NANOMEDICINE 2.0

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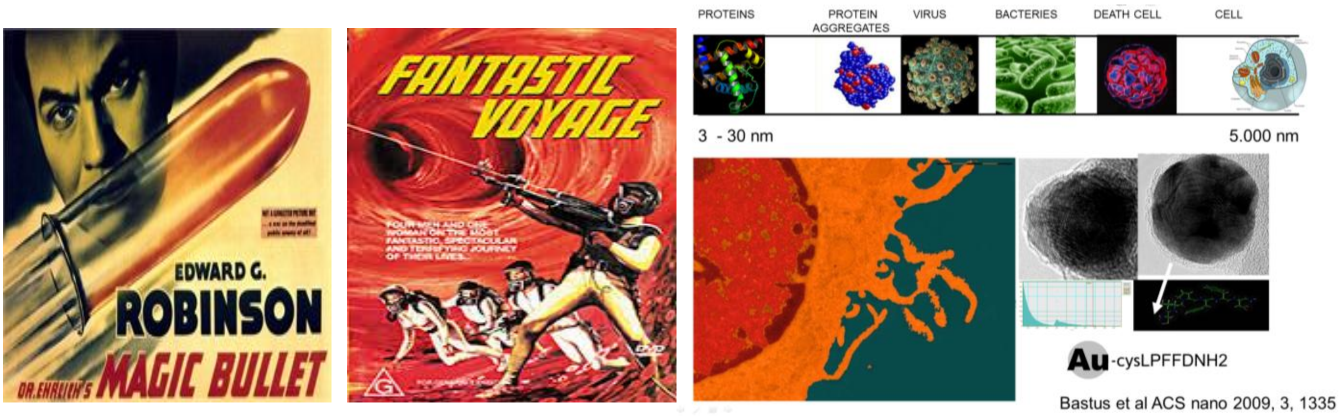
Abstract

Last decade has seen a flourishment in the study of the properties of inorganic nanoparticles for medical applications. Nanoparticles display properties that are strongly determined by both morphology and environment and in the physico-chemical context where they are immersed, therefore allowing to monitor and manipulate biological states. In fact, inorganic nanoparticles behave as "artificial atoms", since their high density of electronic states -which controls many physical properties- can be extensively and easily tuned by adjusting composition, size and shape and used in biological environments. In fact, nanotechnology's ability to shape matter on the scale of molecules is opening the door to a new generation of diagnostics, imaging agents, and drugs for detecting and treating disease at its earliest stages. But perhaps more important, as I will show, it is enabling researchers to combine a series of advances, creating thus nanosized particles that may contain drugs designed to kill tumours together with targeting compounds designed to home-in on malignancies, and imaging agents designed to light up even the earliest stage of cancers. In fact, a description of cancer in molecular terms seems increasingly likely to improve the ways in which human cancers are detected, classified, monitored, and (especially) treated, and for that, nanoparticles, which are small and therefore allows addressing molecular structures in an unique manner, may be especially useful for those tasks.



Normally, not all that is conceived becomes reality, however, what becomes reality, has been previously in the imagination. The magic bullet, a way to drive drugs towards the target avoiding effects to the rest of the body. The fantastic voyage, scientist and a submarine are miniaturized to go and do medical work inside the body. Their fight against the immune system is epic. Both precluded developments on nanomedicine.

When almost 10 years ago, *Science* magazine dedicated the special issue on nanotechnology on cancer treatment [1], clinicians and pharmaceutics did not consider it as a real alternative yet. Currently, this perception may be changing thanks to the intense research efforts and exemplary bold initiatives to develop cancer nanotechnology [2]. As a consequence, more than a dozen nanoparticle-based imaging agents and therapeutics are either on the market, in clinical trials, or awaiting clinical trials [3,4]. Similarly, the use of superparamagnetic nanoparticles for photo-ablation (hyperthermia) of brain tumours is already applied in the clinic [5]. Many indicators suggest that 2013 has been the **turning poitnt** for nanomedicine in oncology become a reality thanks to many that believed on it years ago and have been working hard supporting its development: “Nanomedicine is playing a growing part in pharmaceutical research and development (R&D), primarily in the form of nanoparticle-based delivery systems for drugs and imaging agents. Indeed, by some quantitative measures, the field is flourishing; over the past decade there has been an explosive growth in associated publications, patents, clinical trials and industry activity.” It is also exemplifying how recently pharmaceutical companies are focusing efforts to bring nanotechnology solutions to the cancer treatment market. Thus, BIND, with their engineered Poly(lactic-co-glycolic acid) NPs, signed recently three development agreements with AstraZeneca and CytInmune (Gold NPs) did the same with Amgen, while Cellgen acquired Abraxane (Albumin NPs) not long ago in a billion dollars deal. Similarly, Nanobiotix, heavy atom hafnium oxide NPs as radiotherapy contrast agent, received strong French governmental funding to develop their enhanced radiotherapy technology while MagForce continues applying iron oxide NPs for thermal therapy in brain glioblastomas. This is happening now as the fundamental research is being translated into pharmaceutical and clinical development. “There is a new level of confidence in this approach among the big pharmaceutical companies ... We will see more and more products in clinical testing over the next few years and I think that is very exciting.” “Anything you can do to improve targeting of tumors rather than normal tissue - whether that is through an armed antibody or nanoparticle approach - increases the chance of success,” said Susan Galbraithm in 2013, who leads AstraZeneca’s oncology research. The Nanotechnology Characterization Laboratory (NCL), in coordination with the US National Cancer Insitute (NCI) sponsored companies which developed agreements with big pharmacological industries in 2013 worth over a billion dollars, highlighting a new interest in using such tiny carriers to deliver drug payloads to specific locations in the body. Among many other, venture-backed nanomedicine firms include Selecta Biosciences which has a deal on food allergy vaccines with Sanofi, while Liquidia Technologies which is allied with GlaxoSmithKline on vaccines and inhaled products. In general, companies are increasingly focused on better drug targeting to increase efficacy and lessen the collateral damage caused by medicinal “carpet bombing” - a particular problem in cancer, where toxic compounds are needed to kill tumors. Surprisingly, it seems that we have few other alternatives to bring new drugs to the clinic, or in general, few other ways to promote progress, than via pecuniary profit).

References

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