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Nanobiotechnology — A Promising Future

Those who have been watching the marriage between nanotechnology and bioscience blossom are expecting great things from their union. Dubbed nanobiotechnology, the field involves nanofabrication techniques to produce materials and devices with compelling biological applications, including drug delivery, diagnostics, tissue engineering and therapeutics. Imagine how pleasantly surprised Richard Feynman, the physicist who introduced the topic of nanotechnology in 1959, would be if he were here to witness nanotechnology in practice. He did not deny the ability for matter to be manipulated at the atomic level, but, at the same time, he was doubtful the technology would ever be put into practice.

A mere 50 years later, we not only have the ability to control materials at the molecular level, but we have used this knowledge to create a product or enable a process that was previously unimaginable, such as "smart bomb" cancer drugs that detonate only over their targets, antibody-armed quantum dots that flow straight to cancer cells, and a dendrimer-based microbial gel that protects against HIV infection for 30 minutes after it is applied.

This month's special section on nanobiotechnology (pp. 33–48) describes a multitude of applications that have already been demonstrated successfully by major pharmaceutical firms, industry startups and academia, such as quantum dots for cancer cell detection and treatment. Also featured in this section is an overview on developments in drug delivery systems and differentiated tissue regeneration, authored by MIT's Ali Khademhosseini and Robert Langer.

The products that have made it (or are progressing) through clinical trials have done so, in part, because the market for them is well-defined. Nevertheless, the field as a whole, is still too new to have convinced government and venture capitalists that a market exists for it. A case in point is borne out in the data compiled by the National Nanotechnology Initiative (NNI; Arlington, VA; www.nni.org). Currently, biotechnology R&D receives 10% or less of global government nanotechnology funds (about $6.8 billion). Furthermore, last year, the NNI spent less than 2% of its overall budget (or $5.85 million) on nanobiotechnology research. But there is good news — NNI's 2005 award exceeded that of 2004 by about a half a million. In addition, nanotechnology venture capitalists are preferentially investing in nanobiotechnology opportunities — and with good reason.

According to a recent report by Merrill Lynch, 23 of the world's leading drugs will lose patent protection by 2008, which accounts for $46 billion in revenue. Many pharmaceutical firms will be turning to nanobiotechnology for intellectual property protection. "This will drive commercialization in the nanobiotech sector, despite risks of the potentially long and agonizing drug approval process and significantly high development costs," says the firm.

The last time I recall such reactionary investment and insatiable interest in a "new" technology was right before the Internet bubble burst. But there is no need to fear a bursting bubble this time. Unlike the man-made information highway, Mother Nature is infinitely complex and mysterious. Nanotechnology is the key that will unleash her potential.

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