

Le giornate della salute e del benessere: Innovazione e Ricerca

Milano, 30 Giugno - 1 Luglio



FAST, Piazzale Morandi 2

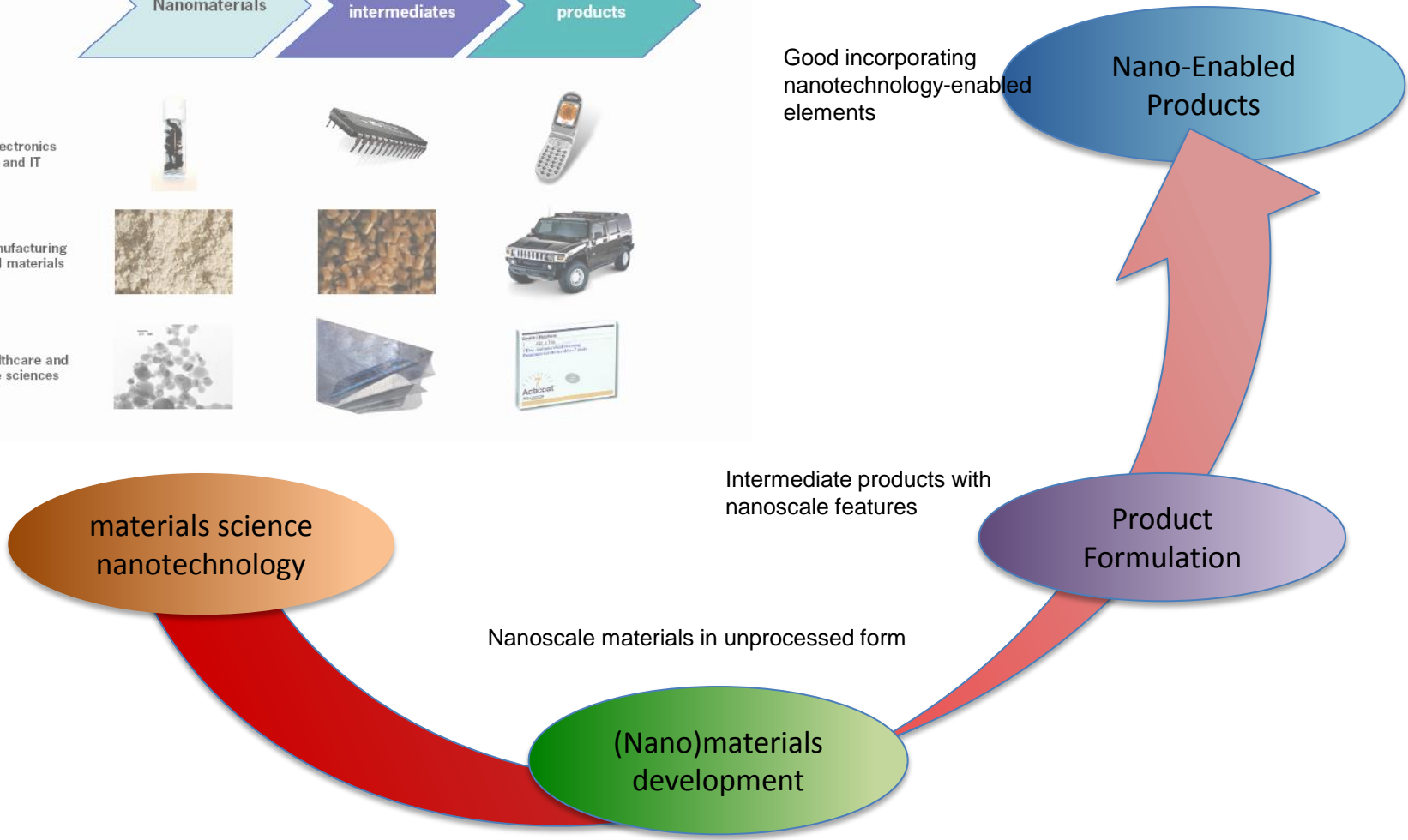
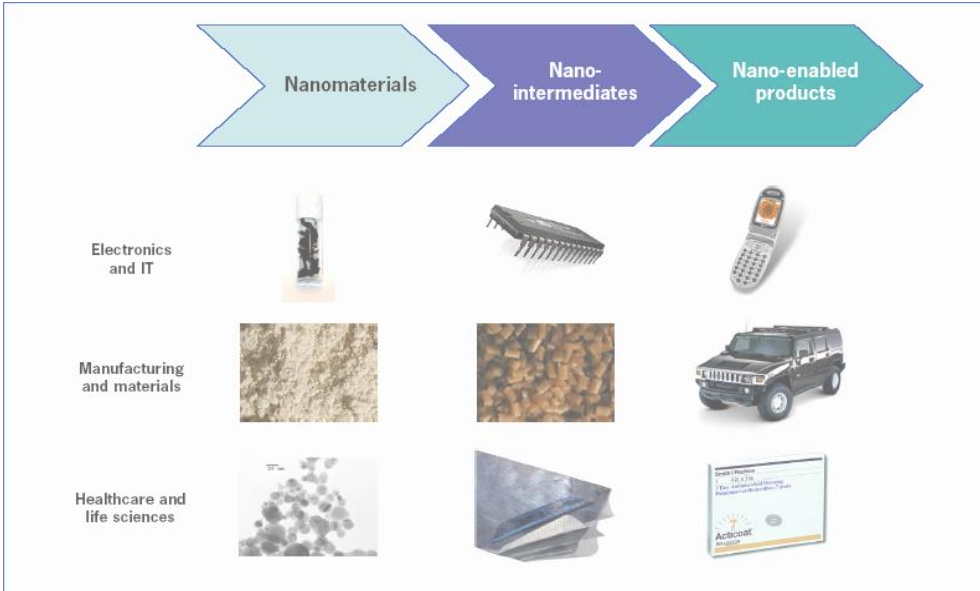


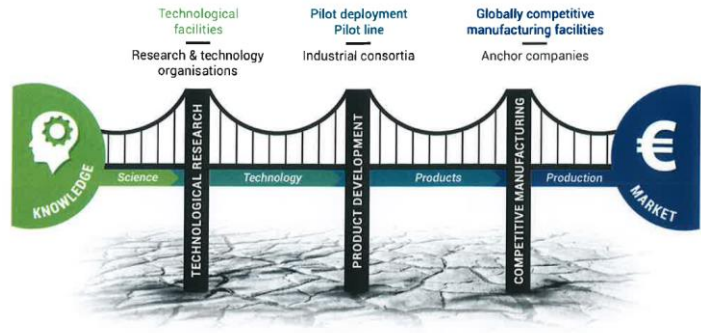
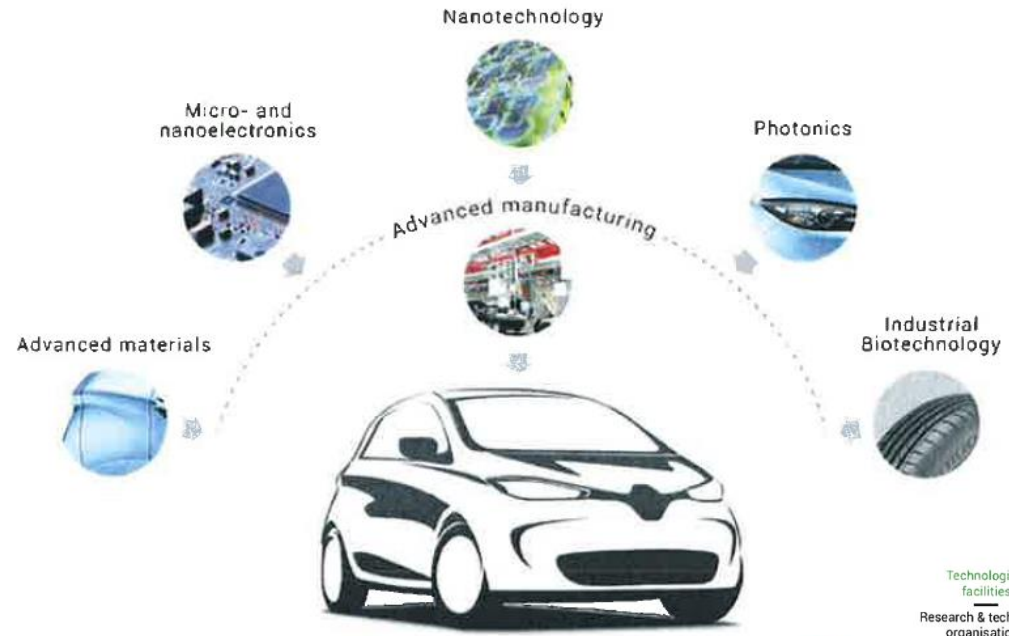
L' utilizzo dei nanomateriali e delle nanotecnologie nell' industria e nel settore medico: vantaggi problemi e prospettive future

Giovanni Baldi

Cericol Research Center Colorobbia Consulting

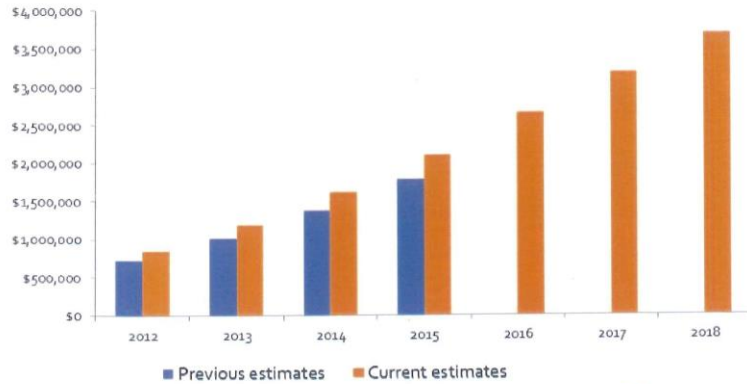
Nanotechnology value chains impact three key sectors



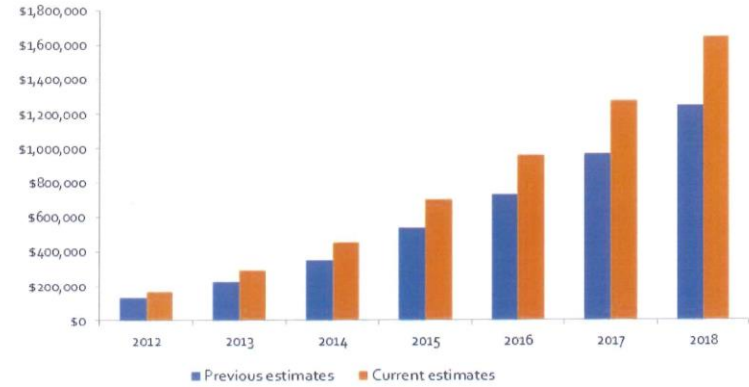


Crossing the KETs "valley of death"

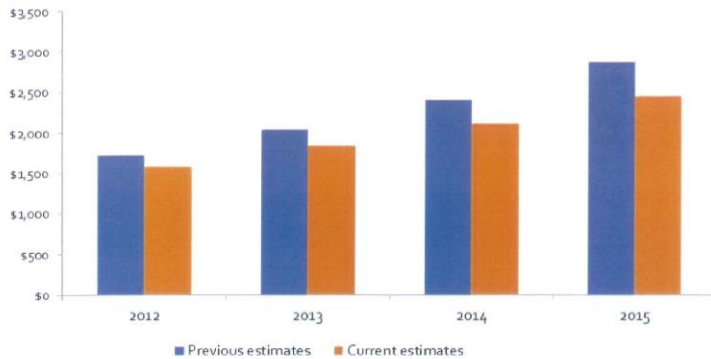
Nano-enabled product revenue (US\$ millions)



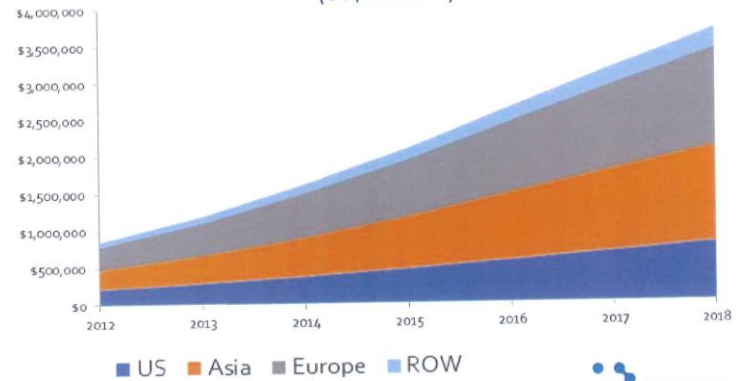
Nanointermediates revenue (US\$ millions)



Nanomaterials revenue (US\$ millions)

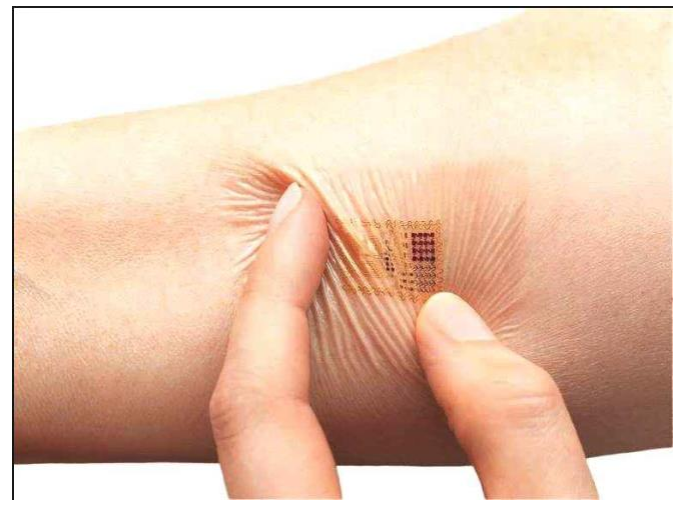
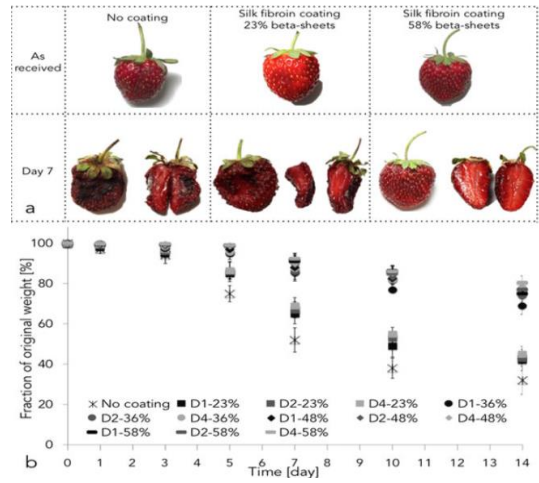
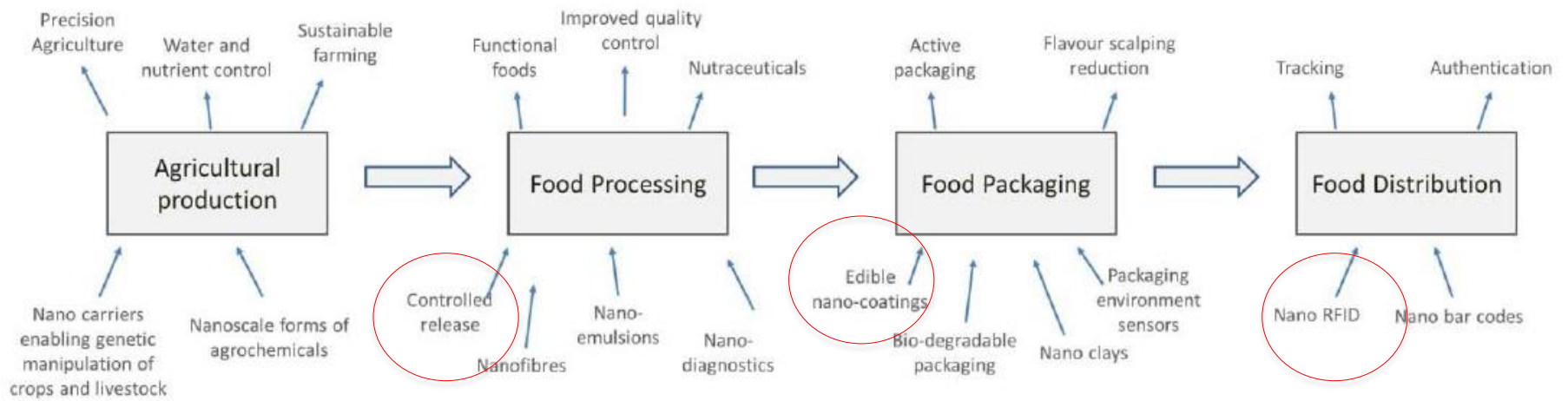


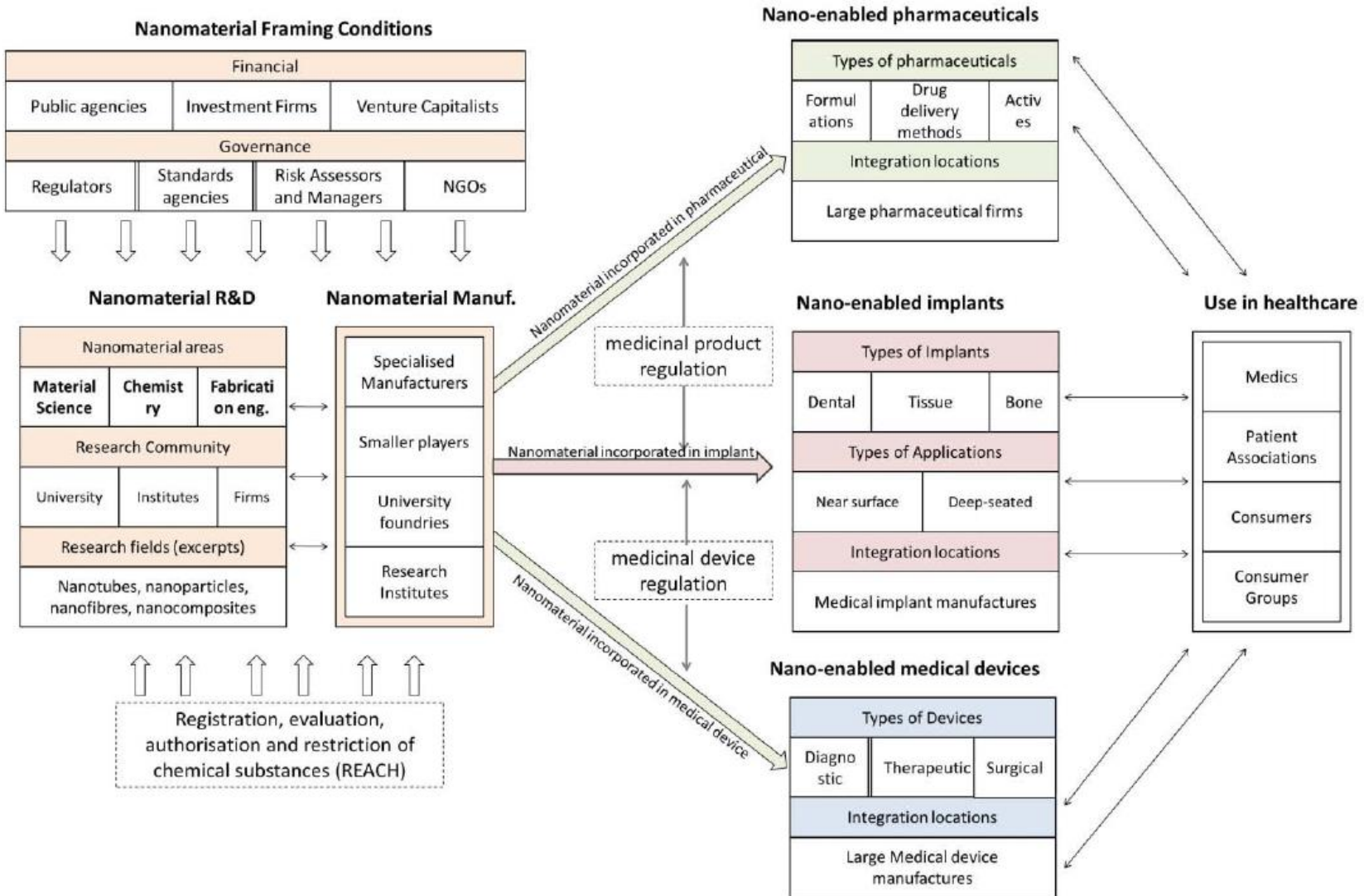
Nano-enabled product revenue geographical distribution (US\$ millions)

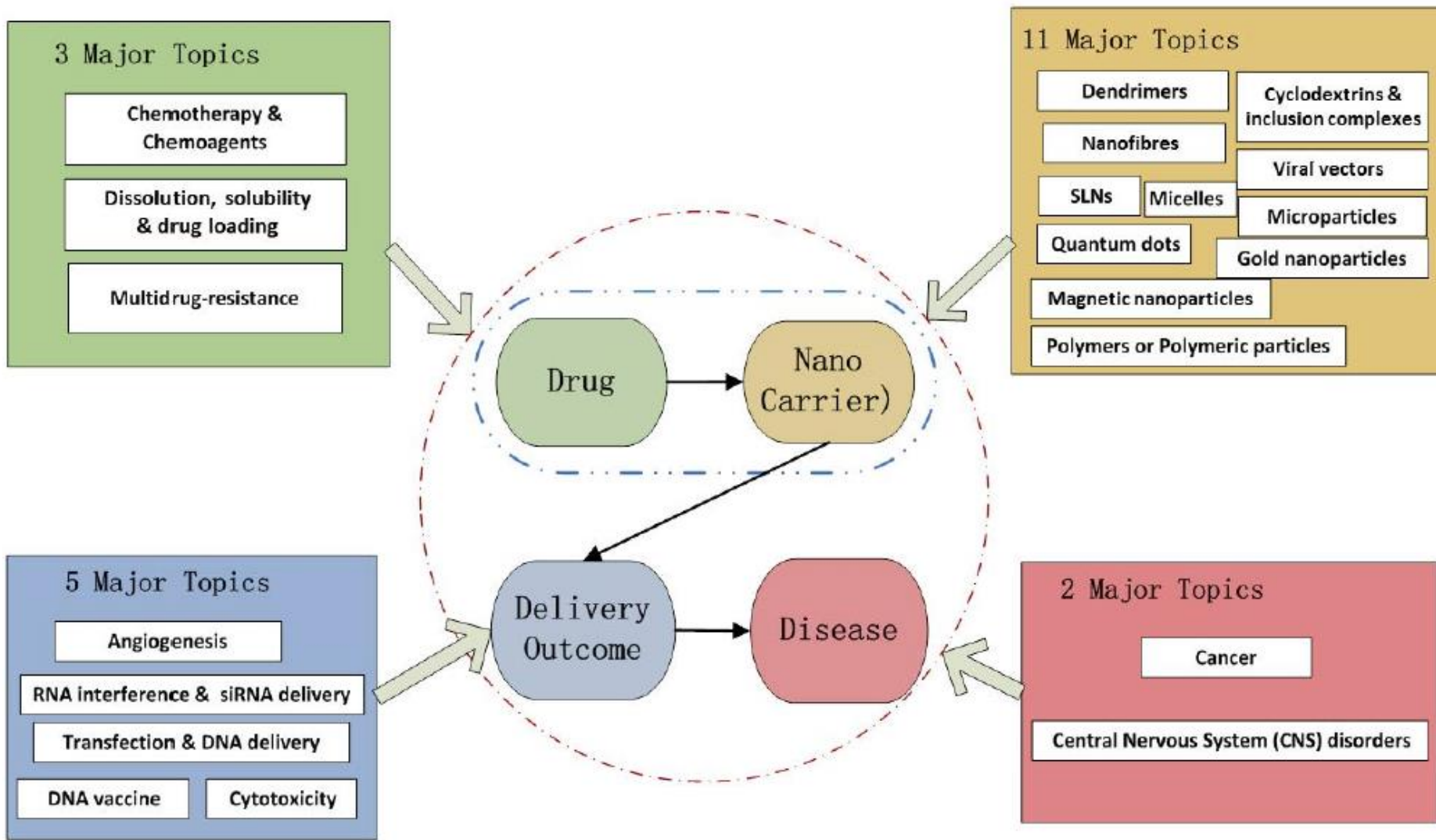


Nano-element	Function/role	Enabled innovation	Envisioned product
Nanomaterial	⇒ Antibacterial coating	⇒ Food processing	⇒ Safe Jam / Jelly
Nanocrystal	⇒ Photon conversion	⇒ Photo-voltaics	⇒ Competitive solar cell options
Nanobiosensor	⇒ Improved detection	⇒ Medical diagnostic	⇒ Disease detection
Nanobiopolymer	⇒ Biopolymer with Rigid and fluid impermeable	⇒ Food and drink packaging	⇒ Biodegradable and biosourced packaging

- Sustainable and green packaging (using nanobiomaterials)
- Targeted drug delivery and controlled drug release (using nanoparticles and nanobiomaterials)
- Neurotechnologies for health and well-being (using nanomaterials and sensors)
- Food safety and security (through advanced sensors)

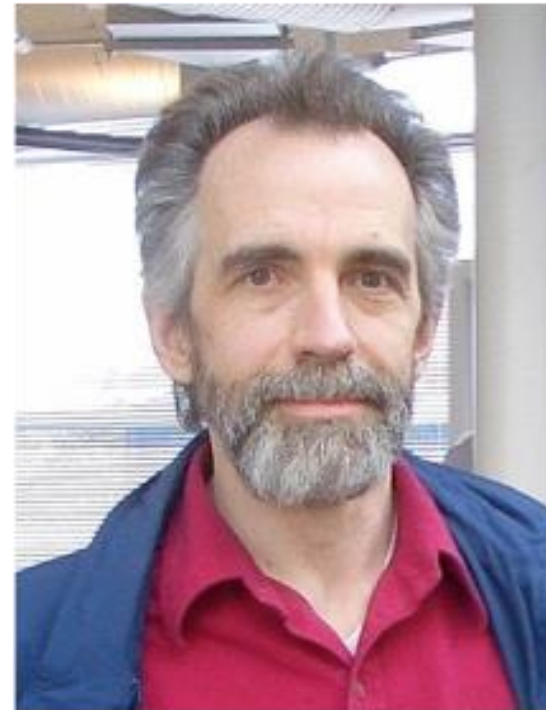
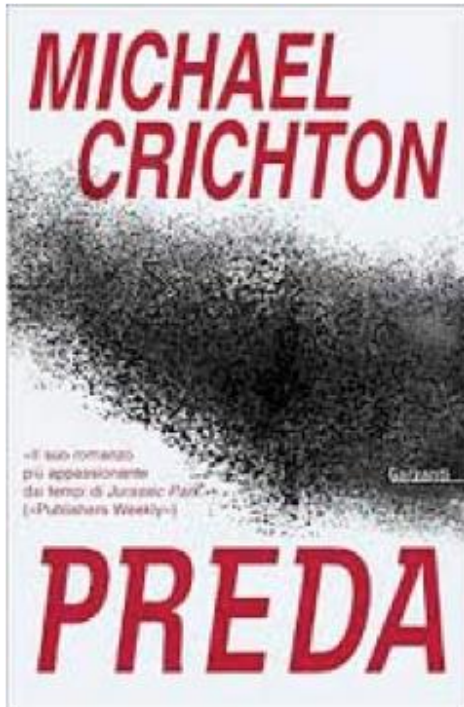




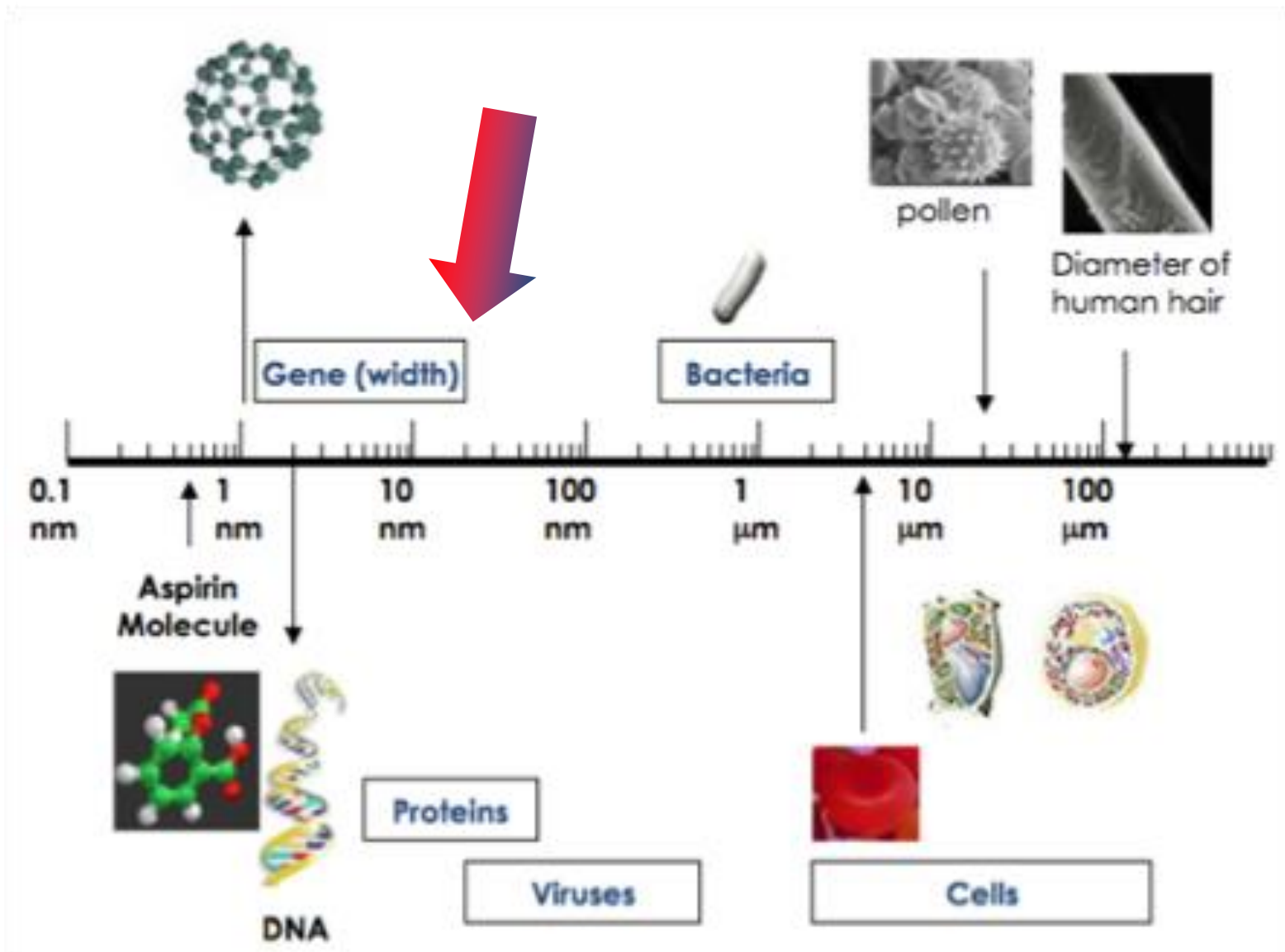


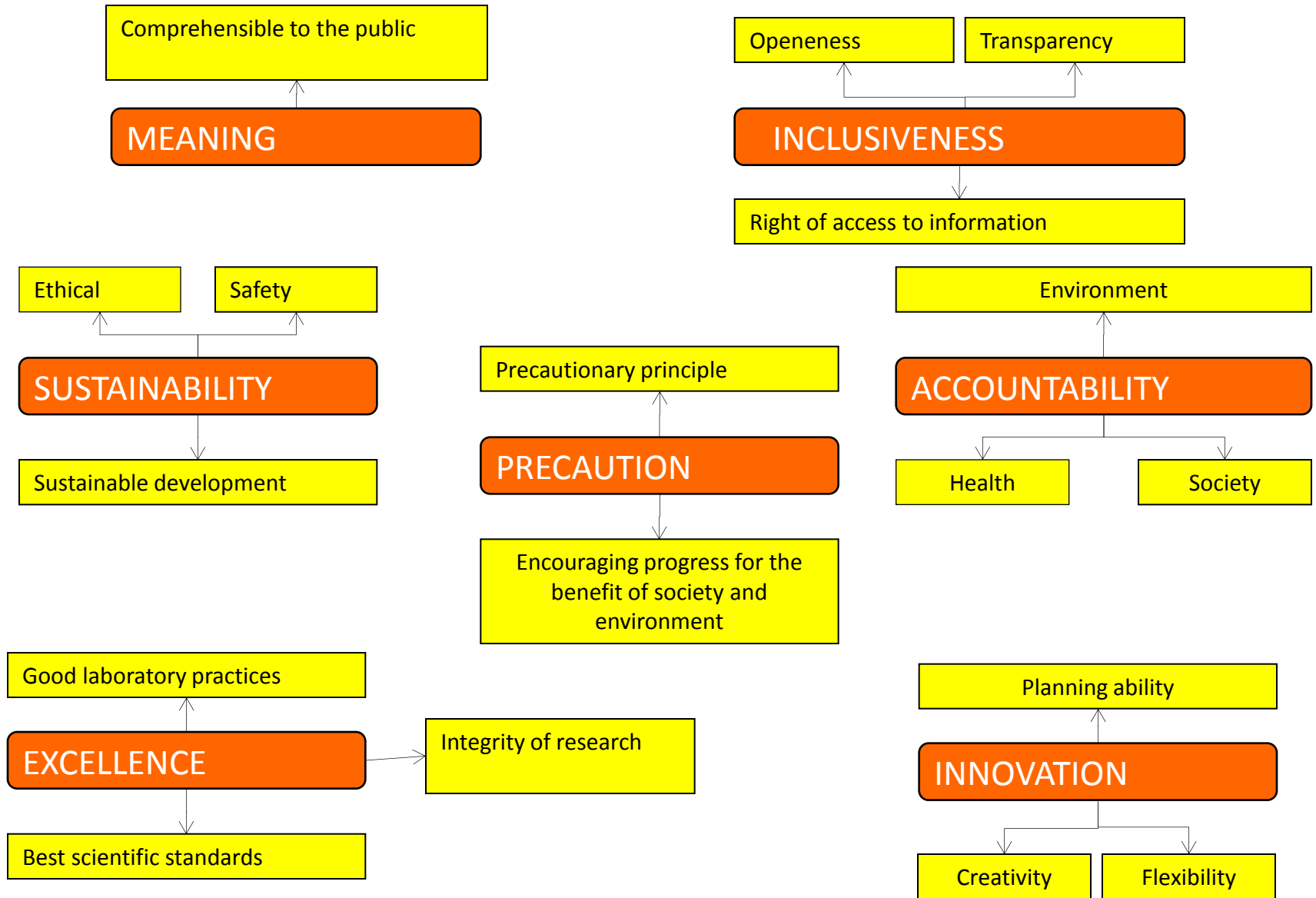
Adapted from Zhou, X., A.L. Porter, D. K. R. Robinson and Y. Guo, (201

GREY GOO, la “nuvola oscura” dell’ apocalisse

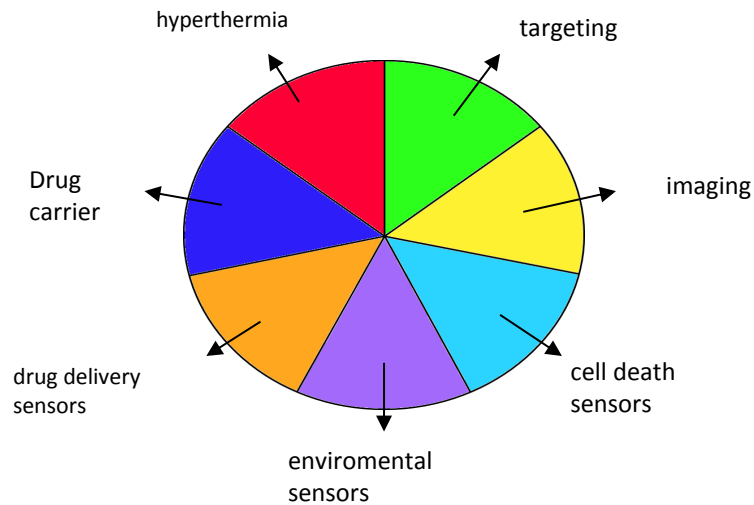


Eric Drexler: Motori di Creazione





(THERApY +-diagNOSTIC)



THERAPY

Magnetic Fluid Hyperthermia

Heat-Drug Action

DIAGNOSIS

Imaging MRI

NIR Imaging

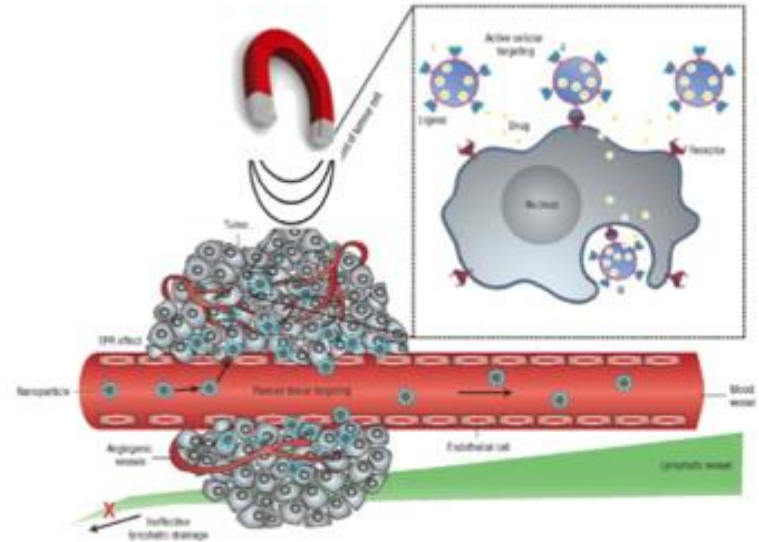
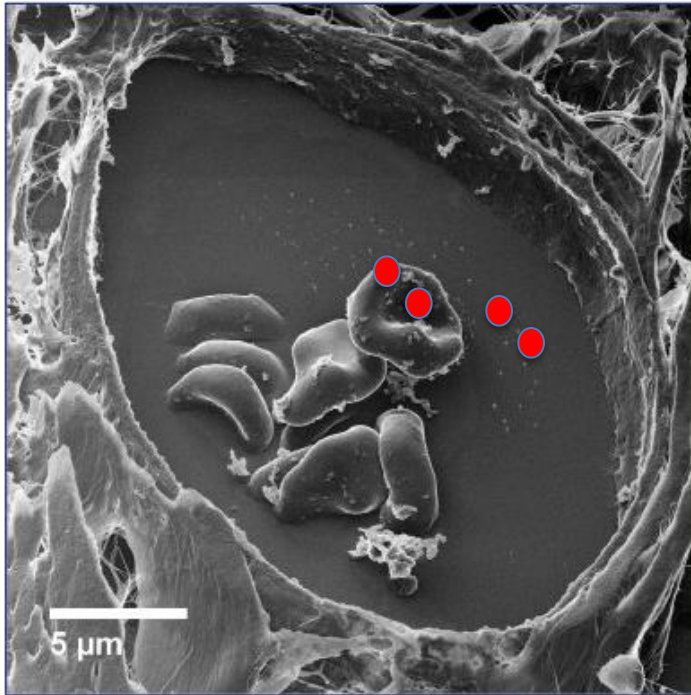
SPECT-PET

SENSORING

Temperature, pH nanosensors

Drug release sensors

Cell death sensors

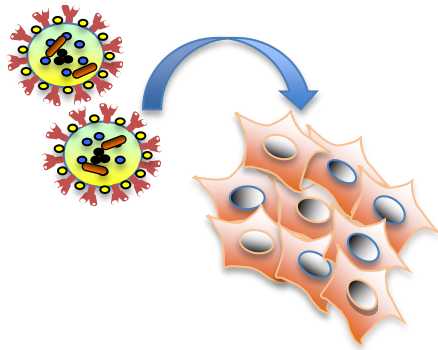


- EPR Enhanced permeation and retention
- Active Cellular Targeting
- Magnetic targeting

Hybrid Au/magnetic nano-carrier features

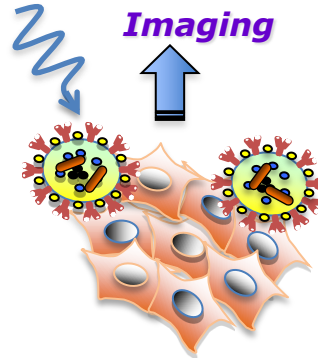
TARGETING

Systems containing specific targeting unit may be selectively accumulated around the tumor cells



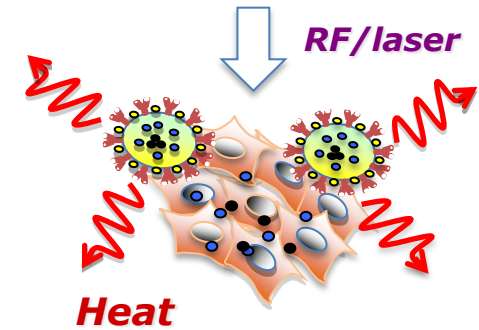
DIAGNOSIS


The loaded magnetic nanoparticles can be visualized with specific imaging techniques (**MRI**); the labeling with **fluorescent dye** allows the Nano Bio Reactor to be used in **fluorescence imaging**





THERAPY

The hyperthermic activation, the controlled drugs release (**paclitaxel, doxorubicin, cis-platinum, gemcitabine**) and/or their joint action, act as therapeutic effect



 **Photo-thermal transducer** (gold nanorods): hyperthermia and drug release triggered by laser activation (surface penetration, ultra-fast conversion → extreme localization of the thermal effect), dark field microscopy, TC

 **Magneto-thermal transducer** (magnetite nanospheres): hyperthermia and drug delivery triggered by magnetic activation (excellent penetration → no endoscopy/laparoscopy, slow conversion); MRI

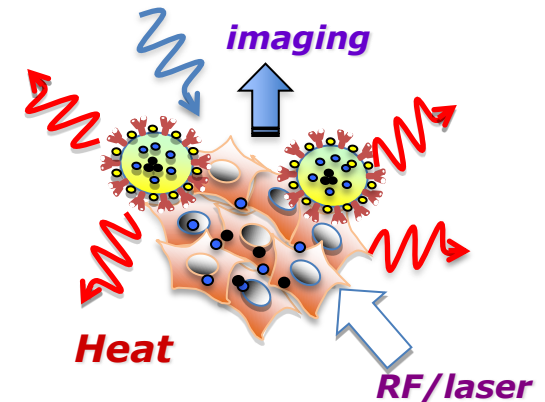
 Fluorescent dye

 Monoclonal antibody (**hERG; EGF; ...**)

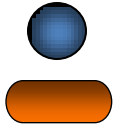
 Biocompatible Copolymer (**PLGA-PEG**)

Theranostic Object:
Therapeutic and diagnostic
Joint action.

THERANOSTIC

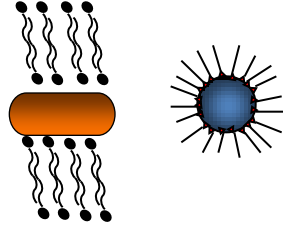


Magnetic nanoparticles synthesis



Gold nanorods synthesis

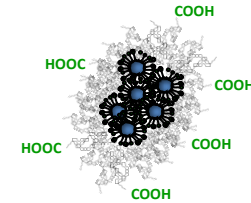
Functionalization



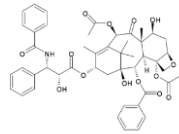
Functional Biopolymer



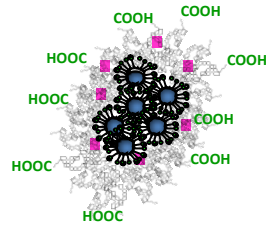
Encapsulation



Loading

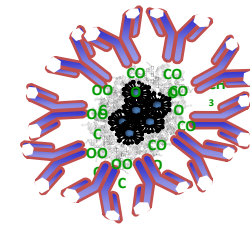
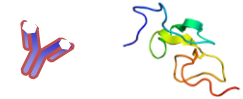


PLGA-PEG-COOH

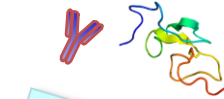


Drug loaded nano bio reactor

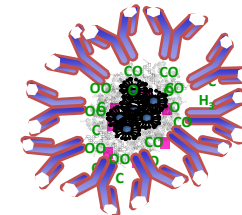
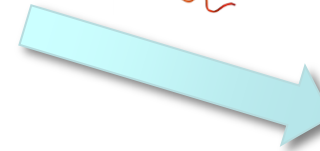
Targeting



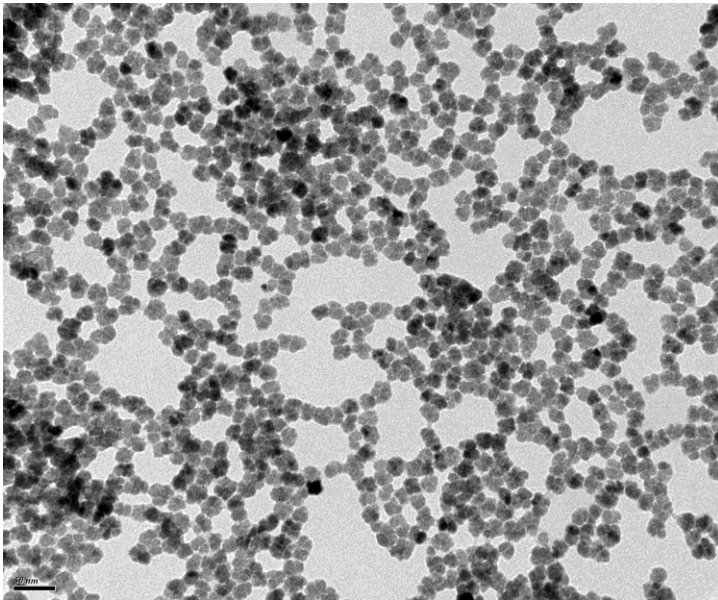
Targeting
Labelling
Loading



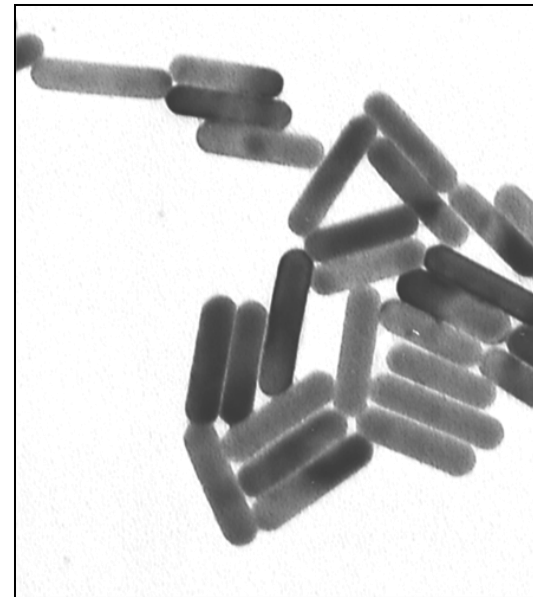
Targeting



Nanoparticles

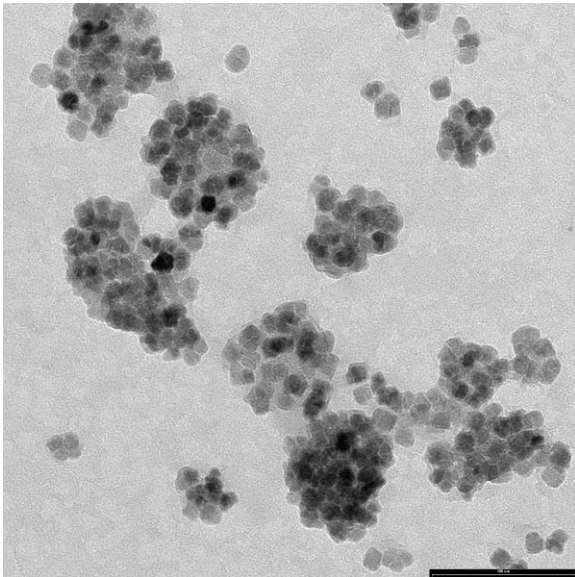


Fe₃O₄ superparamagnetic nanoparticles

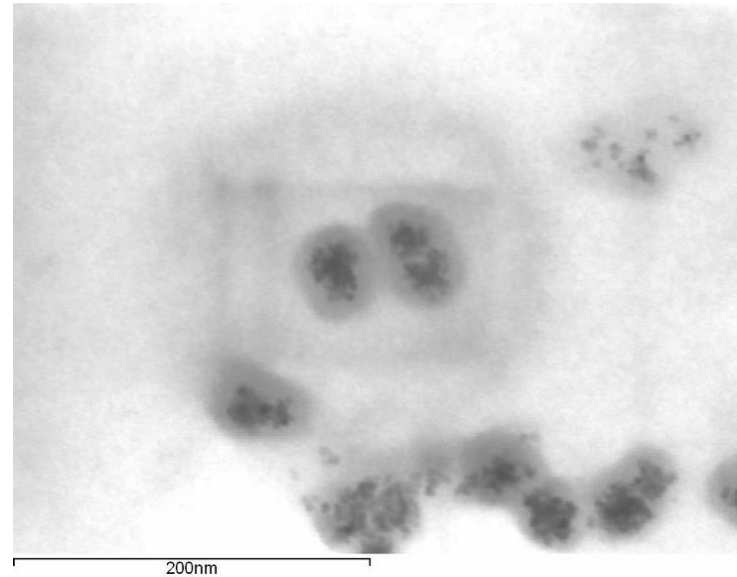


Au⁰ nanorods

Magnetic nano bio reactors

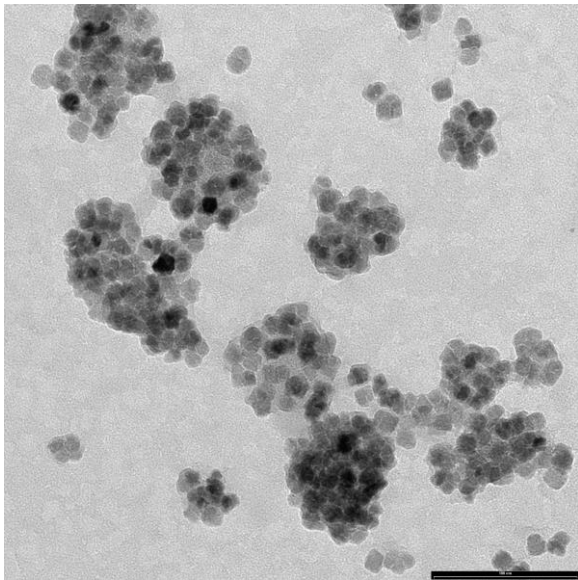
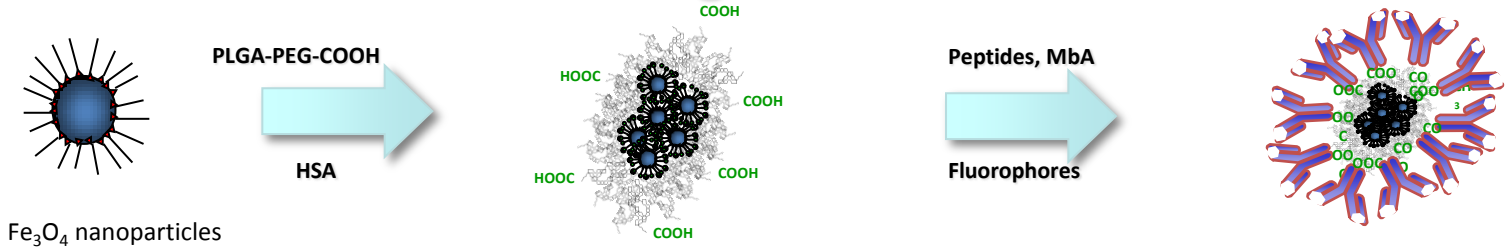


Hybrid magnetic Nps coated with PEG-PLGA polymer

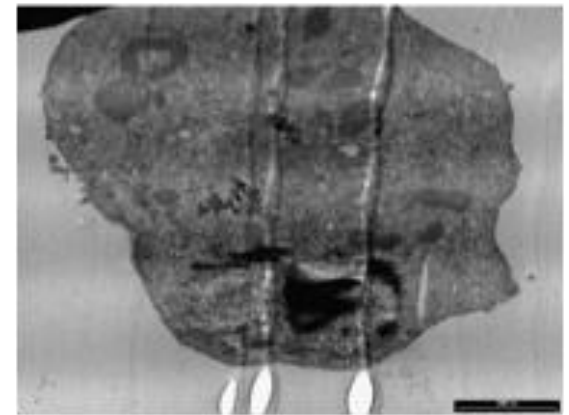
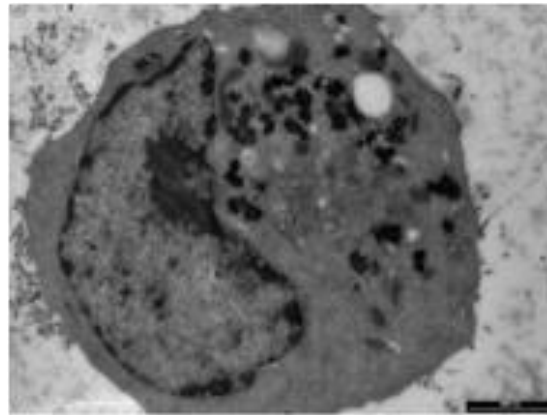


Hybrid magnetic Nps coated with albumine

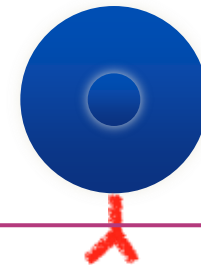
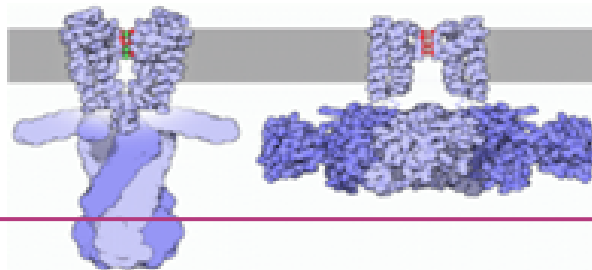
The magic bullet



Hybrid magnetic Nps coated with PEG-PLGA polymer and linked with h-Erg1



Up-take in MIA PaCa-2s



Experimental approach to the determination of the power generated by magnetic fluids

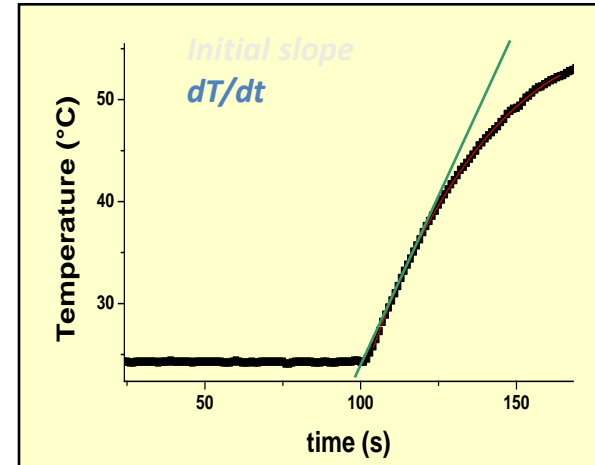
$$SAR = \frac{\sum_i m_i C_{si}}{m_{Oxide}} \cdot \frac{\Delta T}{\Delta t} \left[\frac{W}{gr} \right]$$

i: species involved in heat exchange;

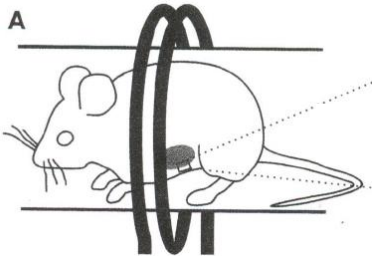
m_{Me} : metal mass in the sample [g];

t_{risc} : irradiating time [s];

Q_i : heat absorbed by each species ($Q_i = m_i \cdot c_s \cdot \Delta T$).



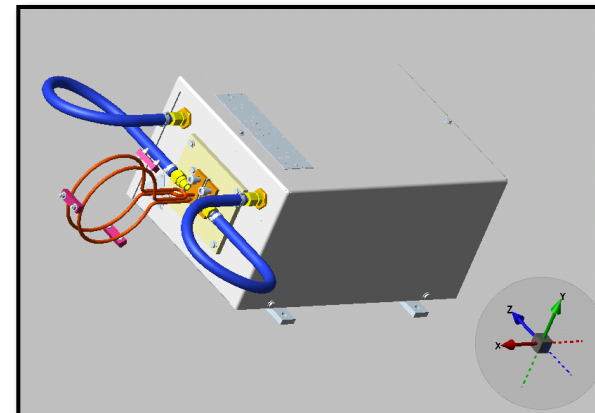
Different coil diameters in order to host different samples (ϕ 3 - 15 cm)



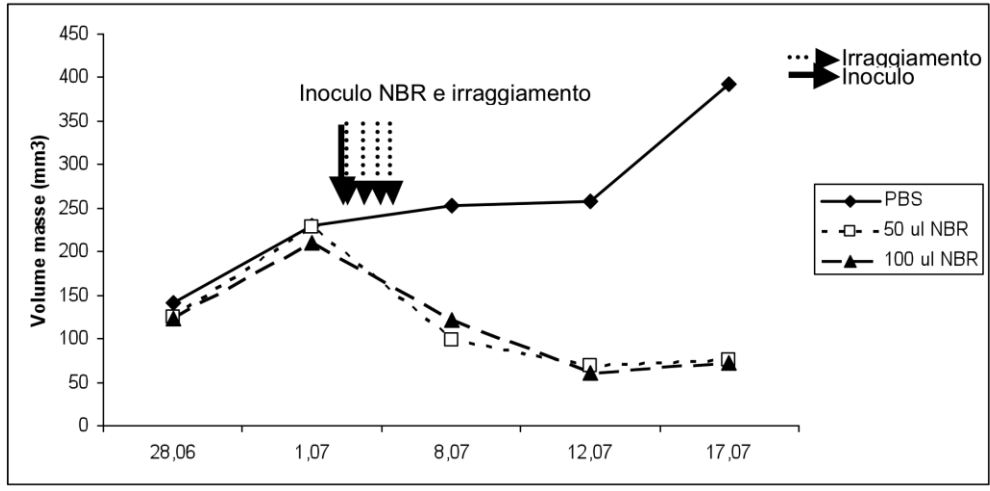
Even suitable for in vivo tests

Applied Conditions:

Irradiating frequency	100 - 400 kHz
Heating time	30 - 60 minutes
Applied field	15 - 20 kA/m

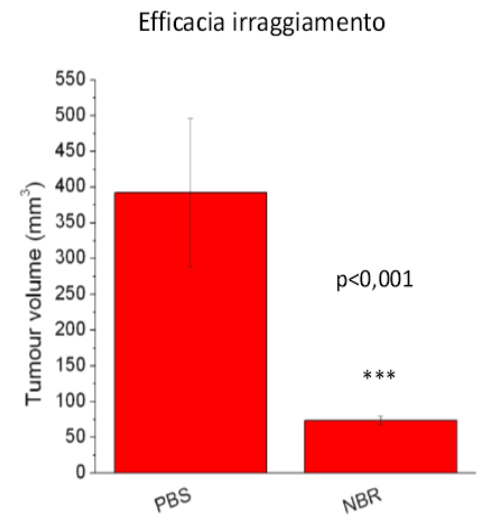


In-vivo efficiency test on xenograft model of pancreatic cancer PDAC cells

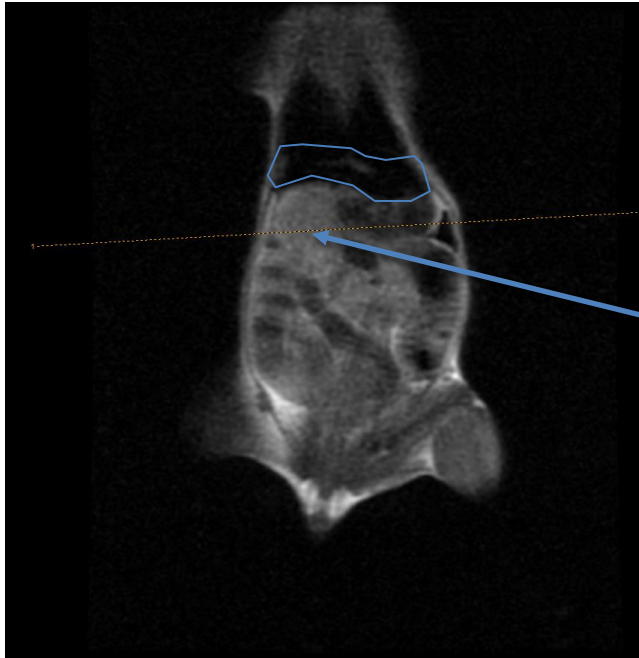


NBR "nude" particles 0,1%

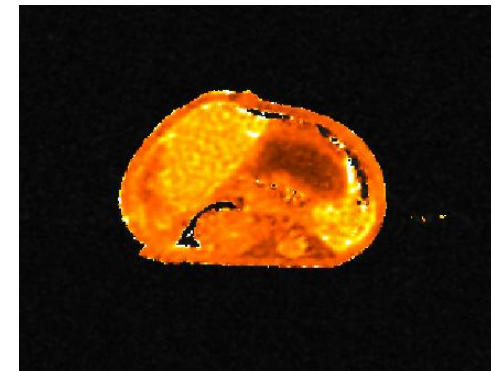
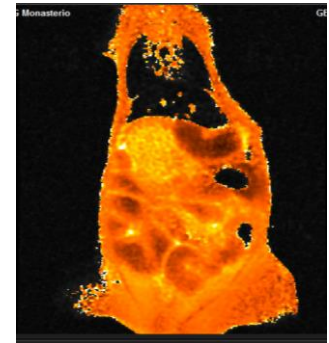
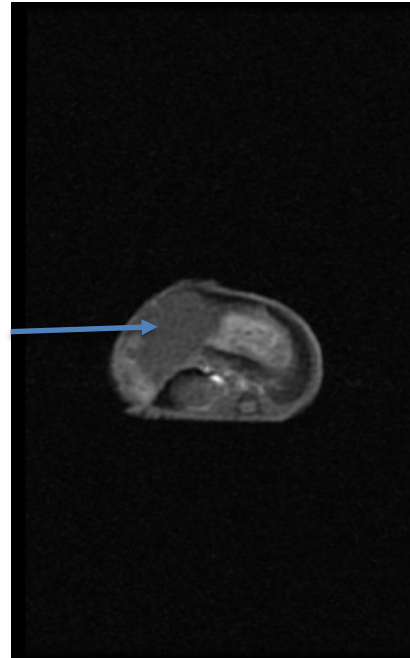
..... Irraggiamento
 —▶ Inoculo NBR



T2 weighted images of pancreatic tumours



Lesione



Tumour bearing mouse :
injected animal (mouse 6)
T2 weighted images of axial (right) and
coronal (upper) sections

T2 mapping of the axial section
(ms) **Yellow**

Con la nanotecnologia si riesce a progettare un materiale a livello degli atomi e degli elettroni. In questa maniera possiamo sviluppare prodotti con caratteristiche nuove e peculiari.

La convergenza tecnologica in aree di ricerca strategica permette la creazione di catene del valore verso prodotti che integrano in maniera ottimale le nanotecnologie e KET. (Medicale-food-ICT)

In nanomedicina emerge con sempre maggior forza la necessità di sviluppare sistemi nano teranostici per la cura di patologie complesse (cancro, malattie neurologiche)

Come in tutti i settori della ricerca che studiano nuovi materiali e tecniche si deve porre la massima attenzione ad uno sviluppo sostenibile che tenga conto di principi etici di comportamento



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