One in thirty-five Australian suffer from Parkinson’s disease, making it the second most common neurodegenerative disorder in our country.\(^1\) Parkinson’s disease is characterised by the progressive death of neurons in a part of the brain called the ‘substantia nigra pars compacta’. Buried deep within our brain and no bigger than our thumbnail, the substantia nigra contains neurons that dole out the neurotransmitter dopamine into the striatum, the region of the brain that helps coordinate movement with our desired outcome. Every time we reach for a glass, write with a pen or even scratch our ear, packages of dopamine originating from our substantia nigra flash through our brain. In Parkinson’s disease, loss of dopamine is the direct cause of the debilitating and horrific symptoms we’re all familiar with.

While we know what causes these symptoms, why these cells die in the first place remains a mystery. Parkinson’s disease itself is something of a blanket term, used to encompass all afflictions that feature dopaminergic cell death. In some cases, scientists have identified genetic, environmental and even acutely traumatic events that lead to neuron death, but for an estimated 90% of those suffering Parkinson’s disease the factor precipitating cell loss is unknown, giving rise to the classification of ‘sporadic’, or ‘idiopathic’ Parkinson’s disease.\(^2\)

Prevention is better than a cure, or so the old adage goes. In disease research we talk about ‘upstream’ events, or biological processes that occur long before any clinical symptoms occur. In Parkinson’s disease this is especially pertinent, as all major treatments in use today only serve to reduce the severity of the physical effects of the disease, and these are only effective for a relatively short period of time. Until we understand the root cause of why neurons die in Parkinson’s disease, we cannot design intervention strategies that prevent cells dying, as opposed to sticking a Band-Aid on the brain that will gradually fall off.

Analytical chemistry, the science of measuring atoms and molecules, holds the greatest hope for unlocking the secrets of why Parkinson’s disease, or any other disease, for that matter, happens; and what we might be able to do to prevent it. Our entire body is driven by chemistry, in a single second a flurry of trillions and trillions of electrons moving around the cells in our bodies uses the oxygen we breathe to generate the energy we need to do the things we want. It thus stands to reason that disease too is simply a matter of chemistry gone wrong. It has only been in the past decade that we, as a species, have developed the tools that provide us the insight into the chemistry of our own bodies.
The decoding of the human genome in 2003 touched off a revolution in biology that still continues today. By producing a blueprint of the chemical makeup of our bodies, we’ve spent the past 10 years determining how our evolutionary design determines how we live today. The ‘-omic’ sciences, from genomics to proteomics and everything in between uses advanced analytical techniques to edge closer and closer to finding that one molecule, or even that one atom, that starts things awry and sets a course for disease. In some cases, this might be relatively easy: a toxic product from a foreign bacteria or a few milligrams of a harmful industrial chemical might be the initiator, providing a starting point for arresting these unwanted effects. However, in slow, progressive diseases like Parkinson’s, a biological finger might not point so directly to the culprit. Numerous suspects have been identified as possibly playing a role in ‘idiopathic’ Parkinson’s disease, from viral vectors in the gut to, as is the subject of this Brain Foundation proposal, how we were nourished as young. As such, we need to use the analytical techniques available to us to provide a more complete chronology of our life history: our past, present and future.

The past encompasses not only our genetic makeup – something we carry from birth, but also how our cells interacted with the chemical onslaught to which they were exposed from the moment of conception. In the modern, post-industrial era we have introduced more chemical diversity in such a short space of time than perhaps evolution originally intended. Whether ever-increasing incidence of chronic disease like Parkinson’s is a biological ‘sign of the times’, or simply an effect of our longer lives due to modern medicine is hidden in the chemical timeline of our ageing body. This is perhaps the biggest challenge to analytical chemistry, an antithesis to homeopathy even, in that how do you measure something that’s no longer there? Looking back at our chemical history is something like peering through Venetian blinds, we might see fractions of a whole picture (like through teeth, as described in this project), but often we’re looking for the straw of hay the needle was once sitting on.

The present is where analytical chemistry is currently thriving. Just this May the first draft of the human proteome, the roadmap to our genomic blueprint, was published. If everything our cell does is a chemical reaction, it’s a protein reacting, and having the ability to take a chemical snapshot of neurodegeneration in process is truly at the cutting edge of analytical science and one we’ll rely upon for years to come.

The future combines both previous aspects of analytical biochemistry to help predict risk of disease and address it before symptoms appear – the holy grail of modern medicine. Unfortunately, the driver here is time. New fields, like ‘personalised medicine’ use advanced analytics to trace your body’s changing chemistry, but accurate predictions need large sample sizes, and until the truly most advanced analytical techniques become commonplace and routine, we’re still some time away.
As was the case in the early 1960s when we first raced to the moon, scientists stand on the edge of a new age of discovery driven by new technology. This time, however, the stakes are more important than a struggle for international prestige. Parkinson’s disease, as well as many other chronic and destructive illnesses, tears at the very fabric of our society. You’d be hard pressed to find a single person not touched in some way by a loved one struck by a slow, debilitating disease that, for all the wonders of medicine, followed a continual downward path. It is perhaps now, when we have all this technology at our fingertips, that we might finally be able to study how the chemistry of disease might eventually become the chemistry of healing.

References: