The Image Matters

Powerful new X-ray images are accelerating the pace of discovery as medical and industrial researchers seek answers to previously intractable challenges.

Since X-rays were discovered in 1895 we've used their penetrating power for numerous medical and industrial purposes. In Australia, researchers are keenly awaiting completion of the Australian Synchrotron's upgraded imaging and medical beamline facilities, which will provide even more extraordinary insights.

A Safer Way to Save Lives

Radiotherapy saves lives but produces unpleasant side-effects. A promising technique called microbeam radiation therapy (MRT) uses an array of parallel synchrotron X-ray beams no thicker than a human hair. The microbeams kill tumour cells with less damage to normal healthy tissue.

Jeff Crosbie and Peter Rogers from the Monash Institute of Medical Research are using a Japanese synchrotron to investigate MRT at a cellular and molecular level and compare it with conventional radiotherapy. They plan to conduct their first MRT experiments on the Australian Synchrotron's imaging and medical beamline before the end of 2009.

"The prospect of one day treating some human cancers on the Australian Synchrotron is very exciting," Jeff says.

Breath of Life

After 9 months in the womb, a baby's first breath is a small miracle. Unfortunately, most infants born after less than 28 weeks of gestation can't breathe unaided because they have trouble clearing their airways of the liquid that filled them during development in the womb. Mechanical ventilation helps premature babies survive the first crucial weeks, but may injure the lung.

Synchrotron X-rays are more powerful than hospital X-rays. They can be tuned to specific energy levels, making them ideal for phase contrast X-ray imaging, which shows fine details of soft tissues such as lungs and airways, as well as bones.

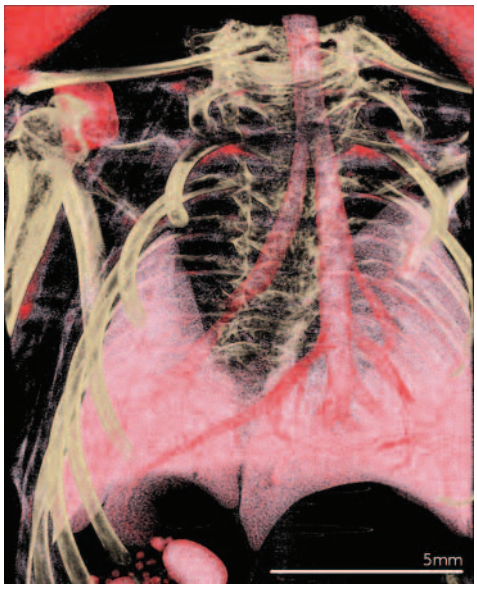
Stuart Hooper and Monash University colleagues used synchrotrons to obtain highly detailed X-ray movies of the lungs of newborn rabbits taking their first breath. This enabled the researchers to discover the process that normally regulates the clearance of liquid from the airways at birth, leading to better methods for helping premature babies to breathe.

Steadily worsening and fatal breathing difficulties are characteristic of cystic fibrosis, an insidious inherited disease that gradually fills lung passages with infected mucus. Together with Karen Siu at Monash University, David Parsons and his team at the Women's and Children's Hospital in Adelaide are developing synchrotron imaging methods to rapidly assess their promising gene therapy approach in mice.

Synchrotron X-rays can reveal micrometre-sized changes in mucus thickness in living mice, providing crucial information about the success of treatments. David's team hopes that similar methods can eventually be tested in large animals and perhaps adapted for people being treated for cystic fibrosis.

Close to the Bone

It looks easy on TV, but identifying unknown skeletal remains requires comprehensive knowledge of bone structure and ageing processes. David Thomas and John Clement from the University of Melbourne have spent many years studying age-related changes in the three-dimensional pore and cell structure of human bone. Their main interests are osteoporosis and dental decay, but they also undertake forensic work.



Synchrotron X-rays offer unique insights into lung and airway structures

Image courtesy of David Parsons and Martin Donnelley (Women's and Children's Hospital) and Karen Siu (Monash University)

Preparing bone sections for conventional studies can destroy most of a sample, but X-ray microbeam computed tomography "creates" sections as thin as 1 μm – and leaves samples intact for further work. Computed tomography combines a series of two-dimensional images to produce a three-dimensional image that can be examined from any angle.

Watch This Space

Due for completion in 2012, the Australian Synchrotron's upgraded imaging and medical beamline will be the world's most advanced instrument of its type. The upgraded facility will substantially reduce the need for Australian researchers to travel overseas, saving time and money and avoiding problems associated with transporting sensitive equipment, biological samples and live animals across international borders. The facility will also accommodate human clinical research, with all work involving animals or humans subject to strict ethical requirements.

Visit www.synchrotron.org.au for more information.