NANOMEDICINE

Midi Minatec| BOISSEAU Patrick| 11 Septembre 2015
IS IT A DREAM...
... OR A REALITY?
DRUG DELIVERY
“... Human health has always been determined on the nanometer scale; this is where the structure and properties of the machines of life work in every one of the cells in every living thing. The practical impact of nanosciences on human health will be huge.”

RICHARD E. SMALLEY, PHD
1996 NOBEL LAUREATE
A nanometre is a unit of length in the metric system, equal to one billionth of a meter (i.e., $10^{-9}$ m or one millionth of a millimetre)

A nanometre is approx $1/100\,000^{th}$ of a human hair

FROM NANO TO MICRO

- Atomes
- Molécules
- Protéines
- Virus
- Bactéries
- Cellules

Nanoparticules
THE IDEAL SCALE
FOR HEALTHCARE

Protein

Nanocarrier

Red blood cell
NANOMATERIALS HAVE...

• A high ratio of surface area to volume

• Tunable optical, electronic, magnetic, and biologic properties

• Can be engineered to have
  ▪ different sizes, shapes, chemical compositions, surface chemical characteristics, and hollow or solid structures.
SURFACE/VOLUME RATIO

3 mL = 190 m²
Diagnostics
In vitro

Medical Imaging
In vivo

Drug Delivery
Systems Devices

Vaccines

Regenerative Medicine
Biomaterials Functionalisation
• In vitro
  - DNA chip array
  - Microfluidic chip
  - PCR on chip

• In vivo
  - Quantum Dots
  - Fluorescent imaging
• DNA Chip
• Lab-on-Chip
• Cell-on-Chip
- **Invasive**
  - On line monitoring of circulating molecules at low concentration
  - Bio friendly, biocompatible instruments
  - Biological barriers crossing capacity
  - Image guided therapy

- **Non invasive**
  - Lenses
  - Pills
  - Surface electrodes
  - Smart catheters and endoscopes
• Nanostructured surfaces
  ▪ Higher exchange surface
  ▪ Faster reactions
  ▪ Lower invasiveness
• Drug Delivery Devices

- Pohang University Nanoporous DDD

- Debiotech Nano Pump

• Drug Delivery Systems

- Liposome

- Nanosphere

- Lipidots®

- Micelles
• **Protect**
  - from external media (pH, …)
  - the external media from contrast agent

• **Target**
  - passive targeting (EPR effect)
  - active targeting (biomolecules attachment)

• **Improve efficiency**
  - better fluorescence quantum yield
  - less photo bleaching…
Molecular imaging & therapy

• Wearable

Digital Plaster

Wireless Body Area Network

Gauze
Antenna
Thin Battery Layer
Sensium

• Implants

Stent

Cochlear implant

Artificial retina
• **Biomaterials**

  - Bioactive signaling molecules

  biodegradable scaffolds

• **(Stem) cells**
230 NANOMEDICINES

2008

36

+ 36%

2013

49

230 produits identifiés

80%

Thérapeutique

Médecine régénérative

Diagnostic in vitro

Diagnostic in vivo

Vaccins

Bionest Partners, 2013
CLINICAL TRIALS

- Oncologie: 4 (31%)
- Maladies Infectieuses: 3 (23%)
- Pathologies Cardio-vasculaires: 3 (23%)
- Immunologie: 2 (15%)
- Ophtalmologie: 1 (8%)

Bionest Partners, 2013
• Estimated 50.1 - 68 Billions (2011)
• Forecasted to 97-129 Billions in 2016 (2012)
• Annual growth rate: +14% from 2011 to 2016
• 38 nanotherapeutics and 46 nano-medical devices have a market authorization

Bionest Partners 2013
SOME FRENCH COMPANIES
• Excellent scientists and entrepreneurs
  - 1500+ academic partners
  - 500+ SMEs

• EC support for research
  - 530 M€ invested under FP7
  - >130 research projects
NANOMED AT CEATECH

- **LETI-DTBS**
  - Drug delivery systems Lipidots®
  - Molecular imaging LipImage™
  - Regenerative medicine
  - Sensors
  - Lab-on-chip

- **LETI-Clinatec**
  - Medical devices

- **LITEN-PNS**
  - Nanocharacterization

- **LITEN-PFNC**
  - Nanocharacterization
DIAGNOSTIC AND PREVENTIVE TREATMENT

Clinical Symptoms

Screening  Early Diagnosis  Preventive Treatment

Current, Symptomatic Medicine

Preventive Medicine

Follow-up

Symptoms

time
CONCLUSIONS

• Nanomedicine is part of medical technologies
• Nanomedicine is an emerging market
• The non technical aspects are as important as the technology itself
  ▪ Ethical
  ▪ Social acceptance
  ▪ Regulation
  ▪ Standards
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Thank you for your attention