Ruth Bowness talks with our new Newsletter Editor, Alys Clark. Alys is an Associate Professor in the Auckland Bioengineering Institute at the University of Auckland. She is one of the lead researchers in the Lung Research Group and is an awardee of a RSNZ Rutherford Discovery Fellowship, and the JH Michell Medal for Applied Mathematics (2017).

1. Tell us a bit about your research area

   My primary interest is in how we get oxygen from our environment to grow and thrive. Before we are born we do this via our placenta, and after birth our lungs. These two organs are exceedingly complex structures with surface areas the size of two double beds (placenta) and a tennis court (lungs), and my primary research is in understanding what is normal in terms of the complexity and heterogeneity in their structures, and how it is influenced in disease. In terms of mathematical modelling the biggest question is how do we capture complexity and heterogeneity in structure/function in models that we can solve in a meaningful amount of time.

2. How did you arrive in your current position?
   I grew up mostly in the UK, and was really into maths at school, mostly down to a great teacher I had when I was around 11 years old. I studied maths for my undergrad at University of Oxford and then went away and travelled a bit before starting a Masters with Yvonne Stokes at University of Adelaide. Yvonne had just started working with a biologist who was interested in the nutrient environment around eggs in the ovaries, and I was really keen on that project so it became a PhD project. Toward the end of my PhD I met a researcher from Auckland Bioengineering Institute (New Zealand) at a conference, and was really interested in their work modelling the human body. I moved to New Zealand for what was going to be a one year postdoc and I am still here, having established a research group here.

3. Describe some exciting research you are currently working on

   We are doing some cool work about how the blood vessels in the uterus evolve in early pregnancy. The biological system is so interesting in itself – to establish a blood supply placental cells invade into the small arteries of the uterus and replace the muscle in their wall, and there are also dramatic changes in the large arteries due to increases in blood flow and hormones. In terms of mathematical biology, this has given us the scope to investigate a range of phenomena using several different modelling techniques from agent based modelling through to fluid dynamics, and to work on experiments that parameterise and test our models at the same time.

4. Can you tell us about the Mathematical Biology community in New Zealand

   The Mathematical Biology Community in New Zealand (and Australia) is large and active so it's a great community to be a part of. There is really interesting research going on across the board. We have our own special interest group of the Australia and New Zealand Industrial and Applied Mathematics society (called MBSIG, which I currently chair), and we have an annual meeting every year which covers many different areas including ecological modelling, disease modelling, and physiological modelling to name but a few.

5. What is your favourite research paper (by another mathematical biologist)?

   There are many, particularly as I work across different fields! I have picked an old one, as its probably my most “used” model (and one I have used as a basis for some new derivations), written by YC Fung and SS Sobin “Theory of sheet flow in lung alveoli” Journal of Applied Physiology 26(4):472-488, 1969. The capillary blood vessels that cover the alveoli are really important for exchange of oxygen and waste from the body, but they are different in structure and in the forces that act on them to other capillaries in the body (due to the movement of lungs during breathing, and relatively low blood pressures in the lung). This is a really comprehensive biomechanical study of how they function, which is still really relevant and widely used today.

6. Have you encountered any surprising results in your research?
   Many! Often, they make complete sense when you think about the physics of the problem, but they may not have been considered biologically before. One example is when we were investigating the function of some small arteries of the uterus, and we included ALL of the arteries in the uterus in the model (large or small) we realised that aspects of the whole system that are important for both interpreting diagnostic ultrasound and for getting oxygen to the fetus. This has resulted in quite a large programme of research and wasn’t expected at the time.

7. What advice would you give to a junior mathematical biologist?

   If you are working with people who are doing experimentation of any sort, try to get into their lab and watch them work (or help them work!). It really helps you to work out what you can and can’t measure, and can help you to work out where to focus your modelling efforts.

8. How do you find working across disciplines? What are the challenges?

   I love it, we have a big meeting once a week with people from a whole range of backgrounds presenting and sharing their work. I guess the biggest challenge is making sure everyone understands what is going on, and translating information can be difficult.

9. What is the best part of being a mathematical biologist?

   My job is so interesting, which means that I am happy to go to work, and often it’s a different problem that I am working on every day which makes life interesting! I also enjoy that there are so many opportunities to work with people with different skills.

10. Finally, how do you spend your weekends?

    I recently decided that I would turn my emails off on weekends completely, so the weekend is all about family. I have a six year old son, and so the weekends start with him playing a rugby match (ripping velcro tabs off the opposition team rather than tackling). That gets us up early, and after that we’d usually do something fun (either a café or an adventure). We try to do something active each weekend, but also movies and popcorn is fun. I recently got my own shed, so when I get the chance I am working out how to do whole grain beer brewing, which appeals to the scientist in me.