

# Era of complex science: biology & climate

In many areas of science, senior researchers like me have entered a new era, at last accessing the underlying complexity of the systems we study. This is immensely gratifying but also extremely challenging. In my case, after more than 40 years of drilling down on narrow mechanisms, I now begin to comprehend how they together control that interface between viral and vertebrate genomes we call infection. Take influenza, for example, which is generally most severe in the very young (no pre-existing immunity) and in the elderly as our immune systems fail with age. Sometimes, however, we see a rapidly fatal disease outcome in healthy, young adults and only recently we have realised that in these cases a massive over-reaction occurs in the early 'innate' response.

We've known for years how antibodies and so called 'killer-T cells', which attack the virus infected cells, work to protect us. This response is modulated by specialised molecules, called chemokines or cytokines. However, when excessively produced, which is the case in these young adults, cytokines can cause severe vascular leakage and shock.

These people drown in their own lung fluids!

In order to know what might be done medically, we need to understand which mechanisms should be enhanced or suppressed, perhaps with new drugs or bio-therapeutics.

Trying to deal with such issues has drawn us into the new, complex science called Systems Biology. Over the past decade we've seen the sequencing of the human, mouse and other genomes, an extraordinary expansion of 'chip' technologies that allow massive data acquisition via laser-drive reader systems and enormously enhanced computing for the analysis of massive data sets.

The numbers are made freely available online, so that others can analyze parameters that are of particular interest to them.

We experimentalists would be lost without the skill sets of PhD astrophysicists and mathematical/computer wizards who've come across into biology. Their input in pulling together the vast spectra of inter-related data drives the new sub-disciplines of genomics, proteomics, glycomics, lipidomics, transcriptomics and so forth. Such 'discovery' science isn't going to replace traditional 'reductionist' approaches where we've identified a cell or molecule of interest and then gone in depth to understand what it actually does, but it does point-up a whole spectrum of new targets and inter-related mechanisms for detailed attention.

That's why contemporary biology is so exciting and why, for example, Australia can't afford to cut back on funding basic research in the molecular sciences. If we lose our place now, we'll be toast! Intellectually, I would be toast in my own field of immunology if I'd quit 5 years back!

Talking about toast, another, great area of complex analysis that is of central importance for human wellbeing is climate science. Will our species be toast within the next millennium or so? Understanding what is happening globally requires, as with Systems Biology, the specialized analysis of massive, inter-related data sets. A few old geology and meteorology practitioners, in particular, are very uncomfortable with this process and over-state the case that their 'historical knowledge' is being ignored. Surely everyone understands that there have been enormous changes in the world's climate through geological time some of which humanity, and certainly not 6.8 billion people, could not readily survive. I've been advised to read geophysicist David Archer's *The Long Thaw* (Princeton University Press). You might also check the website of the Geological Society of America.<sup>1</sup>

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better be absolutely sure that he/she understands current and emerging data sets and deals with them in a way that is both competent and intellectually rigorous. Perhaps you've read that the famous 'hockey stick'

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graph is fraudulent. Look, for example, at the US Government NOAA Paleoclimatology website for leads to the validated version of the hockey stick.<sup>2</sup>

Like biologists, the climate scientists have benefited from massive advances in computing and other technology. For example, new satellites are now able to measure the depth and not just the circumference of the ice fields. This complex and continually evolving process requires pulling information together from a spectrum of disciplines ranging from astrophysics, to glaciology to marine biology. That's why the Intergovernmental Panel on Climate Change (IPCC) of the World Meteorology Organization/UN Environment Program is so important.

A very broad spectrum of specialists collates published, peer-reviewed research from a variety of areas and summarizes the information in ways that policy makers and others can comprehend. Despite what you might read the IPCC reports are nuanced and very (perhaps too) conservatively written. Look for yourself!<sup>3</sup>

If you take, for example, the recent beat-up in a national newspaper that claimed the IPCC process is discredited because the ice mass in Antarctica is increasing, though the West Antarctic Ice Sheet is breaking up, you will find that the IPCC actually predicted 5-20% more precipitation (snow goes to ice) over Antarctica through the next century due to greater hydrological activity in the warmer regions of the Southern Hemisphere. Though it is by no means imminent, the complete melt down of the West Antarctic Ice Sheet would cause sea levels to rise in excess of 5 meters.

Dealing with that in ways that don't involve serious conflict will require a level of social and political sophistication that has hitherto been lacking on our small planet. We can't afford to be self-serving and simplistic as we approach the complexities of the climate change issue, we have to think in the long term and we must do whatever we can now to moderate the situation.

<sup>1</sup> [www.geosociety.org/positions/position10.htm](http://www.geosociety.org/positions/position10.htm)

<sup>2</sup> [www.ncdc.noaa.gov/paleo/pubs/mann2008/mann2008.html](http://www.ncdc.noaa.gov/paleo/pubs/mann2008/mann2008.html)

<sup>3</sup> [www.ipcc.ch/ipccreports/ar4-syr.htm](http://www.ipcc.ch/ipccreports/ar4-syr.htm)

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