EDITORIAL

RADIOACTIVITY - HENRI BECQUEREL'S DISCOVERY

A century has elapsed since Henri Becquerel made public his important discovery, namely the existence of natural radioactivity. Shortly after his discovery George Hevesy enunciated the tracer method leading to the application of radioactivity as a tool in the physical and life sciences. During the intervening time interval the world has seen many benefits that have stemmed from the use of radioactivity as well as the many problems that have also emerged. For years the international unit of radioactivity was the Curie (3.7×10^{10} disintegrations per second), named after the discoverers of natural radium, Marie and Pierre Curie. More recently it has been replaced by a much smaller international unit (SI unit) of 1 disintegration per second, which, quite appropriately, is known as the Becquerel.

Although the use of radioactivity is subject to stringent regulatory controls the picture it conjures in the mind of many is associated with the use of atomic weapons, of major nuclear incidents such as the accident 10 years ago at Chernobyl nuclear power station, and of cancers induced by radiation. Thankfully, there is another, happier side, memorably captured in a statement made by Gordon Dean, one time chairman of the USA Atomic Energy Commission: Radionuclides are used to treat the sick, to learn more about disease, to improve manufacturing processes, to increase the productivity of crops and livestock and to help understand the basic processes of the body, the living things around us and the physical world in which we exist.

Radioactivity, as we know it today, is based mainly on the development of artificial radioactivity, arising from radionuclides produced in either nuclear reactors, or particle accelerators. Hardly any of the vital organs of the human body can not be examined using small, relatively harmless, doses of radioactivity. Radiopharmaceuticals for scanning the brain, liver, kidney, pancreas, prostrate, thyroid, adrenal glands, lungs, heart and bone are all available and widely used. In addition radiation, often combined with chemotherapy, is used to treat various types of cancers. Without such applications millions of people would have suffered premature deaths from undiagnosed or untreated diseases. It is unfortunate therefore that publicity for these beneficial applications of radioactivity frequently has to take second place to the negative aspects, so often publicised by the media.

The industrial applications of radioactivity are many and varied. Radiation sources are used for food irradiation, oil well logging, sterilisation of surgical equipment, for materials safety testing and thickness gauging as well as heat (light) sources, many of which reflect the unique nature of radioactivity. Nuclear energy and power will provide a source of fuel long after other sources have been exhausted. The price to be paid for all these benefits is the need to find a satisfactory solution to the disposal and storage problems associated with radioactive waste.

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Extensive research in the life sciences has benefited greatly from the availability of a range of β-emitting radionuclides - carbon-14, tritium (hydrogen-3), sulfur-35, phosphorus-32 and phosphorus-33 - which have been used to label thousands of organic compounds. Much of this has been directed at studies of the biochemistry of life processes, leading in turn to a better understanding of diseases and the way in which drugs work in the various treatments. Modern genetics and gene therapy developments owe their success to DNA sequencing using [^{32}P]- and [^{33}P]-phosphorus labelled nucleotides. New drug screening and pharmacokinetic studies of drug metabolism mainly use carbon-14 compounds although tritium is best for scintillation proximity assays. The amino acid methionine, labelled with sulfur-35 is frequently used in studies of protein synthesis along with other amino acids labelled with carbon-14 or tritium. Clinical research of neurological disorders such as Parkinsonism and Schizophrenia are often studied with compounds labelled with the short half-life positron emitting radionuclides fluorine-18 and carbon-11.

The previously mentioned regulatory constraints and licensing requirements, coupled with the perceived harmful effects of radiation, have undoubtedly acted as a spur in the search for new non-radioactive methods and technology. Thus, in medicine, Magnetic Resonance Imaging (MRI) has emerged as a powerful method for human body scanning, as have ultra-sound scanners. Enhanced chemiluminescence (ECL), originally developed as an immunoassay detection system, is now displacing radioactive methodology, especially in areas of molecular biology where it is important to detect fragments of DNA and proteins. Similarly, fluorophores (using cyanine and other fluorescent dyes) are used as probes to label proteins and other biological molecules.

Henri Becquerel's discovery has had a major impact on the 20th century. The work that has been carried out using radiation sources and radio-labelled compounds has greatly benefited mankind although man-made decisions have made the benefit to risk ratio less favourable than it could have been. The hope must be that during the next century and beyond that this ratio continues to increase and that the Journal of Labelled Compounds and Radiopharmaceuticals contributes to this process.

Erwin Buncel	(Editor, 1995-)
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