



## Nanomedicine A golden opportunity for the UK

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Nanomedicine – Integrated healthcare

## Topics addressed

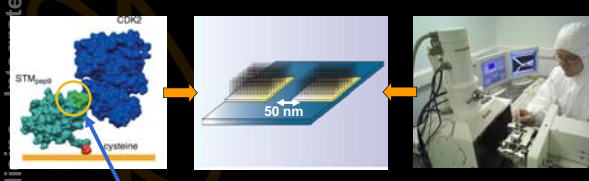
- What is nanomedicine?
- Examples of applications in oncology
- Role of Europe's FP7 NMP programme
- Opportunities for the UK



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## In Vitro Clinical Diagnostic Nanobiosensor

A peptide aptamer is a molecule that binds specifically to a target (e.g. aptamer pep9 binds to protein CDK2 - involved in cell cycles).



STM<sub>pep9</sub> cystine

50 nm


Aptamer (pep9) is inserted in a protein scaffold (STM). A cysteine group binds to electrode and changes the impedance between electrode and fluid changes

G Davies, E Linfield, C Walli & S Evans *et al.*, Journal of Biology 7, 3 (2008).

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## Theranostic Nanoparticle\*



(A-components) Non-classical drugs (APIs) for delivery into cells and intracellular trafficking.  
(B-lipid components), protection against short-term-degradation  
(C- stealth/ biocompatibility polymer layer components) and delivery to target cells  
(D- biological targeting ligand components).

Enables combined delivery of:

1. More effective and less toxic drugs - E.g. short interfering RNA (siRNA)
2. Multiple imaging agents



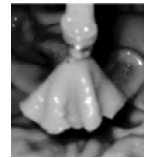
\*Miller A M and Thanou M, Kings College London

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## Nanomedicine-enabled Laparoscopic Surgery

Super paramagnetic iron oxide nanoparticles



Attachment between magnetised tissue and the magnetic probe

**Magnetic retraction  
Less stress to organs**




Figure 21A In vivo laparoscopic resections of fluorescently-labelled tumours

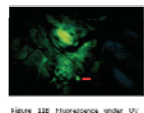


Figure 21B Fluorescence under UV light. Colon wall and the draining lymph nodes are shown in red arrows.

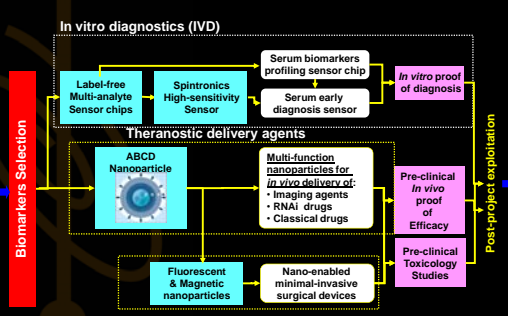
**Fluorescence imaging of Tumours guides resection**

Suh D *et al* 2009 & Neville A, Jayne D, 2010

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## Nanomedicine Strategy for GI & GU Cancers



**Patients' Needs** (Bio markers Selection) → **In vitro diagnostics (IVD)** → **Theranostic delivery agents** → **Minimal invasive surgery** → **Patients' Needs** (Post-project exploitation)

**In vitro diagnostics (IVD)** includes: Label-free Multi-analyte Sensor chips, Spintronics High-sensitivity Sensor, Serum biomarkers profiling sensor chip, Serum early diagnosis sensor, In vitro proof of diagnosis.

**Theranostic delivery agents** includes: ABCD Nanoparticle, Multi-function nanoparticles for in vivo delivery of: Imaging agents, RNAi drugs, Classical drugs, Pre-clinical In vivo proof of Efficacy.

**Minimal invasive surgery** includes: Fluorescent & Magnetic nanoparticles, Nano-enabled minimal-invasive surgical devices, Pre-clinical Toxicology Studies.

\* Leeds Institute of Molecular Medicine, Nanomanufacturing Institute & Leeds NHS Teaching Hospital Trust • Partners

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**Nanomedicine European Technology Platform**

- a. Diagnostic sensors
- b. Imaging
- c. Bone & Tissue Engineering
- d. Surgery
- e. Drug delivery
- f. Wound care
- g. Antiviral applications
- h. Health & safety

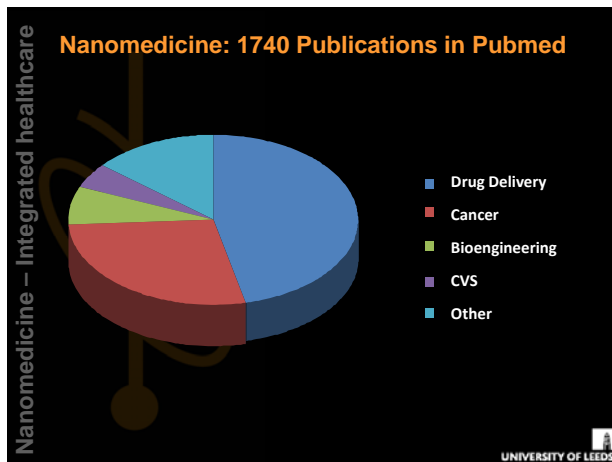
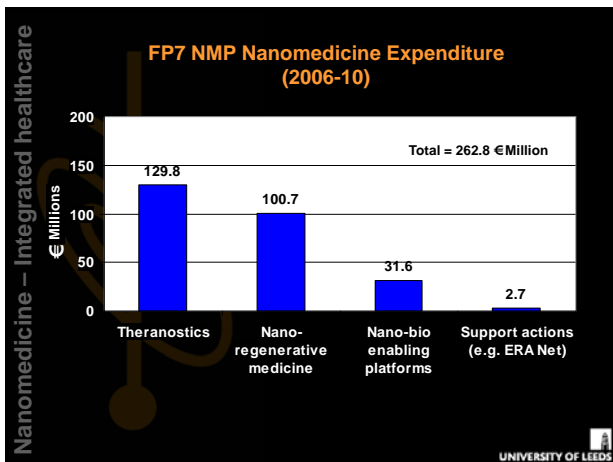
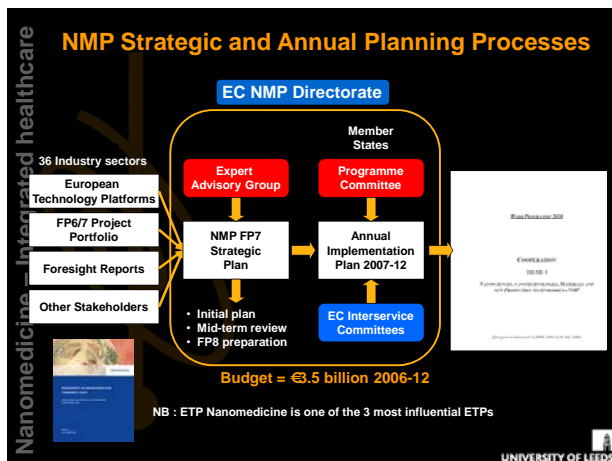
62 Healthcare companies  
78 Universities & RTOs  
10 Other (EC, Hospitals)

**nanomedicine**  
Platform for Technology Integration

Healthcare

*Nanomedicine – European Technology Platform, Expert Report & Road Maps, 2009*  
www.etp-nanomedicine.eu

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**How ready is nanotechnology for oncology applications?**

2004 "..... not mature enough to be useful in cancer research".....  
*ICRF review led by Sir Paul Nurse*

2010 "..... Now ready to aid significant advances in both research and clinical practice in oncology".....  
*Personal communication by Sir Paul Nurse*

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**Summary**

- Nanomedicine has made huge progress in the last 5-years
- Benefits for patients, healthcare providers & Pharma (pipeline & jobs)
- EC and Nanomedicine-ETP strategic approach has been key
- UK science is strong - built on £16.2 million (10 EPSRC grants) in 2008
- UK could take a leadership role in Europe supported by:
  - Royal Society & Royal Academy of Engineering
  - UK Pharma companies
  - GE's leadership of the ETP
  - EU's largest teaching hospital (Leeds NHS Trust)
- A revision of the UK's nanomedicine research strategy is advised:
  - Move to platform grants to integrate UK research base
  - EU engagement plan to support UK research in FP8 (public:public & public:private co-funding partnerships)

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## Open Innovation & Nanomedicine

The diagram illustrates the Open Innovation process across three stages: Fuzzy Front End, Development, and Commercialization. In the Fuzzy Front End, 'Inputs' (represented by grey circles) flow into 'In-sourced ideas & technologies' (white circles) and 'IP in-sourced for development' (grey circles). In the Development stage, 'IP in-sourced for development' (grey circles) and 'IP licensing' (white circles) are shown. In the Commercialization stage, 'Products in-sourced for scale-up' (grey circles) and 'Technology Spin-outs' (white circles) are shown. Arrows indicate the flow of ideas and technologies between these stages.

**OPEN INNOVATION**  
Researching a New Paradigm

Edited by Henry Chesbrough,  
Wim Vanhaverbeke, & Joel West

H W Chesbrough, W Vanhaverbeke,  
J West, Oxford University Press, 2006

- All top US, EU and UK pharma companies have this game plan
- Highly suitable for nanomedicine translational research
- Nanomedicine + non-classical drugs could overcome pharma pipeline problem

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