Chris Glover (pictured) manages the Australian Synchrotron's X-ray absorption spectroscopy beamline, which researchers will use to study how therapeutic drugs are transformed in the body. Photo: Sandra Morrow

Here's to your Good Health!

Potentially carcinogenic diet supplements, new drugs for arthritis and plaque formation in arteries are some of the issues that researchers are exploring with the help of synchrotron light.

Prof Peter Lay and his colleagues recently revealed that chromium dietary supplements used by people with adult-onset diabetes are potentially carcinogenic. They are now assessing an alternative that could be used to design safer and better compounds. Furthermore, Lay and his collaborators believe they have found early-stage changes in cells that are associated with heart disease and degenerative brain diseases.

Metals play many important roles in our bodies. For example, iron is essential in the haemoglobin of our red blood cells, zinc enables hundreds of hormones and enzymes that drive biological processes, and copper is important for vitamin C metabolism and bone formation, among many other functions. Many metal-containing drugs also play an important role in medicine (e.g. the most widely used chemotherapeutics for cancer use platinum).

"When you actually take a metal-containing drug, the parent drug is not active – it is transformed into the active form inside your body," Lay says. "Using synchrotron light, we can follow the biochemistry of these drugs from the mouth through the gastrointestinal system into the blood and the target cells. We look at the chemistry of how they are transformed through interactions in the biological fluids and tissues."

The story started with Lay's interest in chromium (Cr), a carcinogen for which some of the highest levels of occupational exposure have been recorded. Lay initially worked on the chemistry of how it caused cancer, and recognised the risk to people with diabetes who took Cr dietary supplements.

Diabetics have relatively high levels of oxidants such as hydrogen peroxide in their blood that could react with the chromium in dietary supplements to produce carcinogenic forms of chromium. He also found that chromium could replace other metals in biochemical compounds, potentially disrupting their activity.

"The worrying thing is the latency time of 10–40 years that it takes for chromium-induced cancer to develop after exposure," Lay says. "These chromium dietary supplements have been taken by diabetics over the past decade or so. There may already be a potential problem. But until proper epidemiological studies are undertaken, all we can do is alert people to the potential danger, and look for alternatives." Clinical trials of alternative drugs using vanadium are underway in the UK.

Hydrogen Peroxide and Heart Disease

The Sydney team has also been using synchrotrons around the world, and the infra-red beamline in Melbourne, to examine the effects of hydrogen peroxide on cells in the cardiovascular system.

The high levels of hydrogen peroxide in people with diabetes are associated with an increased risk of heart attack, and both healthy and diabetic individuals are subject to hydrogen peroxide-induced damage. The team found that hydrogen peroxide levels are so high in susceptible individuals that it attacks the membranes of cells in the heart and in the lining of blood vessels.

These cells in the blood vessels that are affected by hydrogen peroxide are where the build-up of protein and fatty material known as plaque begins. Plaque is the basis of blockages in the circulatory system associated with heart disease, and the researchers think drugs that inhibit this early-stage damage could be used to reduce cardiovascular disease.

Lay and his colleagues have been frequent flyers to international synchrotrons, but he will be travelling less as more beamlines become available at the Australian Synchrotron. Having a synchrotron in Australia will help the researchers avoid the complex problem of having to gain approval from authorities and airlines to carry biological and chemical samples overseas; it will also enable them to use cells freshly cultured at the facility.

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