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Synthetic Biology activities in European Biotechnology Programmes

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DG-Research

Biotechnologies, Agriculture and Food

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What is Synthetic Biology?

Synthetic biology is the engineering of biology: the synthesis of complex, biologically based (or inspired) systems which display functions that do not exist in nature. This engineering perspective may be applied at all levels of the hierarchy of biological structures – from individual molecules to whole cells, tissues and organisms. In essence, synthetic biology will enable the design of ‘biological systems’ in a rational and systematic way.

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SYNTHETIC BIOLOGY

a new conceptual frame that:

- **[i]** addresses biological systems with the tools and the descriptive language of Engineering
- **[ii]** tackles old questions and challenges with fresh approaches inspired in electric circuitry and mechanical manufacturing and
- **[iii]** pursues the creation of new materials with *à la carte* properties based on the rational combination of standardized biological parts decoupled from their natural context.

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The NEST PATHFINDER initiative on "Synthetic Biology"

...was launched in 2003. Following two calls for proposals, 18 projects have been selected for funding. These projects apply design and engineering principles to biology with the aim to construct new functionalities and novel artificial systems based on sub-cellular biological building blocks.

A high-level expert group was established in 2005 with the aim, to examine, forecast and describe this new and emerging scientific field, its potential impact and support needs. (2005)

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- **BIOMODULAR H2:** Energy project promises a new biotechnology
- **BIONANO –SWITCH:** Matching up living organisms with computers
- **CELLCOMPUT:** Building computers in the body
- **COBIOS:** Solution for complex diseases
- **EMERGENCE:** Coordination puts synthetic biology on firm footing
- **EUROBIOSYN:** A sweeter way to make saccharides

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- FuSyMEM: Functional synthetic membranes to mimic nature's sense of smell
- HIBLIB: Monoclonal antibody production made quick and easy
- NANOMOT: Nature's motors tuned for delivery on demand
- NEONUCLEI: Synthetic analogues of cell nuclei
- NETSENSOR: Genes join up to detect and defend
- ORTHOSOME: When artificial nucleic acids control microbial genetics

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- **PROBACTYS**: Programming bacterial catalysts *à la carte*
- **SYNBIOCOMM**: Pushing the boundaries further
- **SYNBIOLOGY**: A European perspective on synthetic biology
- **SYNBIOSAFE**: Safety and ethics of synthetic life
- **TESSY**: Foundations for a European synthetic biology

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What can the field deliver?

- Biomedicine
- Synthesis of biopharmaceuticals
- Sustainable chemical industry
- Environment and energy
- Production of smart materials and biomaterials
- Security: counter-bioterrorism

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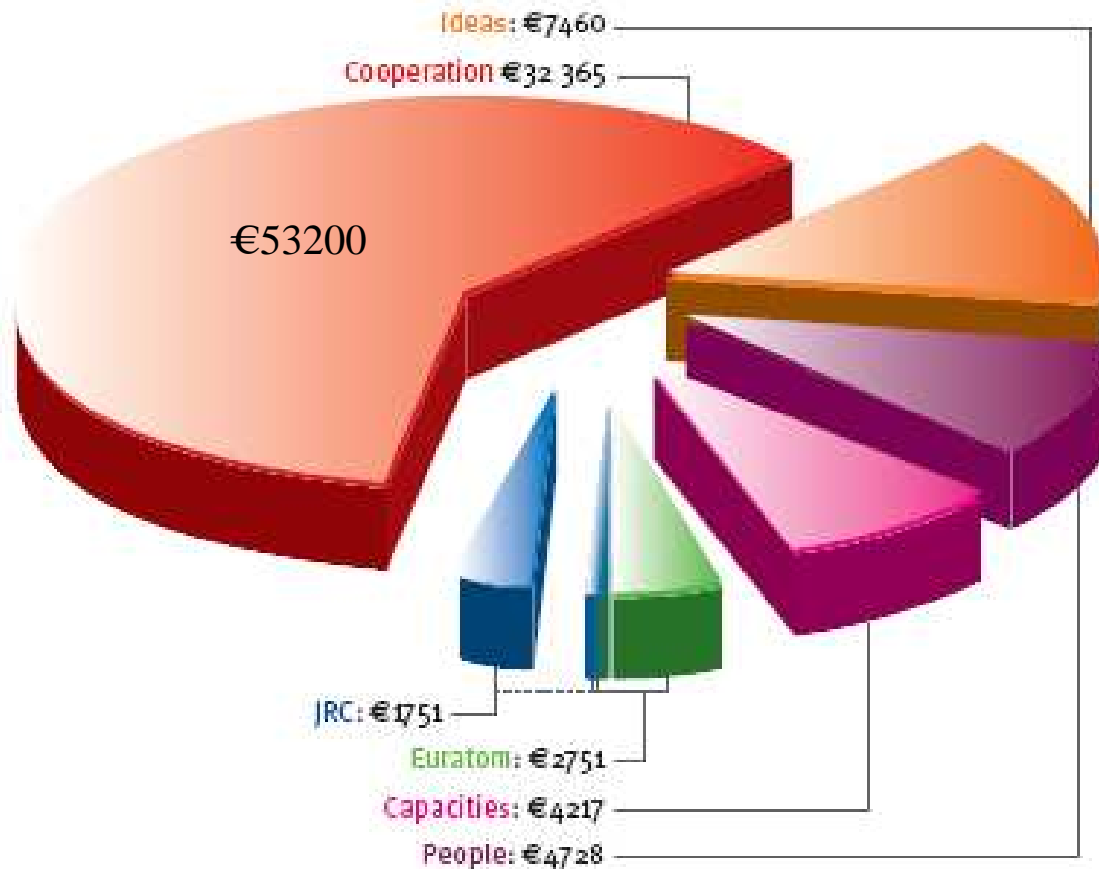


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The Seventh framework programme for Research and technological Development (FP 7)

The indicative breakdown (€ million) of FP7



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SEVENTH FRAMEWORK
PROGRAMME

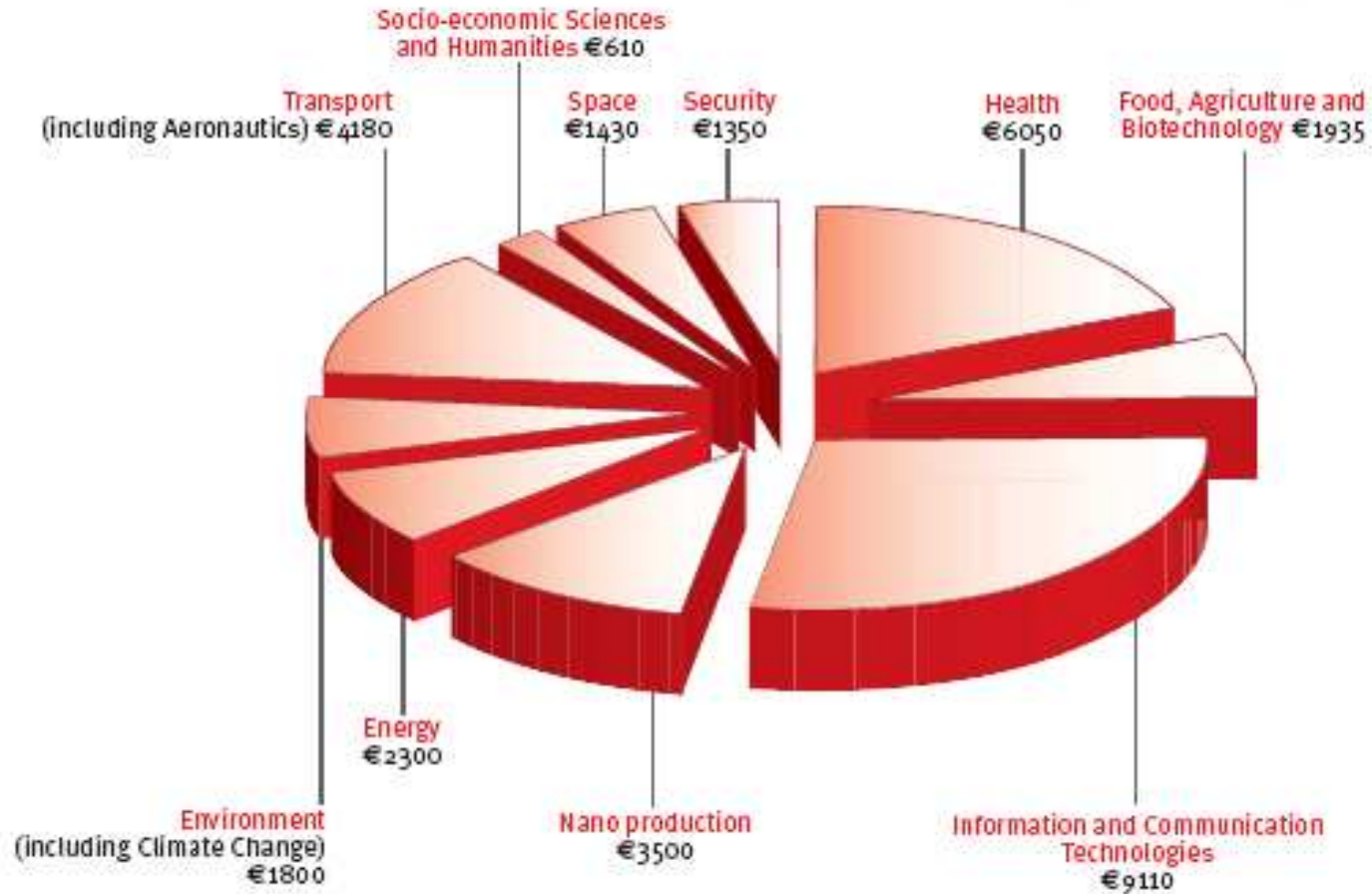


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The Cooperation Programme

The Cooperation Programme breakdown (€ million)



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Synthetic biology in Knowledge-based Bioeconomy

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THE EUROPEAN KNOWLEDGE-BASED BIOECONOMY

NUTRITION (nutrigenomics) - PATHOGENS
CONTAMINANTS - ALLERGENS

CONSUMER CHOICE

STABILITY - BIODEGRADABILITY
FUNCTIONALITY (Chirality)



TRACEABILITY SYSTEMS
ADVANCED FOOD TECHNOLOGIES

PROCESSING

WHITE BIOTECH
CLEAN BIOPROCESSES
RAW MATERIALS/WASTE

LOW INPUT FARMING - BIODIVERSITY
ANIMAL HEALTH - RURAL DEVT.

PRODUCTION

GREEN / BLUE BIOTECH
OPTIMISED RAW MATERIALS

SUSTAINABLE MANAGEMENT OF BIOLOGICAL RESOURCES



(LAND, FOREST, MARINE)



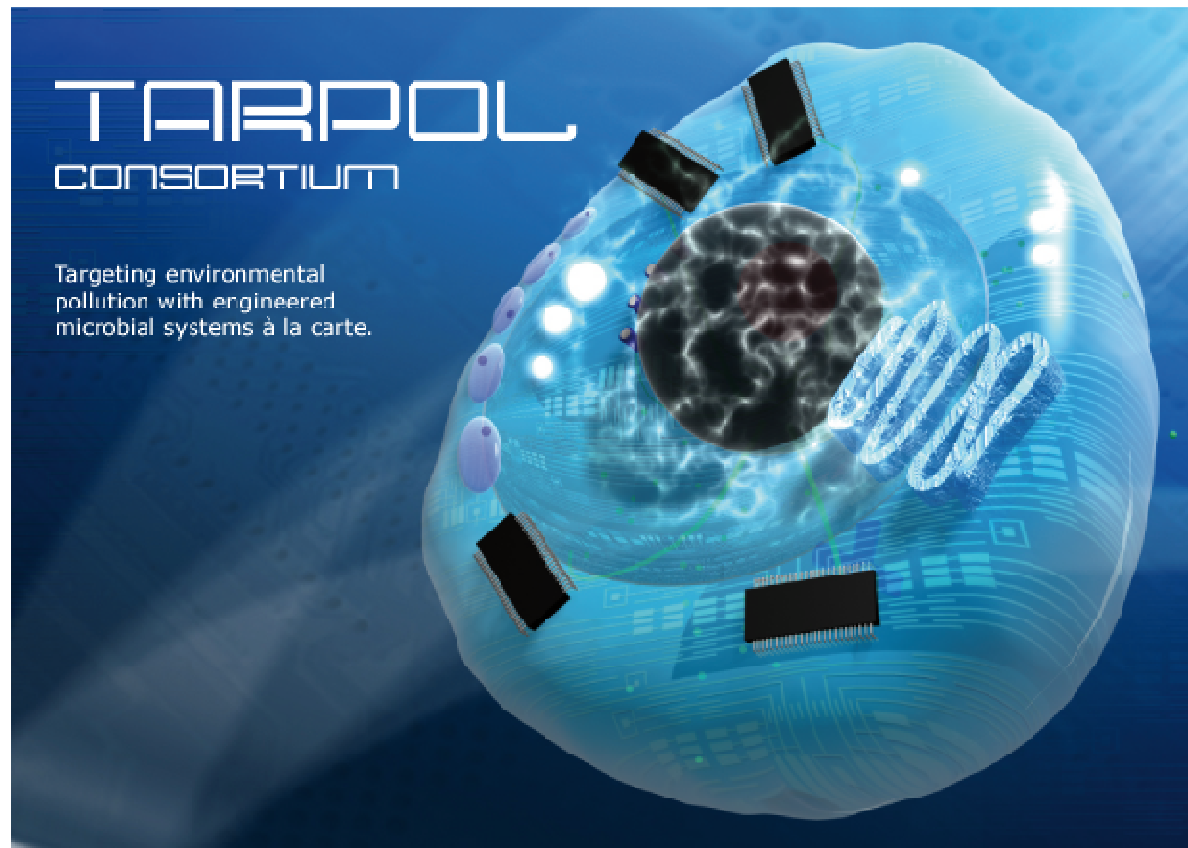


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KBBE-2007-3-3-01: SYNTHETIC BIOLOGY FOR THE ENVIRONMENT - The use of Synthetic Biology for the solution of environmental problems

Call: FP7-
KBBE-2007-1



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TARPOL: *Targeting environmental pollution with engineered microbial systems à la carte*

The 7 Work Packages are:

Conceptual Frame and Consensual Language Definition

Genetic Tools and Molecular Assets

Design and Modelling Tools

Biodegradation and Environmental Metabolism Database

Social, Economic and Environmental Assessment

Training Program and Dissemination

Project Management

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KBBE-2009-3-6-05: Synthetic biology for biotechnological applications

Synthetic biology enables a rational (engineering) recreation from basic elements of predetermined metabolic and catalytic properties. Synthetic biology may lead to minimal or even totally artificial microorganisms that can be used for microbial production processes with significant advantages in industrial or environmental biotechnology particularly where complex metabolic networks are required. Such as yet hypothetical microorganisms could be derived from natural microorganisms with a minimal set of genes (minimal microorganisms), or could be synthetically generated *de novo*, using a given set of essential genes (synthetic microorganism). ***The main objective is the design of artificial cells à la carte with predetermined metabolic or catalytic properties aiming at catalysing microbial production processes or at degrading recalcitrant compounds in the environment.*** Safety and ethical issues should be addressed within the project by involving experts in these areas. It is expected that technological achievements as well as issues of safety and ethics to be discussed at international research fora.

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BASYNTHEC: Bacterial Synthetic Minimal Genomes for Biotechnology

- Consortium of 8 partners
- modify à la carte the chromosome of *Bacillus subtilis*,
- cells with the lowest experimentally determined waste of energy and with industrially relevant phenotypes will be engineered to reroute the flux devoted to biomass formation through rational modifications of the complex metabolic regulations, and will be used as biotechnological platforms to plug in synthetic modules.

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SYNTH-ETHICS

- addresses the **ethical, legal and social implications** of the emerging field of synthetic biology, with a special focus on biosafety and biosecurity and on notions of life. The project starts with discerning relevant ethical issues in close collaboration with the synthetic biology community. Next, the public debates around these issues are analysed. The current ethical and regulative frameworks existing in synthetic biology and closely related fields like nanobiotechnology and genetic engineering will then be reconstructed and assessed for their ability to deal adequately with existing and newly emerging ethical issues in synthetic biology. On that basis, challenges for current regulatory and ethical frameworks will be identified and recommendations for dealing with these challenges will be formulated targeted at three relevant groups:
1) the synthetic biology community, 2) EU policy makers and
3) NGOs/the public

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SYBHEL

- Carry out high quality ethical research and evaluation of SynBio as it will impact on human health and well-being;
- Underpin research with a consistent awareness of the SYBHEL cross-cutting themes, namely: the definition of SynBio; scientific research (including documenting and regularly updating the state-of-the-art); safety and justice;
- Create a hub for all researchers and policy-makers interested in **ethical, legal and social issues arising in SynBio as it applies to human health** to meet and exchange ideas;
- Debate and agree key recommendations for regulation and commercialisation of SynBio as it applies to human health and well-being; and
- Determine a strategy for policy deliberation for SynBio in **human health.**

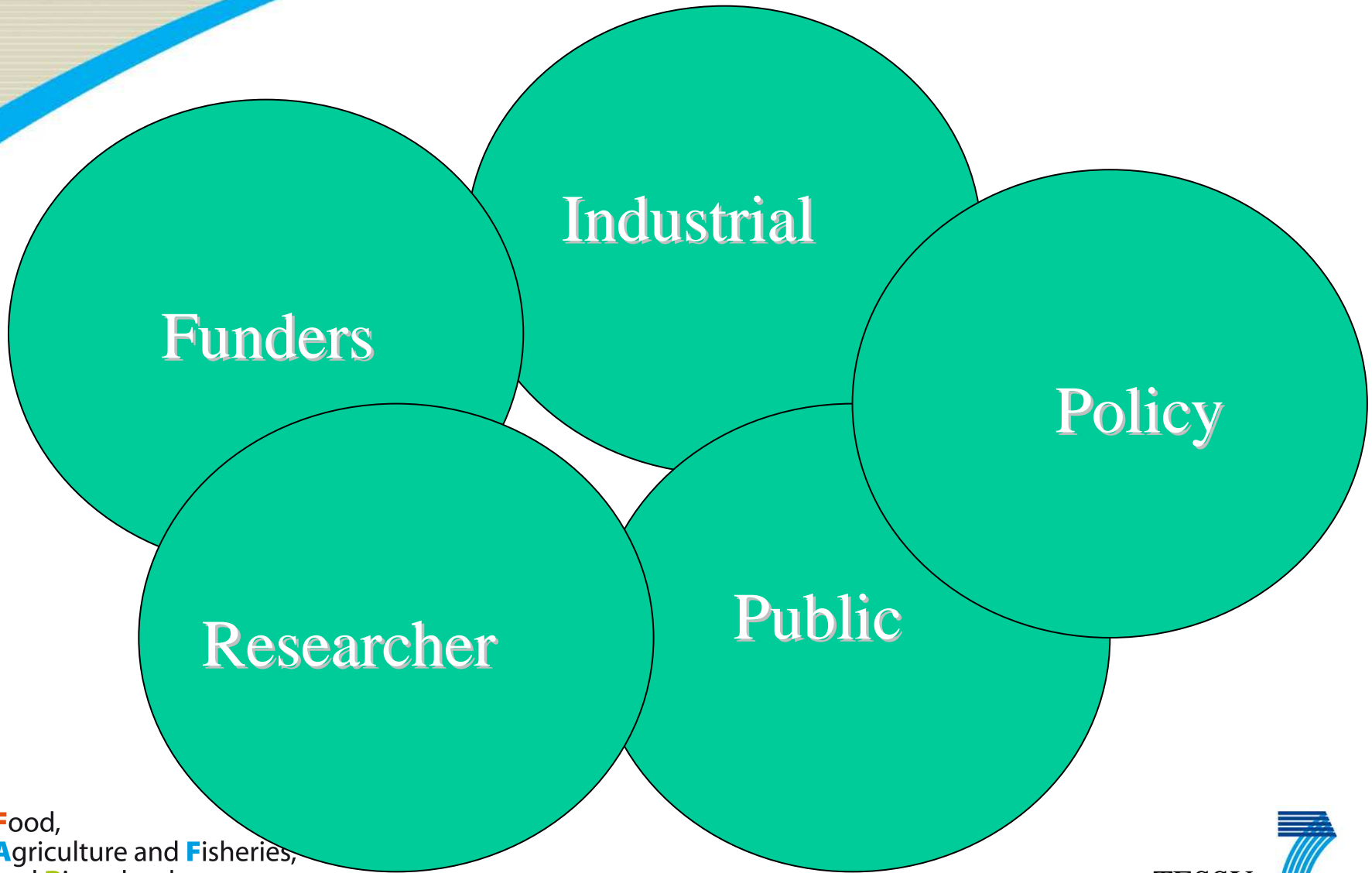
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The EC network for SB

- Themes and Programmes from FP 7 collaboration, ideas (ERC), people (fellowships)
- KBBE-net (WG on SB)
- European Group of Ethics - Opinion

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The EU network for SB

- The FP 7
- The European Science Foundation
- EMBL/EMBO
- The UK Royal Society
- The UK Royal Academy of Engineering

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The International Network for SB

- SB (International) Conferences
- The OECD (Working Party on Biotechnology)
- EC-US Task Force on Biotechnology Research

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