Usage of Nanoparticles for Drug Delivery in Cancer therapy

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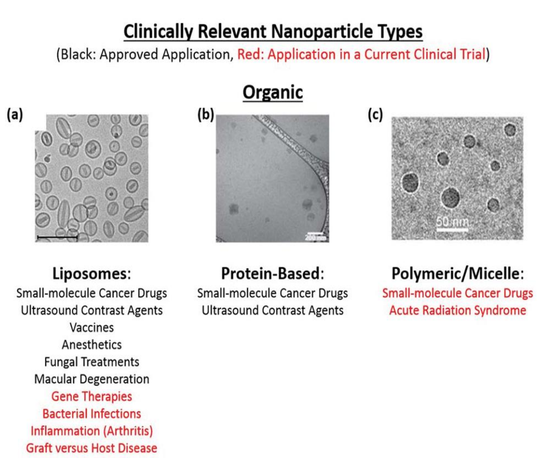
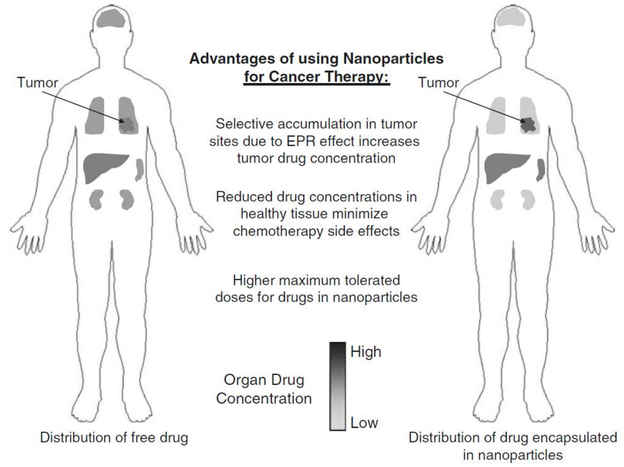
Objective

To simultaneously load drug and encapsulate the drug in a high throughput, massively-arrayed microfluidic type system using a patented Chemtor fiber technology.

Motivation

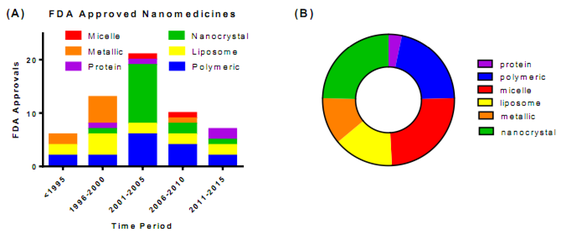
In medicine, nanotechnology has sparked a rapidly growing interest as it promises to solve a number of issues associated with conventional therapeutic agents, including their poor water solubility (at least, for most anticancer drugs), lack of targeting capability, nonspecific distribution, systemic toxicity, and low therapeutic index.

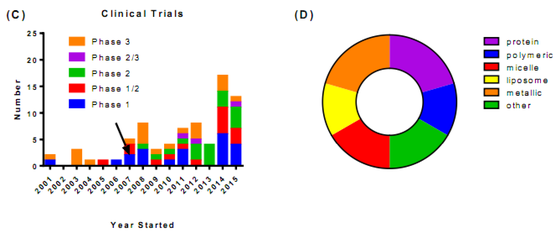




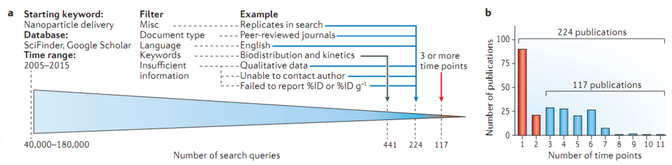
Advantages of using nanoparticles as drug delivery system for cancer therapy compared to free drug

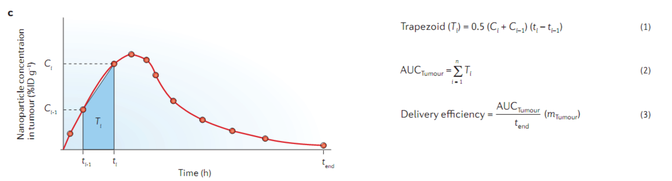
Trends in the development of nanomedicines

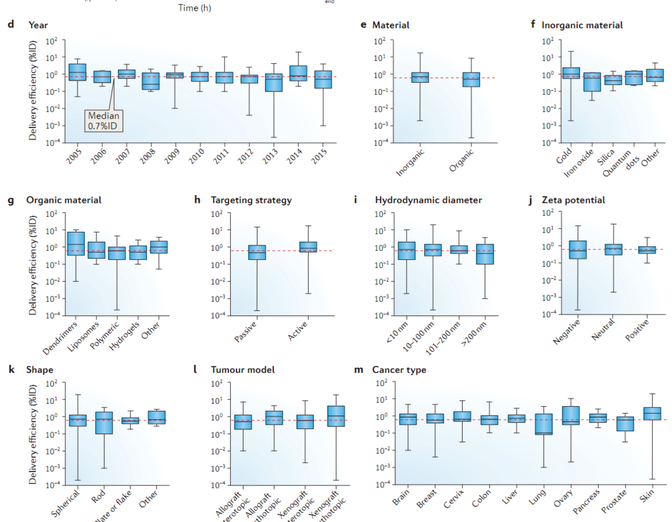




Delivery efficiency and consequences







List of FDA-approved nanomedicines stratified by material category

Name	Material Description	Nanoparticle Advantage	Indication(s)	Year(s) approved
Polymer Nanoparticles – synthetic polymer particles combined with drugs or biologics				
Cimzia®/certolizumab pegol (UCB)	PEGylated antibody fragment (Certolizumab)	Improved circulation time and greater stability in vivo.	Crohn's disease Rheumatoid arthritis Psoriatic Arthritis Ankylosing Spondylitis	2008 2009 2013 2013
Plegridy® (Biogen)	Polymer-protein conjugate (PEGylated IFN beta-1a)	Improved stability of protein through PEGylation	Multple Sclerosis	2014
ADYNOVATE (Baxalta)	Polymer-protein conjugate (PEGylated factor VIII)	Improved stability of protein through PEGylation	Hemophilia	2015
Liposome formulations combined with drugs or biologics				
Marqibo® (Onco TCS)	Liposomal Vincristine	Increased delivery to tumour site; lower systemic toxicity arising from side-effects	Acute Lymphoblastic Leukemia	2012
Onivyde® (Merrimack)	Liposomal Irinotecan	Increased delivery to tumour site; lower systemic toxicity arising from side-effects	Pancreatic Cancer	2015
Micellar nanoparticles combined with drugs or biologics				
Estrasorb™(Novavax)	Micellar Estradiol	Controlled delivery of therapeutic	Menopausal therapy	2003
Protein nanoparticles combined with drugs or biologics				
Abraxane®/ABI-007 (Celgene)	Albumin-bound paclitaxel nanoparticles	Improved solubility; improved delivery to tumor	Breast cancer NSCLC Pancreatic cancer	2005 2012 2013
Nanocrystals				
Avinza® (Pfizer)	Morphine sulfate	Increased drug loading and bioavailability; extended release	Psychostimula nt	2002 (2015)
Ryanodex® (Eagle Pharmaceuticals)	Dantrolene sodium	Faster administration at higher doses	Malignant hypothermia	2014
Inorganic and metallic nanoparticles				
Nanotherm® (MagForce)	Iron oxide	Allows cell uptake and introduces Superparamagnetism	Glioblastoma	2010

References

1. Alexis F., Pridgen E.M., Langer R., Farokhzad OC. Nanoparticle Technologies for Cancer Therapy. Handbook of Experimental Pharmacology, **197**,55-86(2009).
2. Mudshinge S. R., . Deore A. B, Patil S., Bhalgat C. M., Nanoparticles: Emerging carriers for drug delivery, Saudi Pharm J,**19**, 129–141, (2011)
3. Rama Raju G. S., Benton L., Pavitraa E. and Su Yu J., Multifunctional nanoparticles: recent progress in cancer therapeutics, Chem. Commun.,51, 13248(2015).
4. Bobo D., Robinson K.J., Islam J., Thurecht K.J., Corrie S.R. Nanoparticle-Based Medicines: A Review of FDA-Approved Materials and Clinical Trials to Date, Pharm Res., **33**(10):2373-87(2016)
5. Wilhelm S., Tavares A.J., Dai Q., Ohta S., Audet J., Dvorak H.F., Warren C., and Chan W. Analysis of nanoparticle delivery to tumours, Nat. Rev. Mater.,**1**, 16014 (2016)
6. Torrice M., Does nanomedicine have a delivery problem?, Chemical & Engineering News, **94**, 25(2016).