The Bulletin 386

The Royal Society of New South Wales

ABN 76 470 896 415 ISSN 1039-1843 March 2015

Wednesday 1 April 2015

Annual General Meeting (Members and Fellows only) followed by the 1231st Ordinary General Meeting (visitors welcome)

Members and Fellows are invited to attend the Annual General Meeting of the Society to be held on Wednesday 1 April at the UUSC.
Discussion of the Green Paper will commence at 5:15 pm, followed by the AGM, commencing at 5:45 pm.
Please visit the Events 2015 page to download documents for the meeting.

followed at 6:30 pm by the

1231st. Ordinary General Meeting

Is the Brain the Right Size?

Scientia Professor George Paxinos AO DSc FASSA FAA FRSN, HMRC Senior Principal Research Fellow, Neuroscience Research Australia and UNSW

Union, University & Schools Club, 25 Bent St, Sydney . Dress: jacket and tie

Professor Paxinos studied at Berkeley, McGill and Yale universities. He is the author of forty-six books on the brain. His first book, *The Rat Brain in Stereotaxic Coordinates*, is the third most cited book in science following *Molecular Cloning* and *The Diagnostic and Statistical Manual of Mental Disorders*.

He produced two paradigm shifts in the field of neuroscience. The first, during a sabbatical at Cambridge in 1977, he learned immunohistochemistry and applied it for the first time in brain atlases. That is, he used the chemical phenotype of neurons as a criterion for identifying brain regions and for establishing brain homologies across experimental animals and humans. The second, in his avian brain atlas, he used neuromeric criteria to delineate the entire brain for the first time.

Most scientists working on the relation between the human brain and neurologic or psychiatric diseases, or animal models of these diseases, use his maps and concepts of brain organization. His human brain atlases are the most accurate ones for the identification of deep structures and are used in surgical theatres.

Future Events

Wednesday 1 April 2015
Annual General Meeting
Green Paper discussion commences at 5:15 pm, AGM commences at 5:45 pm, followed at 6:30 pm by the
1231st Ordinary General Meeting
Is the Brain the Right Size?
Delivered by:
Scientia Professor George Paxinos AO
Union, University & Schools Club
25 Bent St, Sydney
Enjoy a welcome drink from 5:00 pm. (Book for dinner after the meeting: $75 per head)
Please note dress code: jacket and tie

Wednesday 22 April 2015
Clarke Memorial Lecture
Delivered by:
Professor Bill Griffen
Professor of Geology,
GEMOC ARC National Key Centre,
Earth and Planetary Sciences,
Macquarie University

Tuesday 5 May 2015
Annual Dinner
1232nd Ordinary General Meeting, Royal Society of NSW 2015
Distinguished Fellows Lecture and presentation of Awards
Union, University & Schools Club
25 Bent St, Sydney
Please note: Black tie
6:30 pm for 7:00pm
(Book for the annual dinner: $95 per head)

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From the President

As mentioned in my report last month, the Council has developed a Green Paper for consideration and discussion of the membership, so that we can re-establish the as the leading learned institution in NSW. Originally, we intended to have a separate meeting during March to discuss but as we were so close to the AGM, it was decided it would be better to have a discussion session immediately before the AGM on Wednesday 1 April. I hope as many members as possible can attend the AGM – it's a good opportunity to contribute to the direction of the Society over the coming year.

It is very pleasing so many members nominating for the ten Council member positions – for the first time in many years, it requires an election.

Also at the AGM, the Council will recommend some changes to the By-Laws of the Society, continuing improvements that we have made over the last 18 months to the way in which the Society functions. These were tabled at the OGM in March and have been circulated to the membership. At the March meeting, a By-Law change was adopted that the President is expected to serve two two-year terms, in the final year of which, one of the Vice Presidents becomes President-elect. If elected at the AGM, this will be my fourth year as President and in the spirit of this By-Law, it will be my last. At the AGM, it is expected that one of the Vice Presidents will become President-elect. If you cannot attend the AGM and vote in person, please download the proxy form from the website.

There is a great deal of excitement about the new directions that we are charting for the Society. A number of members have already responded with very constructive comments regarding the Green Paper – please take time to read it and send me your comments. We want to make the final strategic document as comprehensive and vibrant as possible.

As always, I am easily contacted by email at president@royalsoc.all.au and would like to hear from you.

Donald Hector

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being investigated are 10-20 nm in size. The diffraction limit for a visible light microscope is about 250 nm which means that they cannot resolve these molecules. This requires super-resolution fluorescence microscopy, form of light microscopy that allows capture of images that at a much higher resolution than the diffraction limit. Super-resolution fluorescence microscopy enables investigation down to the to the size range of the T-cell molecules of interest.

By acquiring very large samples of data (20,000 frames), x-y coordinates can be determined and statistical methods can be used to analyse structure of specific molecules. Professor Gaus's research has identified a number of interesting observations about the function of T-cells. It seems that only some T-cells trigger on exposure to an antigen and receptors seem to be triggered in dense clusters. TCR clustering appears to a key element in antigen recognition and some antigens appear to induce TCR clustering. This raises interesting questions such as, can we use nanoparticles to induce clustering?

Recently, Professor Gaus has been investigating ways in which the z-axis can be explored so that molecules can be investigated in all three spatial dimensions as her earlier work suggests that the dynamics of the molecules (such as oscillating like a yo-yo) may be important in their function.

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Wednesday 3 June 2015
1233rd. Ordinary General Meeting
Union, University & Schools Club.

Wednesday 1 July 2015
1234th Ordinary General Meeting
Science in Literature
Delivered by :
Dr. David Ley
Editor, Sydney Review of Books
Union, University & Schools Club
25 Bent St, Sydney
6.00 pm for 6:30 pm
Enjoy a welcome drink from 5600 pm.
(Book for dinner after the meeting: $75 per head)
Please note dress code: jacket and tie

SOUTHERN HIGHLANDS BRANCH

Thursday 16 April 2015
Plastics/pollution in the ocean using isotope studies
Delivered by:
Professor Richard Banati, ANSTO
The Performing Arts Centre,
Chevalier College, Bowral
6:30pm

Report of the Society's 1230th Ordinary General Meeting

held on Wednesday 4 March 2015

Super-resolution microscopy: Understanding how T-cells make decisions

Scientia Professor Katharina Gaus

ARC Centre of Excellence in Advanced Molecular Imaging

NHMRC Program in Membrane Interface Biology

University of New South Wales

At the 1230th OGM Scientia Professor Katharina Gaus case of insight into her ground-breaking work on understanding the structure of T-cells, one of the major components of the immune system. Professor Gaus is a cell biologist who uses super-resolution microscopy to explore the structure of cell membranes. Hopefully, this will lead to improved treatments for infectious, cancer and autoimmune diseases.

The adaptive immune system is the body's first line of defence against infection. It is acquired over the life of the organism, developing a "memory" for antigens (antigens are the invading agent). This highly sophisticated system is antigen-specific and must be able to distinguish between foreign antigens and substances made by the host. It is mediated by T-lymphocytes – a type of white blood cell that plays a central role in cell-mediated immunity. T-lymphocytes are characterised by the presence of a T-cell receptor (TCR) on the cell-surface. Antigens bind to T-cells through major histocompatibility complex (MHC), a set of cell-surface molecules that controls a major part of the immune system in all vertebrates. Humans can make up to 25,000,000 different TCRs, representing an enormous variety of substances against which the body can mount an immune response.

The role of T-cells is to hunt for antigens. Over the last 50 years or so, the way in which T-cells identify antigens has been characterised: TCRs can only recognise peptides on MHC; T-cells do not recognise self-peptides on self-MHC; and T-cells that react to self-peptides on self-MHC result in autoimmunity. T-cells are responsible for life-and-death decisions – they have to distinguish between self-peptides and foreign peptides. This is like looking for a needle in a haystack: there are many more self-peptides and foreign peptides. Gaining a better understanding of the structure and function of T-cells is important in developing treatments for autoimmune diseases and cancer. For example, it is known that T-cells play a role in the body's resistance to various types of cancer. However, one of the problems in cancer immunotherapy is to determine why some cancers escape T-cells and whether or not they can be retrained.

Professor Gaus' work is focused on using microscopy to identify the structure of T-cell membranes. There are two major problems that need to be solved to investigate this. T-cells are very mobile – they move rapidly through the blood and it is difficult to capture images of them *in vivo*. Fortunately, once they bind to an antigen, they become almost stationary. The second problem is one of resolution. The molecules

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Southern Highlands Branch

Report of 19 February 2015 Meeting

Science, Humility and the Fallacy of the Planet of the Apes

Professor Charlie Lineweaver

School of Astronomy, Astrophysics and Earth Sciences, ANU

Before his appointment at ANU, Dr Charlie Lineweaver held post-doctoral positions at Strasbourg Observatory and the University of NSW where he taught one of the most popular general studies courses "Are We Alone?". As the 107 person audience from the Southern Highlands streamed into the Chevalier College Performing Arts Centre to hear him present the February lecture, it was clear that they too were intrigued by what he sees as the flawed logic of much of what we think about our evolution.

The Planet of the Apes hypothesis is that there is a "human-like intelligence niche", where there is selection pressure on other species (including our ancestors) to occupy this niche. In our absence in a terrestrial setting (or on other planets) some species will evolve into that niche and develop technology. Carl Sagan called the occupants of this niche the "functional equivalent of humans". When biologists are asked whether human-like intelligence is a convergent feature of evolution, they answer no. When physicists and Hollywood are asked the same question, they answer yes.

Lineweaver's view is that since generic intelligence is poorly defined, he prefers the term "human-like intelligence niche", rather than the "intelligence niche". Each animal species with or without a brain seems to have its own version of intelligence. Our human-like intelligence, unlike any other type of intelligence on Earth, has allowed us to build radio telescopes and be heard across interstellar distances. This ability that humans have, and that we are able to look for in others, is a "species-specific characteristic".

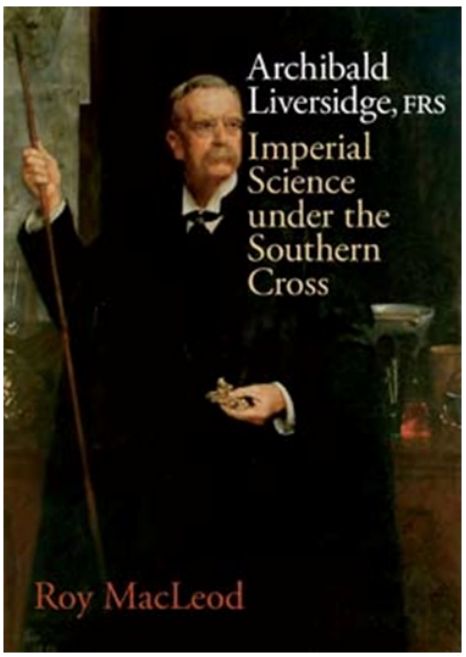
It is not surprising that humans search for contact with others in the universe when it is known that there are approx 10^22 Earth-like planets. However, other planets capable of sustaining similar life are on average 1.8 billion years older than Earth. In that time, humans have climbed up the evolutionary ladder from microscopic single-celled amoebas. Extra-terrestrials may not want to communicate with beings so far their evolutionary inferiors, and in any case they would probably not communicate via relatively primitive radio waves.

Lineweaver adds that it makes no sense to concoct an imaginary set of which we are the only terrestrial member, and then suppose that biological evolution elsewhere in the universe evolves toward this set. He describes this concoction as The Planet of the Apes Hypothesis. It is testable, and so far paleoneurology does not support it. Half a dozen multi-million year experiments in vertebrate evolution offer no support. They strongly suggest that there are no "functionally equivalent humans" in the universe. Hence the *Great Silence.*

Lineweaver's surprising conclusion to this fascinating lecture was that despite everything he had discussed and proposed, he does support SETI because…

- When we have new technology to cheaply explore new parameter space we should do it.
- Null results are important
- The universe may be stranger than we imagine
- Lineweaver himself may be wrong about the Planet of the Apes!

Anne Wood



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Southern Highlands Branch

Report of 19 March 2015 Meeting

Your Poo and You: gut microbes, diet and modern lifestyle changes

Professor Andrew Holmes

School of Molecular Bioscience and Microbiome Project Node Leader

in the Charles Perkins Centre, University of Sydney

Professor Holmes' current research is focused on understanding the dynamics of gut microbial community composition, the mechanisms of host-microbe interaction in the gut and the development of tools to enable management of the gut microbial ecosystem. He delivered a challenging lecture on his work and that of his team to an appreciative audience of 110 people at the Chevalier College Performing Arts Centre, Burradoo.

Our gut houses the microbiological equivalent of a large biodynamic organic vegetable patch that has a profound effect on our health. Holmes called on the old adage "You are what you eat", suggesting it could just as well be "You are what you grow in your gut". Our gut microbiome consists of the 1000 or so species of microbe that are normally present for most of our life.

Just as with our genome, each of us has a unique microbiome which encodes basic properties that influence our health and well-being. A key difference however is that whereas we acquire our genome more or less instantaneously at conception and hold it for life, we acquire our microbiome over a far more protracted period, and it is more malleable, for good or for bad. Holmes spoke of studies comparing the microbiome of healthy and sick people which revealed a wide range of metabolic, immunological and even neuropsychiatric conditions where a dysfunctional microbiome is part of the underlying problem. It appears that disruption of the gut microbiota can be significant in influencing obesity, diabetes, chronic inflammatory diseases such as arthritis, inflammatory bowel disease, ulcerative colitis and Crohn's disease, and some cancers.

Microbes are not simply 'on us' or 'in us', they are a part of us. A well performing microbiome promotes health, and a badly performing one promotes disease. Our gut is the primary interface between our body and our environment, our intestines having many more bacterial cells than there are human cells in our entire body. Our microbiota lie at this interface between our body and the world around us. It is not surprising then that microbe studies demonstrate their profound effect on human health. Far from being 'freeloaders', microbes perform essential functions such as digesting food, manufacturing vitamins and priming the immune system.

Much of Holmes' research into the complicated dynamics of the gut has been performed using animal studies. He described the dramatic changes that were found in the microbe community structure among rodents on different diets. Among other findings, it was found that a rise or fall in the amount of calories that the mice consumed shifted the ratio of the two main phyla of bacteria that lived in their guts – the bacteroides and the firmicutes, which are also found in humans. In the mice study,

upsetting the internal ecosystem affected the performance of their immune system and their overall metabolic health.

The dynamic nature of the body's internal ecosystem suggests potential treatments for people with microbe-related diseases could be as simple as re-engineering their microbiota, possibly through medication or a change in diet. In the meantime, there is much research to be done in this complicated field. Professor Holmes received warm applause at the conclusion of his excellent lecture, and very kindly agreed to return for a further address as his research unfolds.

Anne Wood

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