces to focus on solving an ambitious scientific and technological challenge, like understanding the Human Brain or developing the new materials of the future, such as Graphene.

Marie Skłodowska-Curie actions

The Marie Skłodowska-Curie actions (MSCA) provide grants for all stages of researchers' careers for transnational, intersectoral and interdisciplinary mobility. The MSCA enable research-focused organisations (universities, research centres, and companies) to host talented foreign researchers and to create strategic partnerships with leading institutions worldwide

Types of MSCA

- **Research networks (ITN): support for Innovative Training Networks**
  ITNs support competitively selected joint research training and/or doctoral programmes, implemented by European partnerships of universities, research institutions, and non-academic organisations.The research training programmes provide experience outside academia, hence developing innovation and employability skills. ITNs include industrial doctorates and joint doctoral degrees delivered by several universities. Furthermore, non-European organisations can participate as additional partners in ITNs, enabling doctoral-level candidates to gain experience outside Europe during their training.

- **Individual fellowships (IF): support for experienced researchers undertaking mobility between countries, optionally to the non-academic sector**
  Individual Fellowships support the mobility of researchers within and beyond Europe - as well as helping to attract the best foreign researchers to work in the EU. The grant usually covers two years' salary, a mobility allowance, research costs and overheads for the host institution. Individual researchers submit proposals for funding in liaison with their planned host organisation. Proposals are judged on their research quality, the researcher's future career prospects, and the support offered by the host organisation. Fellows can also spend part of the fellowship elsewhere in Europe if this would boost impact, and those restarting their career in Europe benefit from special eligibility conditions.

- **International and inter-sectoral cooperation through the Research and Innovation Staff Exchanges (RISE)**
  RISE supports short-term mobility of research and innovation staff at all career levels, from the most junior (post-graduate) to the most senior (management), including also administrative and technical staff. It is open to partnerships of universities, research institutions, and non-academic organisations both within and beyond Europe. In worldwide partnerships, academia-to-academia exchanges are permitted.

- **Co-funding of regional, national and international programmes that finance fellowships involving mobility to or from another country (COFUND)**
  The MSCA offer additional funding to regional, national and international programmes for research training and career development. COFUND programmes encourage the movement of researchers across borders and provide good working conditions. The scheme can support doctoral and fellowship programmes.

Leadership in Enabling and Industrial Technologies (NMBP)

http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/main/h2020-wp1415-leit-nmp_en.pdf

Bridging the gap between nanotechnology research and markets
NMP 1 – 2014: Open access pilot lines for cost-effective nanocomposites
NMP 2 – 2015: Integration of novel nanomaterials into existing production lines
NMP 3 – 2015: Manufacturing and control of nanoporous materials
NMP 4 – 2014: High definition printing of multifunctional materials
NMP 5 – 2014: Industrial scale production of nanomaterials for printing applications
NMP 6 – 2015: Novel nanomatrices and nanocapsules
NMP 7 – 2015: Additive manufacturing for table-top nanofactories

Nanotechnology and Advanced Materials for more effective Healthcare
NMP 8 – 2014: Scale-up of nanopharmaceuticals production
NMP 9 – 2014: Networking of SMEs in the nano-biomedical sector
NMP 10 – 2014: Biomaterials for the treatment of diabetes mellitus
NMP 11 – 2015: Nanomedicine therapy for cancer
NMP 12 – 2015: Biomaterials for treatment and prevention of Alzheimer's disease

Nanotechnology and Advanced Materials for low-carbon energy technologies and Energy Efficiency
NMP 13 – 2014: Storage of energy produced by decentralised sources
NMP 14 – 2015: ERA-NET on Materials (including Materials for Energy)
NMP 15 – 2015: Materials innovations for the optimisation of cooling in power plants
NMP 16 – 2015: Extended in-service life of advanced functional materials in energy technologies (capture, conversion, storage and/or transmission of energy)
NMP 17 – 2014: Post-lithium ion batteries for electric automotive applications

Exploiting the cross-sector potential of Nanotechnologies and Advanced materials to drive competitiveness and sustainability
NMP 18 – 2014: Materials solutions for use in the creative industry sector
NMP 19 – 2015: Materials for severe operating conditions, including added-value functionalities
NMP 20 – 2014: Widening materials models
NMP 21 – 2014: Materials-based solutions for the protection or preservation of European cultural heritage
NMP 22 – 2015: Fibre-based materials for non-clothing applications
NMP 23 – 2015: Novel materials by design for substituting critical materials
NMP 24 – 2015: Low-energy solutions for drinking water production
NMP 25 – 2014/2015: Accelerating the uptake of nanotechnologies, advanced materials or advanced manufacturing and processing technologies by SMEs

Safety of nanotechnology-based applications and support for the development of regulation
NMP 26 – 2014: Joint EU & MS activity on the next phase of research in support of regulation "NANOREG II"
NMP 27 – 2014: Coordination of EU and international efforts in safety of nanotechnology
NMP 28 – 2014: Assessment of environmental fate of nanomaterials
NMP 29 – 2015: Increasing the capacity to perform nano-safety assessment
NMP 30 – 2015: Next generation tools for risk governance of nanomaterials

Addressing generic needs in support of governance, standards, models and structuring in nanotechnology, advanced materials and advanced manufacturing and processing
NMP 31 – 2014: Novel visualisation tools for enhanced nanotechnology awareness
NMP 32 – 2015: Societal engagement on responsible nanotechnology
NMP 33 – 2014: The Materials "Common House"
NMP 34 – 2014: Networking and sharing of best practices in management of new advanced materials through the eco-design of products, eco-innovation, and product life cycle management
NMP 35 – 2014: Business models with new supply chains for sustainable customer-driven small series production
NMP 36 – 2014: Facilitating knowledge management, networking and coordination in NMP
NMP 37 – 2014: Practical experience and facilitating combined funding for large-scale RDI initiatives
NMP 38 – 2014/2015: Presidency events
NMP 39 – 2014: Support for NCPs
NMP 40 – 2015: Support for clustering and networking in the micro- & nanofluidics community

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H2020 action types (funding schemes)

Type of action	Description	Reimbursement rate
Research & Innovation	Activities aiming to establish new knowledge and/or to explore the feasibility of a new or improved technology, product, process, service or solution. For this purpose they may include basic and applied research, technology development and integration, testing and validation on a small-scale prototype in a laboratory or simulated environment. Projects may contain closely connected but limited demonstration or pilot activities aiming to show technical feasibility in a near to operational environment	100%
Innovation	Activities directly aiming at producing plans and arrangements or designs for new, altered or improved products, processes or services. For this purpose they may include prototyping, testing, demonstrating, piloting, large-scale product validation and market replication.	100% non-profit 70% for profit
ERC		100%
Marie Skłodowska-Curie		100%

http://ec.europa.eu/research/participants/docs/h2020-funding-guide/grants/applying-for-funding/find-a-call/h2020-structure-and-budget_en.htm

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Vinča Nuclear Institute
Belgrade, Serbia

- Founded 1946 . Nuclear sciences research institute. Now part of the University of Belgrade
- Two pressurised water cooled research reactors. Decommissioned 1984 and 2010
- Currently attempting to diversify research portfolio
- Isotope production for medical imaging and therapy

FP7-REGPOT ERACHAIRS-2013-1 (capacity building)

Strengthening of the MagBioVin Research and Innovation Team for Development of Novel Approaches for Tumour Therapy based on Nanostructured Materials

Total cost:
EUR 2 796 660
EU contribution:
EUR 2 243 828

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