Human biomonitoring

A sophisticated technique which requires an equally sophisticated interpretation framework

It has long been known that certain chemicals are toxic to humans. Obviously they can only exert this toxic effect insofar as they are absorbed in the body. Scientific advances have made it possible to detect minute quantities of man-made chemicals in complex media such as human blood, urine and hair. This type of analysis is often referred to as human biomonitoring.

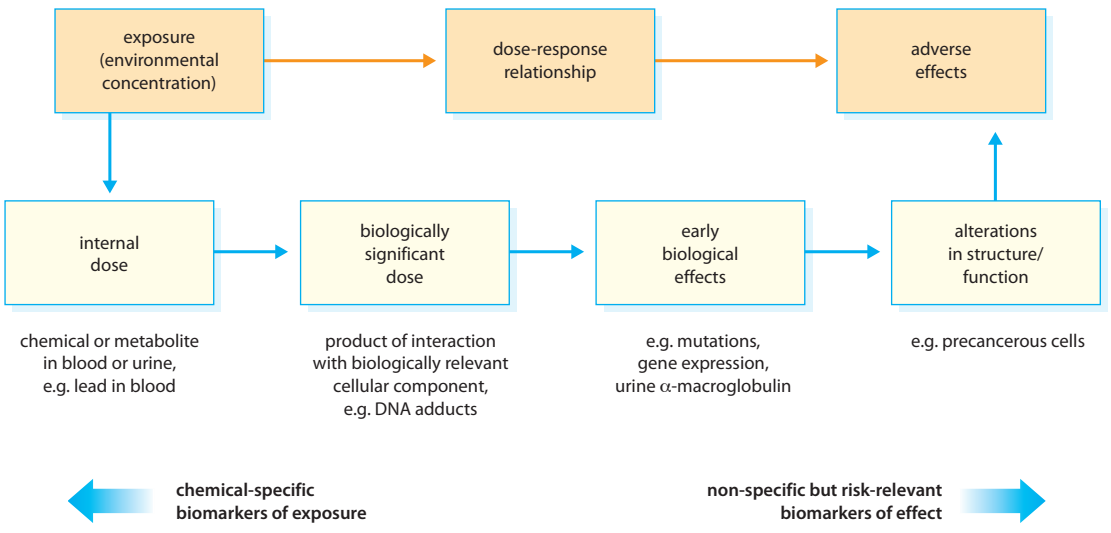
'Chemicals' can be released into the environment from many sources, both man-made and natural. Uptake of 'chemicals' in the body can occur via inhalation, through food and drinking water or through direct contact with the skin and indeed, exposure to some chemical compounds can occur through more than one of these routes. One of the attractions of biomonitoring lies in its ability to account for the combination of the different exposure routes through a single measurement.

A chemical which has entered the body is eliminated at a certain rate. Long-term exposure leads to an equilibrium level between uptake and elimination. Often chemicals are transformed via enzymatic processes into 'metabolites' which are then excreted. An example of this is cotinine which can be measured in urine and is derived from nicotine in inhaled cigarette smoke or from the use of nicotine patches on the skin.

The advances in the analytical field have not yet been followed by full scientific insights about possible health risks associated with the detected levels of chemicals. For a chemical substance to present a risk to health it needs somehow to interfere with the body's systems and it needs to be present in sufficient quantity to overcome the body's defence (i.e. de-toxification) capability.

Figure 1 describes the chain of events necessary for a chemical to have an effect. Upon exposure to a chemical, uptake occurs, followed by other internal transformation processes. The resulting concentration of the chemical or a close metabolite, e.g. in blood, urine or exhaled air, is known as a biomarker of exposure. Other events further down the chain are called biomarkers of effect. The latter may often result from exposure to more than one chemical compound. Biomarkers of

Figure 1 Biomarkers in the assessment of risks from toxic environmental chemicals
(courtesy of S. Kyrtopoulos, National Hellenic Research Foundation)



Human biomonitoring

A sophisticated technique which requires an equally sophisticated interpretation framework

exposure are of course indicative of chemical exposure but not necessarily of a possible health effect. Biomarkers of effect indeed indicate that a biological effect process is taking place, but they are often not specific to a single chemical.

In recent years a number of human biomonitoring campaigns have been reported in rather emotional terms by the press. In most cases these reports referred to biomarkers of exposure. While there is a widespread public perception that it would be preferable for no man-made chemicals to enter our bodies, their mere presence may not be construed as a health risk and should be viewed in perspective.

As is the case in all areas of sound science, application of novel scientific concepts for societal risk management needs to be preceded by validation studies. Several organisations have recently published guidance for the interpretation of results of human biomonitoring campaigns (ECETOC, CEFIC, US National Academy of Sciences). Human biomonitoring should be considered as one of the tools to manage human health risk, not as a goal in itself. If the theoretical basis is insufficient for a risk-based interpretation of the results, the only possible use of biomonitoring data is for descriptive purposes, for instance to establish:

- Who is most/least exposed?
- How does an individual's exposure compare with the entire population?
- Is this a new or a long-standing exposure?

Descriptive data can be used to track trends, for example in response to a policy measure. Currently, under the EU's Environment and Health Action Plan 2004–10, a working group is developing proposals for pilot projects in several EU Member States. The principal purpose is to improve standardisation of survey protocols and associated communication programmes. The experience with and attitude towards human biomonitoring is quite diverse in different EU Member States. Whereas in some countries (e.g. Germany) large population surveys have already been conducted, in others there is no experience and consequently no infrastructure of laboratories and scientific expertise to support this type of programme. CONCAWE's toxicologists provide support to the European working group, building on experience gained with biomonitoring applications to identify and control exposures to hazardous substances in the industrial work environment, such as benzene and polycyclic aromatic hydrocarbons for which analytical methods to measure their metabolites in urine have been established and validated.

Remarkable advances in chemical analytical techniques now make human biomonitoring possible. It is essential that the data thus generated are supported by an equally sophisticated interpretation framework. This must include thorough validation studies to ensure that human biomonitoring leads to sound and efficient environmental policy making. It is a promising development but, like all tools, it needs to be used expertly and sensibly if it is to help improve management of environmental health risks.