As nanoparticles continue to permeate our lives in increasingly diverse ways, a comprehensive database is under development to enable scientists to identify links between the chemical properties and biological effects of specific particles. **Professors Oded Maimon** (left) and **Rafi Korenstein** tell us more

Changing the face of nano discovery

What are the main objectives of the 'Nano health-environment commented database' (NHECD) project?

OM: Our underlying aim is to facilitate the identification of nanoparticles that can be hazardous to human and environmental health. Ultimately, we seek to develop a predictive model so that such hazards can be averted. The project itself gathers all available data and employs methods to rate it against a set of principles. In this way, articles already in the public domain are indexed, providing an easy-to-access database for the research community. Keywords are generated so that specific material can be searched for and accessed in a hassle-free way. This is what we call a 'commented database'.

RK: Our first question is to ask why some particles are taken up by biological systems more than others. This involves a consideration of the relationship between the chemical characteristics and the biological effects of nanoparticles. To tackle this, we are forming a large scientific database in order to delineate emerging patterns. This is currently lacking in the field and we seek to translate informatics tools used in other fields – such as chemistry – and apply them to nanoparticle toxicology.

How are you planning to maintain a successful database that collects information about the impact of nanoparticles and their levels of toxicity?

RK: The database is not yet complete, but we have gathered around 10,000 open source articles thus far; all are in English. The tool will in a short time be officially opened to a select audience and will eventually be made available to scientists, regulators, policy makers and other stakeholders – not to mention the general public! Once the project reaches the end of its lifespan, our partners at the Joint Research Centre (JRC) in Ispra, Italy, will be responsible for incorporating additional input. This will ensure the database is kept up-to-date as and when new articles enter the public domain.

In what ways will the construction of your database strengthen existing research within this area?

OM: The vision is to provide tens of thousands of journal articles to the research community for data mining. We aim to provide a consolidated resource, bringing together articles from various sources into one database. This will mark a completely new innovation in the field of nanoparticle toxicity.

RK: Previously, data could be searched for via keywords. Now we are going to present information relating to toxicity, combining all results, so that people can discover the safe use of nanoparticles in various applications and fields, such as medicine.

Could you highlight some of the major features that will be provided through your database?

RK: Within the database, information regarding specific characteristics of nanoparticles' toxicity can be extracted automatically and put into data. As such, anyone who wishes to access a specific article can get more detailed analysis in an automatic way; if, for instance, one asks a specific question regarding the use of certain nanoparticles under *in vivo* or *in vitro*, one can get a list of detailed information, in order to assess key questions.

Where are you hoping to see the potential applications of this database?

OM: The database will be used to predict the properties and toxicological effects of nanoparticles. By applying intelligent modelling one will be able to identify links between the physico-chemical properties of nanoparticles and their specific biological effects. If such associations can be made, then one can predict and advise on the expected toxicology of new nanoparticles, ensuring their safe future application.

Can you provide a brief synopsis of the project's partners?

RK: At our core is the IT group led by Professor Maimon at Tel Aviv University's Department of Industrial Engineering. Then we have 'domain' experts in toxicology: the group at the Department of Physiology and Pharmacology, Tel Aviv University, focuses on *in vivo* and *in vitro* topics; our partners at the JRC consider environmental impacts; and our collaborators at IVAM UVA in The Netherlands are experts in occupational health, dealing with the exposure of workers to nanoparticles. Currently, IVAM UVA is addressing both the regulatory and scientific questions associated with exposure of nanoparticles in the manufacturing workplace. TP21 is responsible for the project management. There is no doubt that the geographically diverse group reflects the global relevance of harmonising existing literature into a single, comprehensive database.

The **nano** hub

As our reliance on nanomaterials increases, so too does our awareness about the impact they have on health, the environment and safety. Researchers at **Tel Aviv University**, Israel, in collaboration with international partners, have created a database that manages, locates and retrieves content about nanotoxicity

NANOTECHNOLOGY HAS LED to advances in many diverse areas, including medicine and healthcare, IT, energy, household and consumer products, to name but a few. It has diffused in the marketplace and has certainly revolutionised scientific areas such as organic chemistry, molecular biology and semiconductor physics. This thriving marketplace, however, has also led to an increase in the awareness of possible risks to environmental safety, human health and safety when using these new materials. For example, certain nanoparticles, upon entrance into the body, have not only been shown to cause serious lung problems, but are also transported to other organs like the brain or heart, where it is not known whether they pose additional risks. Nanoparticles or nanomaterials (a nanometre being one millionth of a millimetre) pose a potential risk due to their minute size, meaning they function and behave differently from their larger counterparts (eg. bulk matter). Uncovering the potential harmfulness nanoparticles (nanotoxicology) remains a very active and ongoing area of research, and this has called for deeper investigation into their impact.

A NEW PRACTICE

The rise of potential health hazards has led to the creation of a new discipline. Nanotoxicity – the study of toxicity in nanomaterials – is considered to be an essential part of nanotechnology development. This can be a lengthy process as all nanomaterials are different and need to be investigated individually and separately. Therefore, some nanomaterials are likely to demonstrate more biological effect than others. Interest regarding the impact that nanoparticles have on human health and the environment has started to grow, and the potential of nanotechnology to progress will be largely marked by the strategies we use to ensure safety in these key areas. The European industry's interest surrounding nanosafety has enlarged due to the number of nanoproducts being sold commercially. Also, environmental and ethical groups are concerned with the regulatory measures being taken during product development. Despite the large amount of money that is applied to nanosafety R&D, there are still issues with quantifying and qualifying all of the information on nanotoxicity. A successful evolution of nanotechnology is therefore dependent on our ability to attest for all precautions and preoccupations, as well as keeping policy makers, the general public, industry, scientists and researchers, companies and governments in-the-loop and aware of the hazards. New and improved approaches towards the safety of nanotechnology have become a high priority on the agendas of many scientists and political groups and to meet this growing demand, a multitude of organisations and institutions are tackling the issues. One challenge facing many of those exploring nanosafety is that the sheer extent and volume of information is incredibly high. In order to collect this data effectively and efficiently, investigators will need to invest in a suitable method for dealing with a variety of data types.

THE NHECD REPOSITORY

Professor Oded Maimon from Tel Aviv University (TAU), Israel, is currently leading a multidisciplinary project, funded by the EU under the umbrella of the Seventh Framework Programme (FP7). The team has been gathering data from existing literature in the area of nanotoxicity and has created a novel system known as the 'Nano health-environment commented database' (NHECD). Using their recently collected advanced research results, the team's free access web-based information system includes a knowledge repository on the impact and effects of nanoparticles on the environment, health and safety. Ensuring that all the different data sources that are a part of the database (eg. scientific papers, white papers) are categorised into a solid and coherent structure is no easy task. This is why NHECD uses a robust content management system (CMS), which acts as the centre point of the entire system. All of the information collected thus relates to the environmental and health effects of nanoparticles, and can be easily accessed, thus reducing time consumption and filtering inappropriate content. The team is working towards the completion of five Work Packages including: provision of IT; toxicology; tools and environment; interactions with stakeholders and dissemination; and project management. Coming to the end of the project's year, the system has already made some landmark achievements. Using a mixture of unique features, robust and concrete database management and expertise within the team has allowed for a solid web-based product, enabling users to access information quickly and directly.

HOW DOES IT WORK?

The system was constructed with the major purpose of facilitating the extraction of relevant and suitable information from a vast sea of documentation. In a short time, it will become available to academics, industry and public institutions, in accordance with their particular needs and requirements. Thereafter, the resource will be opened up to the general public fairly soon, in a bid to generate more awareness about the effects of nanoparticles and the hazards that are associated with its development.

INTELLIGENT SEARCHING

One of the NHECD's unique features is its ability to perform an intelligent search, specifically aimed at targeting a particular piece of information required by the user. The search method was initially created for researchers' nanoscience needs and is capable of allowing the user to search for content by cell or/and animal model, experiment or by distinguishing characteristics. Currently, the system includes basic, advanced, intelligent and taxonomic level search features, depending on the specifics required during the retrieval process. This provides a comprehensive solution to wading through copious amounts of information, and provides the user with an option to make either a general or specialised search.

NHECD

NANO HEALTH-ENVIRONMENT COMMENTED DATABASE

PROJECT ACHIEVEMENTS

To date, the system includes a number of tailored features that support both users and administrators, including:

- A crawling system designed to navigate selected sources (automatically or semi-automatically) for the purpose of obtaining data materials related to NHECD
- An information extraction feature that allows users to view list of relations from each scientific paper found in the repository
- A rich set of computer based taxonomies related to the NHECD target areas, easing users' search queries
- A robust infrastructure which carries out administration and maintenance activities effectively; this will also be used after the project has officially ended

Currently, the team is looking at ways of communicating and collaborating with leading publishing companies in order to generate further awareness about NHECD while respecting intellectual property rights. In the near future, the NHECD team is looking to work on issues regarding awareness, the restrictions of information extraction and improving text mining facilities. Thereafter, the project will be passed on to the Joint Research Centre, who will be responsible for updating the resource with the latest research articles, ensuring it remains relevant and entirely up-to-date.

NHECD TEAM

OBJECTIVES

The goal of NHECD is to build a free access, robust and sustainable web-based information system including a knowledge repository on the impact of nanoparticles on health, safety and the environment. NHECD leverages information dispersed over thousands of relevant scientific publications and adds value by making this knowledge accessible via a unique interface. The creation of the NHECD repository increases public understanding of the impact of nanoparticles on health and the environments; supports a safe and responsible development and use of engineered nanoparticles; and represents a useful instrument for the implementation of relevant regulatory measures and law making.

PARTNERS

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ODED MAIMON is a Professor of Industrial Engineering and head of the Oracle Research at Tel Aviv University, Israel. Formerly at MIT, he is a world expert and leader in data mining and knowledge discovery from data. Maimon has written six leading research and application books in this area in the last 10 years, and has published numerous scientific papers.

NHECD
knowledge on the health, safety and environmental impact of nanoparticles