Future Developments in Nanobiotech

Main Results from a Worldwide Expert Survey

Why Expert Survey?

Creating a shared vision on future outcomes of NBT research

Prioritise 20 envisioned developments based on their impacts and commercialisation prospects/barriers

Estimate likely times of realisation (in the timeframe 2006-2030)

Identify needed measures to foster realisation

Identify (dis)agreements on key issues

Main value of such surveys is the elicitation of knowledge from a large number of experts; reflecting the professional opinion of the relevant community.

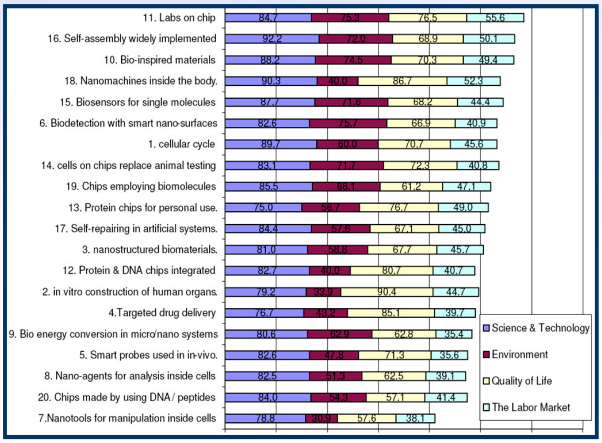
Participants:

139 experts from 30 countries (incl. 30 N2L members)
Europe- 58% US&Canada-21% Israel –9.4% RoW- 11.6%
University & Research Institutes – 73%
Industry – 9% Government & other – 18%
Male – 84% Female – 16%

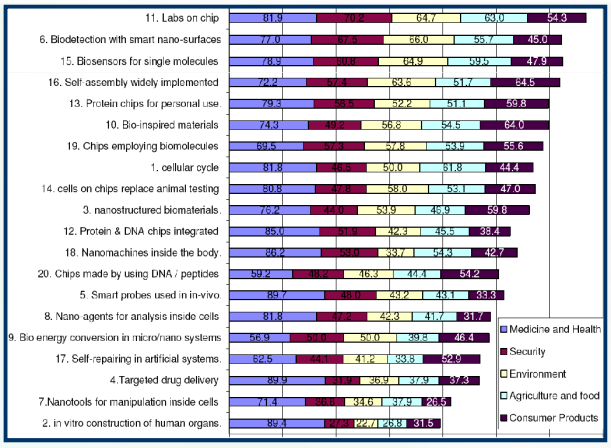
20 Statements on Future NBT Developments:

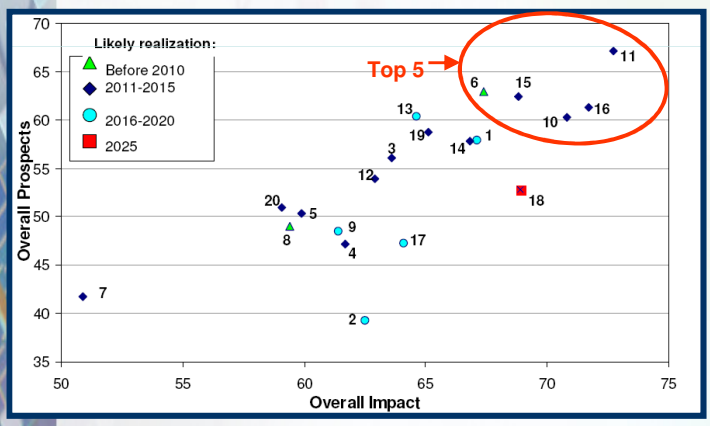
1. Thanks to NBT, fundamental processes of the ***cellular cycle*** are mostly understood.
2. Advancements in NBT enable the construction in vitro of ***artificial human organs***.
3. Novel ***nanostructured biomaterials*** replace existing materials (e.g. polymers).
4. ***Targeted drug delivery*** based on nanoparticles becomes a standard tool
5. ***Smart probes*** are practically used in diagnosis in-vivo.
6. Smart adaptable nanoscale surfaces are the basic building block for ***Biodetection***.
7. ***Nanotools*** are used for manipulation in cells (keeping the cells' integrity and activity).
8. ***Nanosized imaging agents*** (e.g. quantum dots) are used for analysis inside cells without affecting their normal functionality.
9. ***Biol. energy conversion*** systems are practically used in artificial micro/nano systems.
10. Advanced bioengineered materials based on ***bio-inspiration*** are widely used.
11. ***Labs on chip*** are widely used for various applications, including in households.
12. ***Protein chips*** are integrated with ***DNA chips*** for diagnosis in hospital practices.
13. ***Protein chips*** are widely used by the public for personal use.
14. In vitro tests based on ***cells on chips*** replace animal testing for various applications
15. ***Biosensors*** for single molecules based on nano arrays are commercially available.
16. ***Self-assembly*** is widely implemented for development of materials and devices.
17. Living ***self-repairing*** abilities are implemented in artificial systems.
18. ***Nano-machines for theranostics*** are practically used inside the body.
19. ***Chips employing biomolecules*** as active elements are commercially manufactured.
20. ***Nanoelectronics chips*** are commercially manufactured by ***using DNA or peptides*** (as templates or for nanopatterning).

Impact on Four Domains (low=0, high=100)



Commercialisation Prospects (low=0, high=100)





What limits commercialisation in the health sector? (examples, % of respondents)

Statement	Nothing limits	Many barriers
3. Nanostructured biomaterials	44.2	36.5
4.Targeted drug delivery	42.1	50.9
11. Labs on chip	42.1	44.7
12. Protein & DNA chips integrated	45.8	45.8
2. In vitro construction of human organs	22.0	75.6
17. Self-repairing in artificial systems	21.4	78.6
18. Nanomachines inside the body	28.6	71.4

disagreement | agreement

Actions needed to foster realisation (examples)	Increase in basic or applied research	Solve ethical problems or public acceptance
2. In vitro construction of human organs	78.0	62.0
5. Smart probes used in in-vivo	90.0	32.5
17. "Living" self-repairing in artificial systems	85.0	50.0
18. Theranostic nanomachines inside the body	85.7	57.1

Main Findings:

Practical applications of the selected developments will be realized mainly in medicine. In other areas, the commercialisation prospects are questionable (except topics 6,12,15 which are important for security and environment)

Much research still needed to develop the field and to identify potentially successful applications.

No critical limitations, except a few cases where issues of ethics and public acceptance are identified.

High priority topics are: *Labs on chip* (11), *Self-assembly* (16), *Materials based on bio-inspiration* (10), *Biosensors for of single molecules* (15), *Biodetection with smart nano-surfaces* (6).

The degree of agreement differs considerably among the 20 statements. Some topics exhibit high consensus, and other reveal marked disagreement. For example, 22% of the experts think that topic 17 will *never* be realised.

This calls for further discussions. Usually foresight surveys require several rounds in order to clarify controversial issues.

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