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Editorial

# Nano Pharmaceuticals

Pharmaceutical companies are in trouble. With patent expirations on numerous "blockbuster" drugs on the rise, large pharmaceutical companies are searching for new competitive business strategies. Drug revenues worth $70–$80 billion will potentially be lost by 2011 as various drugs go off-patent. Some argue that "big pharma" has been more focused on shareholder profits than innovative therapies. All agree that in today's global economy, big pharma faces enormous pressure to deliver high-quality products to patients while maintaining profitability. It must constantly reassess how to improve the success rate of new potential drugs while reducing research and development (R&D) costs and cycle time associated with producing new drugs, especially new blockbusters. The cost (often $800+ million) and time (frequently spanning 10–15 years) of developing and launching a new drug to market are daunting. Annual R&D investment by drug companies has risen from $1 billion in 1975 to $40 billion today, while annual new drug approvals have remained flat at between 20–30 drugs. Simply put, big pharma's business model, which relies on a few blockbusters to generate profits via enormous promotional campaigns, is clearly broken. Consequently, there is a critical need to alter research approaches and business models. Therefore, it is not surprising that drug companies today are turning to miniaturization and nanotechnology to enable faster drug target discovery and drug development. Nanotechnology-based pharmaceuticals offer potential solutions to fundamental problems in the drug industry ranging from poor water solubility of drug compounds to a lack of target specificity. In time, nanotechnology should reduce the cost of drug discovery, design, and development. However, Nano pharmaceuticals currently are creating challenges for government agencies such as the Food and Drug Administration (FDA) and the U.S. Patent & Trademark Office (USPTO). Although Nano pharmaceuticals will eventually be an integral part of modern medicine, their path is paved with regulatory and patent uncertainty. One of the problems regulators and lawyers face regarding nanotechnology is the confusion and disagreement among experts about its definition. One often used, yet clearly inaccurate, definition of nanotechnology is that used by the U.S. National Nanotechnology Initiative (NNI). It pigeonholes nanotechnology into "dimensions of roughly 1 to 100 nanometers."1 Government agencies such as the FDA and the USPTO continue to use a similar definition based on a scale of less than 100 nm. However, this NNI definition presents difficulties because nanotechnology represents a cluster of technologies, each of which may have different characteristics and applications. For example, although the sub-100 nm size range may be critical for a Nano photonic company where quantum effects depend on particle size (i.e., quantum dot size dictates the colour of light emitted therefrom), this size limitation is not critical to a drug company from a formulation, delivery, or efficacy perspective because the desired or ideal property (e.g., improved bioavailability, reduced toxicity, lower dose, enhanced solubility, etc.) may be achieved in a size range greater than 100 nm. Several examples of Nano pharmaceuticals being introduced by pharma highlight this important point. Nano pharmaceuticals are colloidal particles of 10 to 1,000 nanometres (1 micron) in size. They are widely used in drug delivery. Nano pharmaceuticals are diverse both in their shape and composition and often offer an advantage as compared to their "bulk" counterparts primarily because of size. In recent years, various nanotechnologies have been employed successfully to tackle drugs with low water solubility. Numerous pharmaceutical companies are using nanotech to revisit shelved drugs that were "difficult" from a formulation point of-view due to their solubility profiles. All Nano pharmaceuticals currently on the market (table 1) have been approved by the FDA according to pre-existing laws and without any special testing (e.g., with respect to pharmacokinetic profiles). However, approval of new Nano drugs and "Nano reformulations" has challenged the FDA's regulatory framework. Products submitted to the FDA for market approval are evaluated on a category-based system. A drug, biologic, or device would be assigned for evaluation respectively to the Center for Drug Evaluation and Research (CDER), the Center for Biologics Evaluation and Research (CBER), or the Center for Devices and Radiological Health (CDRH). However, certain therapeutics are "combination products," which consist of two or more regulated components (drug, biologic, or device) that are physically, chemically, or otherwise combined or mixed to produce a single entity. The FDA's category-based approval process has resulted in inconsistency when applied to combination products.