

# Research



Australian Government

## Ansto

Nuclear-based science benefiting all Australians

## Medical research

ANSTO is the mainstay of nuclear medicine in Australia, manufacturing about 70 per cent of the radioisotopes needed for the diagnostic and therapeutic drugs used to detect or treat a range of cancers, heart disease and other serious disorders.

### Nuclear imaging

In Australia, ANSTO provides in excess of 500 000 doses or procedures a year for the treatment of cancer patients. Many of the doses rely on the use of diagnostic *radiotracers* – molecules containing short-lived, radioactive isotopes that emit gamma rays as they move through the body's tissues. Nuclear imaging techniques such as single photon emission computed tomography (SPECT) and positron emission tomography (PET) use sensitive gamma cameras to detect the source of the rays within the body, making it possible to locate and map areas of unusual activity or shape and hence identify early signs of disease or organ degeneration.



SPECT lung scan

### Therapeutic treatments

Most patient doses comprise powerful radiopharmaceuticals such as iodine-131 and iridium-192 for the treatment of cancers of the liver, thyroid, breast and prostate, as well as disorders of the bone marrow and endocrine system. These radioactive drugs are designed to target the cancer cells and destroy them with nuclear radiation internally, rather than from an external source.

In addition to its key role as a manufacturer of radioisotopes for use in medicine, ANSTO is actively involved in research into new methods for producing radioisotopes of potential value to nuclear medicine and the development of new and improved radiotracers that promise to increase the power and applicability of nuclear imaging.



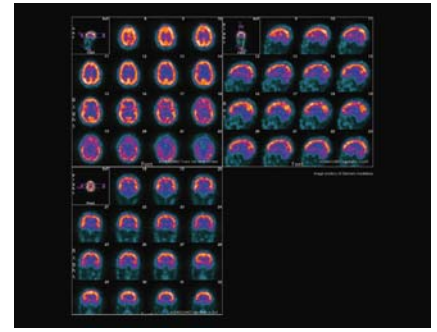
Making radioisotopes requires the use of either a particle accelerator (such as the National Medical Cyclotron, operated by ANSTO at the Prince Alfred Hospital in Sydney) or ANSTO's nuclear reactor at Lucas Heights. The OPAL reactor will allow ANSTO to increase the quality, quantity and range of radiopharmaceuticals useful in Australian hospitals for diagnosis and therapy and opens up new avenues of research for the future development of nuclear medicine in this country.

### New radiotracers for neurodegenerative diseases

An area of active investigation at ANSTO is a new class of radiotracers based on iodine-123 and fluorine-18 that can be used to image neurodegenerative diseases such as dementia, Alzheimer's disease and Parkinson's disease. The novel radiotracers are based on biomolecules known as benzodiazepine receptors, which play a role in cell respiration. Certain types of these receptor molecules bind to sites in the glial cells in the brain which provide support and protection for neurons. Using nuclear imaging to map any unusual activity within the glial cells and associated cells, doctors may be able to pick up early signs of degeneration among the neurons before any clinical symptoms emerge.

The benzodiazepine receptor radiotracers may also be useful in detecting inflammatory disease and cancer and the underlying patterns in brain structure and function that manifest themselves in disorders such as Alzheimer's, epilepsy, depression and schizophrenia.

Results to date from this area of research are very promising.



*PET-CT scan of the brain*

### **PET scanning for cancer**

Positron emission tomography has already proved itself able to image living tissue in finer detail than other imaging methods such as MRI and computed tomography (CT) scans. Research into novel radiotracers has the potential to make PET an even more valuable diagnostic tool than it is today.

For example, most PET procedures rely on the use of fluorodeoxyglucose (FDG), a molecule similar in function to glucose. Tagged with a radioactive fluorine-18 atom, it can reveal sites in the body where glucose is being absorbed rapidly (so-called 'hot spots') and where glucose is not being absorbed ('cold spots').

Unusually high uptake of glucose is a reasonably reliable sign of tumour activity or metabolic dysfunction. However, in some applications, FDG is not accurate enough. In collaboration with the Peter MacCallum Cancer Centre in Melbourne, ANSTO is testing a new radiotracer based on the amino acid, fluoroethyltyrosine, which is taken up by aggressive tumours, especially in the brain. Following removal of a tumour, the PET scanner looks for any remnant of cancerous tissue. In clinical trials conducted to date, scans made using the radioactive amino acid have been able to detect remnants of tumour too small to be spotted using FDG as the tracer molecule. Regulatory approval of the experimental radiotracer may lead to improved prognoses following the surgical removal and treatment of certain cancers.

Other areas of research at ANSTO with medical applications include the investigation of potential new therapies based on novel radiopharmaceuticals and the use of radiotracers to better understand key biological interactions, such as the interaction between a cell and an antibody at a molecular level.

ANSTO is a participating organisation in the Cooperative Research Centre for Biomedical Imaging Development Ltd (CRC BID), which is devoted to research aimed at producing novel radiotracers and improved radiation detectors. ANSTO is proud of the research & development links it has developed with the academic and industry participants in CRC BID and beyond.

### **Understanding the brain**

In collaboration with the Nobel Institute in Sweden, ANSTO researchers have shown that brain cells age with us rather than being regularly replaced like other cells in the body. Genomic DNA is stable after a cell's last division, which means the carbon within the DNA can be used as a date marker.

Carbon-14 analysis was performed on DNA samples by accelerator mass spectrometry and the data was related to the atmospheric carbon-14 levels, and the birth date of the particular cell population was directly determined. This study did not detect any postnatal neurogenesis (nerve cell growth) within the occipital cortex. However, the non-neuronal population was found to be younger than the person's age, implying that some cellular turnover was occurring after birth. Other brain regions are being investigated now, as well as tissue from various pathological states. This has important implications for research into brain disease and memory.

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