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Risk of nanotechnology

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Nano-this and nano-that. These days it seems you need the prefix “nano” for products or applications if you want to be either very trendy or incredibly scary. This “nano-trend” has assumed “mega” proportions. Vague promises of a better life are met by equally vague, generalized fears about a worse future. These debates have some aspects in common: the subject is complex and not easy to explain; there is no consensus on risks and benefits. - A particular problem with nanotechnology lies in the huge gap between the public perception of what the hype promises and the scientific and commercial reality of what the technology actually delivers today and in the near future.

There is nanoscience, which is the study of phenomena and manipulation of material at the nanoscale, in essence an extension of existing sciences into the nanoscale. Then there is nanotechnology, which is the design, characterization, production and application of structures, devices and systems by controlling shape and size at the nanoscale. Nanotechnology should really be called nanotechnologies: There is no single field of nanotechnology. The term broadly refers to such fields as biology, physics or chemistry, any scientific field really, or a combination thereof, that deals with the deliberate and controlled manufacturing of nanostructures.

In addressing the health and environmental impact of nanotechnology we need to differentiate two types of nanostructures: (1) Nanocomposites, nanostructured surfaces and nanocomponents (electronic, optical, sensors etc.), where nanoscale particles are incorporated into a substance, material or device (“fixed” nanoparticles); and (2) “free” nanoparticles, where at some stage in production or use individual nanoparticles of a substance are present.

There are four entry routes for nanoparticles into the body: they can be inhaled, swallowed, absorbed through skin or be deliberately injected during medical procedures. Once within the body they are highly mobile and in some instances can even cross the blood-brain barrier. How these nanoparticles behave inside the organism is one of the big issues that need to be resolved. Not enough data exists to know for sure if nanoparticles could have undesirable effects on the environment. Two areas are relevant here: (1) In a free form nanoparticles can be released in the air or water during production (or production accidents) or as waste byproduct of production, and ultimately accumulate in the soil, water or plant life. (2) In a fixed form, where they are part of a manufactured substance or product, they will ultimately have to be recycled or disposed of as waste.

To properly assess the health hazards of engineered nanoparticles the whole life cycle of these particles needs to be evaluated, including their fabrication, storage and distribution, application and potential abuse, and disposal. The impact on humans or the environment may vary at different stages of the life cycle.

Regulatory bodies in the U.S. as well as in the EU have concluded that nanoparticles form the potential for an entirely new risk and that it is necessary to carry out an extensive analysis of the risk. It is imperative that national and international regulatory bodies cooperate closely not only with each other, but also with academia and industry; based on that, nanomaterials and nanotechnology can be developed responsibly. With that in place we can look forward to optimizing the benefits of nanotechnology while minimizing and controlling the risks.