DESIGN AND DEVELOPMENT OF NEXT GENERATION NANOMEDICINES

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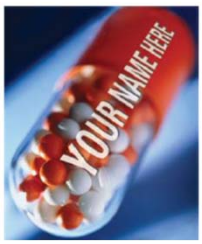
ISPE's April Education Event

Defining the Challenges: Personalized Medicine

- The Challenges
  - Inhomogeneity and adaptability of major chronic diseases such as cancer or inflammatory disorders
  - A seemingly infinite variability of the patients' genomes and responses

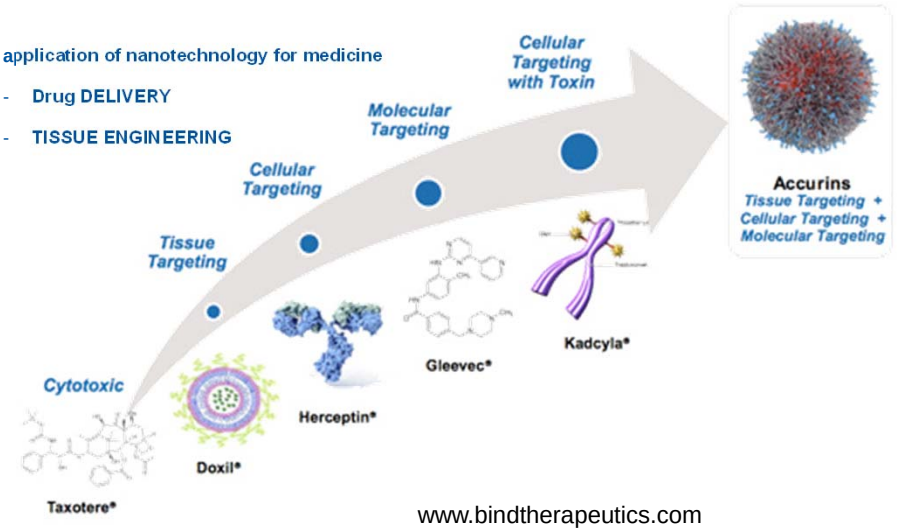
- Facing the challenges: Personalized (patient-tailored) medicine
  - To adapt the treatment to the patient specific characteristics
  - This requires
    - Knowledge of the underlying molecular defects of the cancer
    - Systems to effectively and efficiently identify those defects, deliver, and monitor the therapy



Nanomedicine

application of nanotechnology for medicine

- Drug DELIVERY
- TISSUE ENGINEERING

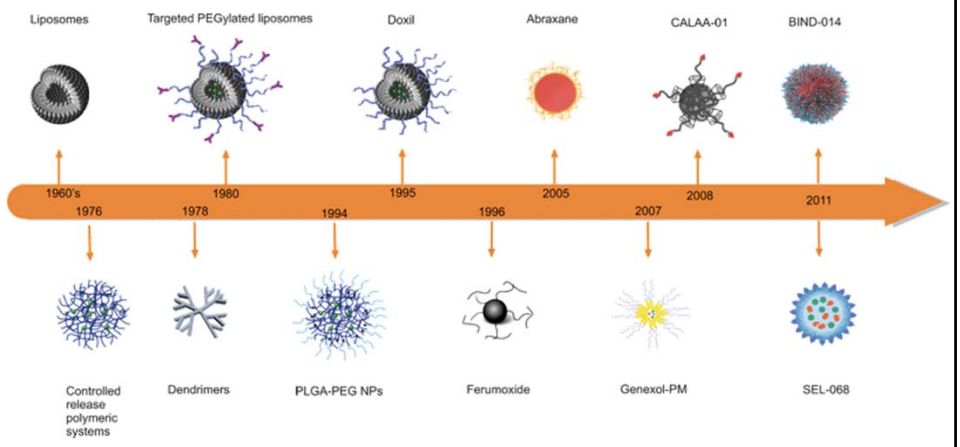


www.bindtherapeutics.com

Drug Delivery - Why?

- More than 25% of the marketed drugs fail to provide expected commercial returns
- Reasons? Poor drug distribution and absorption levels (pharmacokinetics)
- Drug delivery systems could help improve this
- Rapid enhancements in drug discovery technologies have lead to developments in proteomics and genomics and had a greater impact on drug delivery technology market
- Changing market trends + quick cycle of innovations have compelled pharmaceutical companies to focus on emerging technology and enhance market positions in terms of revenues and growth

Time line of clinical stage nanomedicine firsts.



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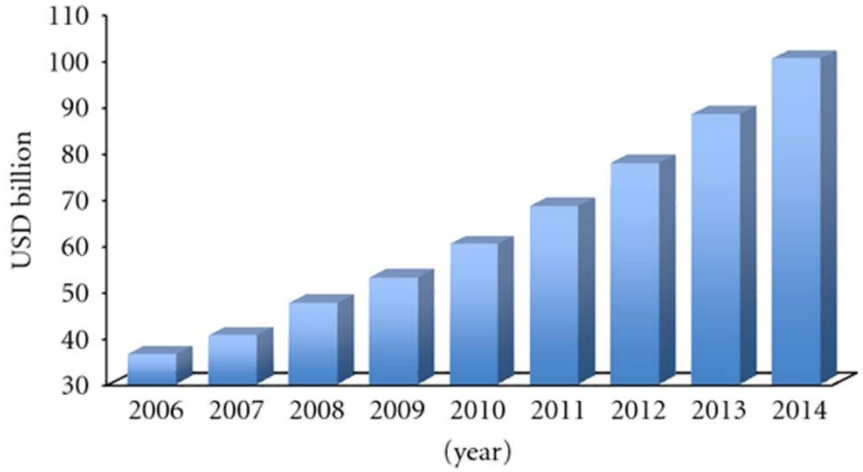
Global Market for Nanomedicine

2006-2014



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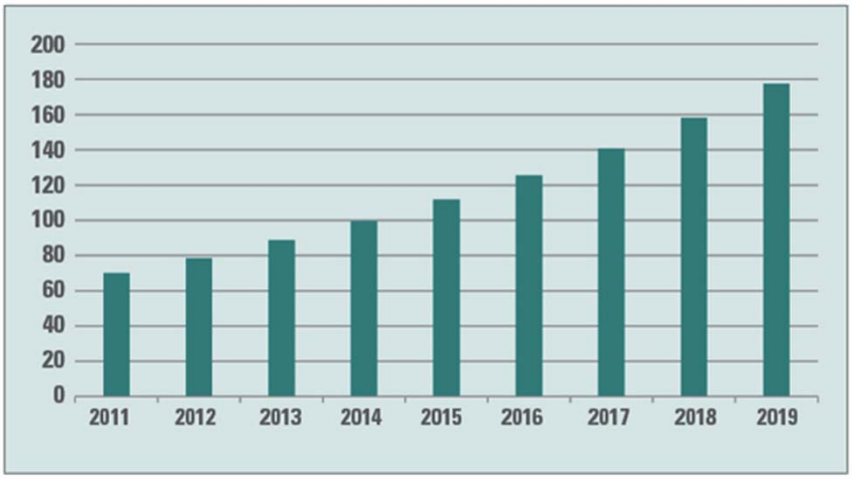
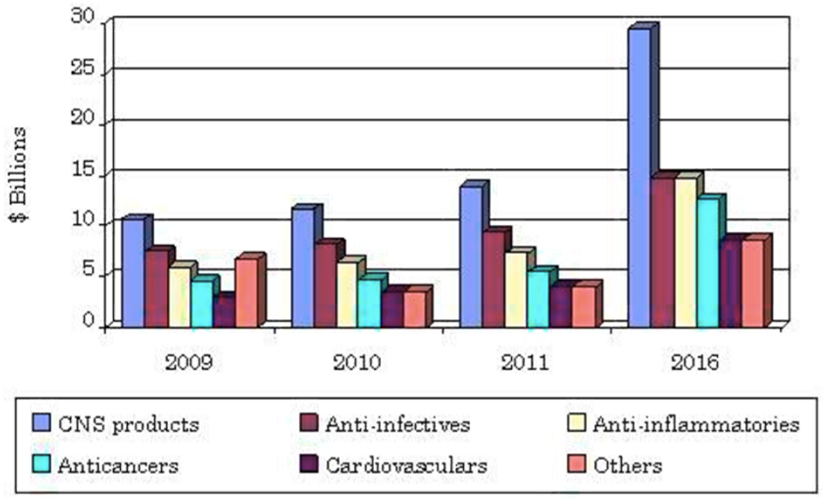
Global Nanomedicine Market Through 2019 (billions of dollars)



Source: Transparency Market Research

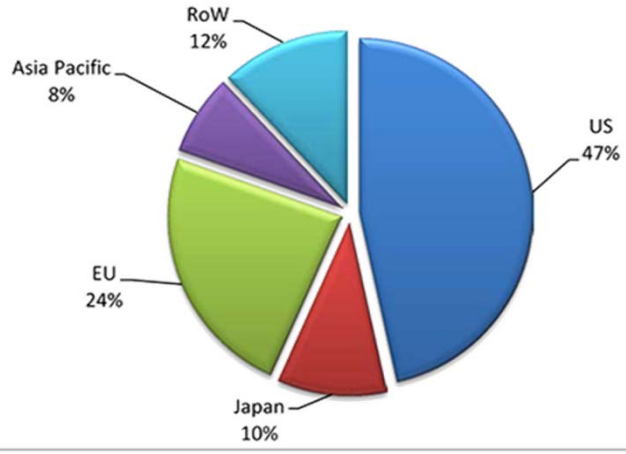
Global Market for Nanomedicine

Characterized by diseases



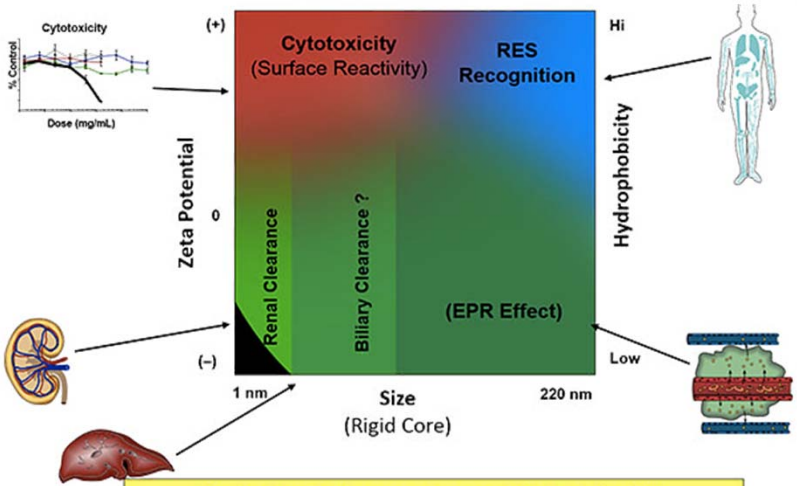
Global Market for Nanomedicine

Leading National Nanomedicine Markets by % Share, 2025



Source: visiongain 2015

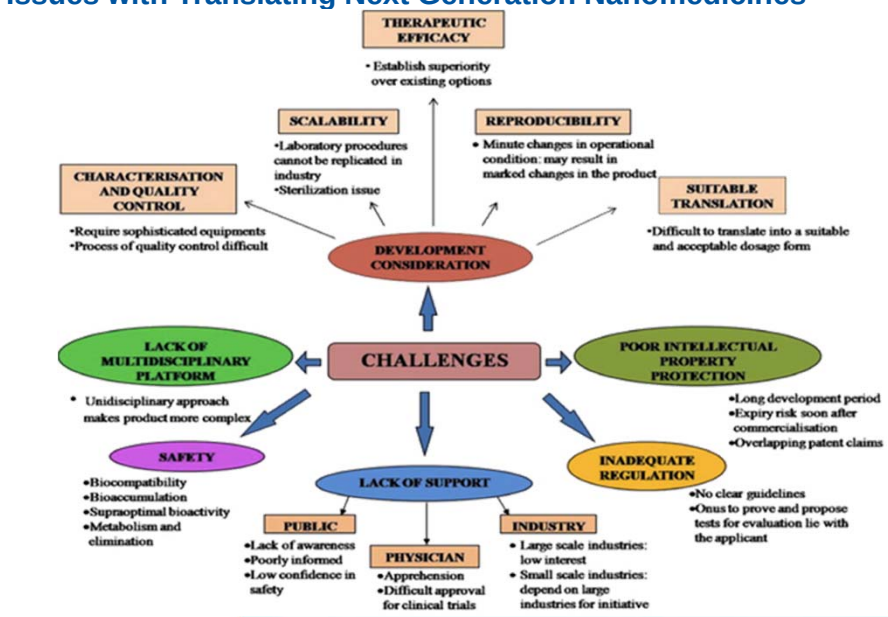
Design in Nanomedicine is Key



Physicochemical parameters contribute to toxicity.

McNeil (2009), Wiley Interdisciplinary Reviews: Nanomedicine and Nanobiotechnology, 1:264-271.
Nel et al. (2009), Nature Materials 8: 543-557.
Cover of Advanced Drug Delivery Reviews, June, 2009.

Issues with Translating Next Generation Nanomedicines



Unanswered Questions – Several Remain

Passive vs. active targeting: how important is active targeting? How effective is "passive targeting (e.g. enhanced permeability and retention effect)"?

Immunoavoidance vs. immunorecognition: when is immunorecognition beneficial? How important is immunoavoidance?

Biodegradability vs. non-biodegradability: is biodegradability an absolute must? Where do non-biodegradable materials find uses?

What are some of the strategies to implement factors discussed above?

What are the implications of the MPS system on nanoparticle clearance *in vivo*?

Is the EPR effect real and how do *in vivo* results translate to human clinical data?

What are some of the preclinical study pitfalls that are unique to testing nanomedicines?

What are the biggest challenges yet to be met regarding the characterization and manufacture of nanomedicines?

What advancement(s) are imminent that will revolutionize the characterization and manufacture of nanomedicines?

Unanswered Questions – Several Remain

How do you plan to assure comparability of nanomaterials (e.g., those used in toxicology vs. clinical testing)?

How will Quality by Design be executed for nanomedicines?

What are the unique ADME/toxicity challenges posed by nanomedicine drug development, as compared to more conventional drug candidates?

What research approaches are needed to address these challenges?

What are the differences in data requirements to enable first-in-human evaluation, as compared to product registration?

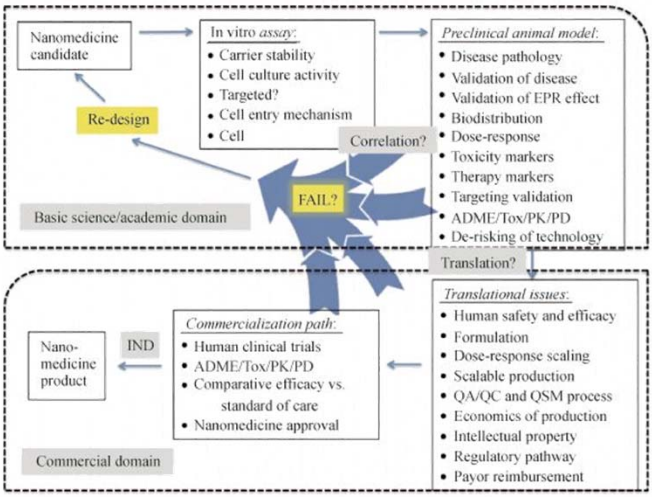
Are there opportunities to better leverage available clinical data from published results including non-industry sponsored trial data related to the efficacy of approved active pharmaceutical ingredients to support regulatory submission for nanopharmaceuticals with the FDA and other international agencies?

What novel clinical trial designs may be appropriate to support the efficacy evaluation of nanopharmaceuticals with known approved active pharmaceutical ingredients that can accelerate identification of efficacy signals in phase 2 and/or registration trials?

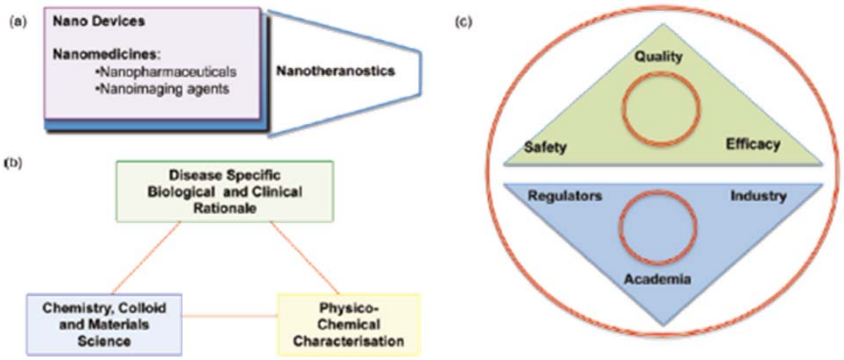
Are there challenges and opportunities to assessing safety and risk-benefit evaluation unique to nanopharmaceuticals for phase 0 or phase I clinical trials?

Nanomedicine product development task set

From conception through basic science assessment to preclinical proof-of-concept and then to translation



Moving Nanomedicine Forward
Multidisciplinary, Multifocal Academic – Industry partnerships



Harnessing multidisciplinarity: A successful template for design and transfer of nanopharmaceuticals into clinical use. Panel “a” shows the relationship between the nanotechnologies under development for medical use highlighting the complex regulatory boundaries. The need for partnership between the core scientific disciplines (panel “b”) and academia, industry, and regulation (panel “c”) to engine translation and “Quality by Design" is also shown.

Moving Nanomedicine Forward
Academic – Industry partnerships

Contribution of nanomedicine to Societal Challenges

Thank You !

Questions ?