Radioisotope Production and Radiation Technology

Objective

To contribute to improved health care and to safe and clean industrial development in Member States by strengthening national capabilities in the production of radioisotope products and in the use of radioisotopes and radiation technology.

Radioisotopes and Radiopharmaceuticals

Progress in nuclear medicine is currently being driven by advances in imaging technology and associated development of specific radiopharmaceuticals. The combination of positron emission tomography (PET) and single photon emission computed tomography (SPECT) cameras with computed tomography (CT) into new hybrid systems is now a standard method for diagnostic imaging and has enhanced the scope for better utilization of some diagnostic tracers.

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One area that has emerged recently and has attracted significant interest from clinicians is dedicated imaging systems for breast cancer detection. Hybrid imaging scanners used in conjunction with appropriate molecular imaging products help surgeons to detect the spread of cancerous cells, possibly affecting the first lymph node closest to the tumour. Localization of this first lymph node, a diagnostic procedure commonly known as sentinel lymph node detection (SLND), permits histological analysis after surgical removal to assess the presence of metastatic cells. This evaluation is of critical importance for determining the most appropriate therapeutic treatment for the patient. To facilitate the widespread use of this diagnostic methodology in Member States, a CRP ending in 2010 developed new molecular imaging agents for SLND labelled with technetium-99m (Fig. 1). The 18 participating research groups also developed two novel technetium-99m tracers. Another important result was the production

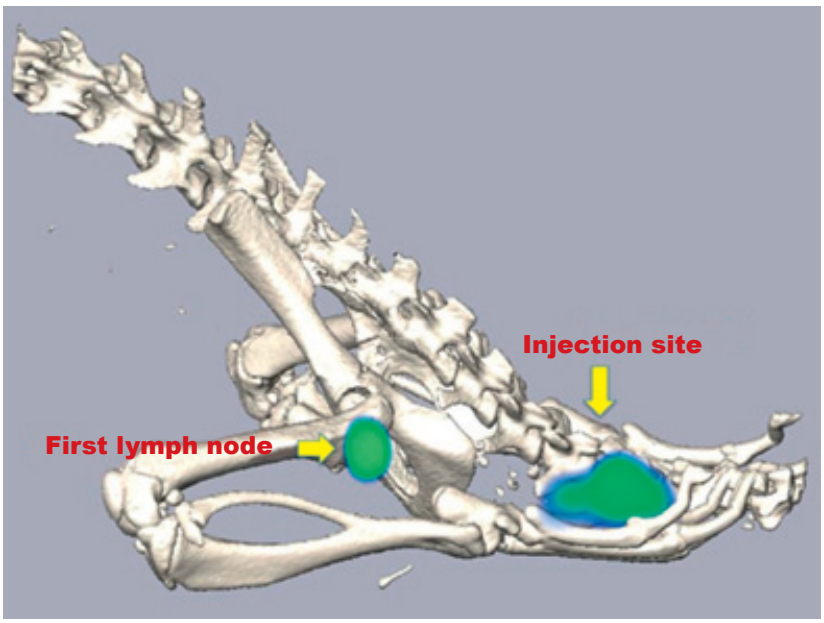

FIG. 1. SPECT–CT image of the first sentinel node in a rat obtained with a small animal tomograph after subcutaneous administration of a new imaging agent for SLND (image courtesy of Y. Arano).

of two freeze-dried kit formulations for easy preparation of the new tracers suitable for clinical use.

Therapy with radionuclides remains an active field of research, although only a few therapeutic radiopharmaceuticals are currently in use for the treatment of cancer. In view of the crucial importance of such therapy, the Agency hosted a technical meeting in Vienna in May 2010 at which the prospects and requirements for promoting the use of a number of interesting beta emitting radionuclides, as well as the challenges involved in developing effective therapeutic agents for cancer therapy, were discussed.

A new CRP was initiated in 2010 with the goal of developing an easy to use kit for labelling antibodies and peptides with lutetium-177 for the treatment of certain primary cancers such as non-Hodgkin's lymphoma and cerebral gliomas.

Through its technical cooperation programme, the Agency concluded a project in 2010 in Cuba that strengthened the indigenous production of radiolabelled monoclonal antibodies, thereby improving nuclear medicine services to cancer patients.

To facilitate better understanding of the issues and requirements in the production and utilization of some parent nuclides for generators, a new publication was issued in 2010 entitled *Production of Long Lived Parent Radionuclides for Generators: ^{68}Ge, ^{82}Sr, ^{90}Sr and ^{188}W* (IAEA Radioisotopes and Radiopharmaceuticals Series No. 2).

Radiation Technology Applications

Radiation induced grafting is a powerful technique for the preparation of value added materials based on readily available and low cost synthetic and natural polymers. There is a growing interest in developing materials as special adsorbents and membranes for use in environmental and industrial applications. A CRP concluded in 2010 focused on the use of gamma rays, electron beams and swift heavy ions for the grafting of various monomers onto natural and synthetic polymers for the development of novel adsorbents and membranes for environmental and industrial applications, an area of growing interest. A network of 16 Member State laboratories developed methodologies for the preparation of radiation grafted adsorbents, for example membranes to remove heavy metal ions and toxic compounds from wastewater and water. Also developed in this CRP were a low cost sensor to detect extremely low (parts per billion) levels of

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FIG. 2. Electron beam treatment of wastewater (image courtesy of B. Han, Eb-tech).

heavy metal ions in treated wastewater, radiation grafted surfaces for biomedical applications, such as laboratory scale antibacterial bandages, and protein separators and radiation grafted membranes for fuel cells and batteries.

Chronic water shortages have stimulated interest in appropriate technologies for treating wastewater for reuse, for example for urban irrigation, industrial uses (cooling, boilers and laundry), gardens and parks, and cleaning purposes. Wastewater treatment is also required due to new environmental policies which require stricter discharge regulations and lower permissible contaminant levels in industrial waste streams. The standard biological treatment processes commonly used are not always capable of treating many of the complex organic chemicals that are found in varying quantities in wastewater (for example, persistent organic pollutants). A new CRP was started in 2010 with the objective of evaluating radiation treatment as an add-on option in wastewater management, with a particular focus on wastewater containing organic pollutants (Fig. 2). The 16 participating teams from 15 Member States will study the applicability of radiation technology (in combination with other processes) to treat wastewater contaminated with organic compounds, validate analytical methods to characterize and evaluate effects of by-products in treated wastewater, and develop guidelines for selection of areas where the radiation treatment will have a high probability of successful application.

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In 2010, the Institute of Nuclear Chemistry and Technology (INCT) in Poland became a new IAEA Collaborating Centre (IAEA-CC) for Radiation Processing and Industrial Dosimetry (RAPID). The role of this IAEA-CC is to help implement industrial dosimetry intercomparison exercises for the effective and efficient application of radiation processing technology. In addition, the centre is supporting the feasibility assessment of emerging applications of radiation processing. The Malaysian Nuclear Agency, which has again been designated for the period 2010–2014 as the IAEA-CC for Radiation Processing of Natural Polymer and Nanomaterials, demonstrated the radiation aided production of non-toxic, environment friendly palm oil acrylates for printing applications.

An Agency technical cooperation project on radiation technology helped the Philippines to upgrade its gamma irradiation plant facility and increase the cobalt-60 source strength. The cobalt sources in this facility needed to be refurbished so that they would continue to be strong enough for a range of manufacturing applications. Following the upgrade, the facility started pilot scale production of hydrogel for wound dressings, to be marketed in collaboration with a private company.

To assist Member State electron beam facilities in designing processes to treat materials, the Agency published the first volume in its new IAEA Radiation Technology Series, entitled *Use of Mathematical Modelling in Electron Beam Processing: A Guidebook.* Aimed at those who wish to have a better understanding of irradiation methodology and process development for new products, the guide focuses on the application of mathematical modelling in industrial irradiation methodologies, with extensive reference to the existing literature and applicable standards.

To facilitate the availability of advanced non-destructive testing (NDT) methods in Member States, the Agency is helping to build national capabilities for the development of an affordable computer aided radiographic testing (RT) method. The participants in a CRP that ended in 2010 on optimization of digital industrial radiology (DIR) techniques designed and developed an affordable, low cost digital fluoroscopic system that can be built at a cost about 10–20% of that for comparable commercial digital radiographic systems with similar image quality. There was agreement among the CRP participants — Argentina, Germany, India, Malaysia, Pakistan, Romania, Syrian Arab Republic, Uruguay and Uzbekistan — that the system would be beneficial for developing countries adopting digital radiographic technology. The advantages of this technology include economy of storage, reduced radiation risks, and efficiency in the communication of images, which can also be sent through a network to experts for real time evaluation and verification.