BIC
BIOMOLECULAR INTERACTION CENTRE

Biomolecular Interaction Centre

UC
UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Interface Workshop

Recent advances at the bio/abio interface

22–24 June

10

Interface Workshop

Welcome

Welcome to our workshop entitled 'Recent advances at the bio/abio interface', which aims to bring together a select group of leading academic experts across disciplinary boundaries to explore synergies that occur between the physical, material and biological sciences. By assembling key researchers in a small scale setting we aim to stimulate new ideas and collaborations at the under-explored boundary of the biological engineering and material sciences.

The workshop will be broad in scope but provides three main focal areas for discussion:

1. Characterisation tools at the liquid-solid interface

Emerging research methodology and theory to interrogate molecular structure at surfaces will include advanced spectroscopy methods (e.g. sum frequency vibrational spectroscopy), microscopic techniques and molecular dynamic calculations.

2. Biological scaffolds 1:

Material synthesis Focussing on the use of biological or biologically-inspired templates or platforms for the synthesis of materials with useful properties

3. Biological scaffolds 2:

Molecular engineering Placing protein engineering in the context of the broader field of supramolecular synthesis, including nucleic acid engineering and supramolecular assembly of organic molecules.

The workshop is hosted by the Biomolecular Interaction Centre (BIC), a new Research Institute at the University of Canterbury that aims to research and harness biomolecular interactions critical to biological function through synergistic, interdisciplinary collaborations. We hope that you will stay in touch after the workshop and consider returning for a longer stay.

You can learn more about BIC on our website: http://www.bic.canterbury.ac.nz/

Juliet Gerrard and **Charlene Mello** (conference chairs)

Acknowledgements

We wish to thank the US Army Research Office for generous support of this event and the International Technology Center – Pacific (ITC-PAC) for their contribution to this workshop

Committee members

Professor Juliet Gerrard (Co-Chair), Biomolecular Interaction Centre, University of Canterbury

Dr Charlene Mello (Co-Chair) US Army Natick Soldier Research, Development and Engineering Center

Professor Conan Fee, Biomolecular Interaction Centre, University of Canterbury

Professor Nicholas Abbot, University of Wisconsin-Madison

General Announcements

Venue

All workshop sessions and catering are in the Coppertop, Level 2 of the Commerce Building. University of Canterbury.

Audio Visual

Please take your presentation on a data stick to the Coppertop, during the catering break preceding your talk. A technician will be available to assist with loading your presentation.

Cell Phones

Please turn off all cell phones during workshop presentations.

Emergency Medical Assistance

- 24 Hour Surgery, corner of Bealey Avenue and Colombo Street Ph: 365 7777
- After Hours Pharmacy, corner Bealey Avenue and Colombo Street. Ph: 366 4439 open Monday to Thursday 6.00am – 11.00pm

Transport Options

Taxis

- Blue Star 379 9799
- Corporate Cabs 379 5888
- Executive Cars 377 7999
- First Direct 377 5555
- Gold Band 379 5795

Door to door shuttle services

- Airport shuttle 354 1540 airportshuttles@jihug.co.nz
- Super shuttle (0800) SHUTTLE www.supershuttle.co.nz

Bus service

Christchurch offers an excellent bus service. Check with your accommodation provider for timetable information, or contact Metro: phone 366 8855 www.metroinfo.org.nz

Non-smoking Policy

Smoking is not permitted inside any building on the University campus.

Dining Out

Wednesday has been left free for delegates to make their own evening meal arrangements. There are a number of options reasonably close to the University, or you may wish to visit one of Christchurch's many and varied inner city establishments.

Suggestions close to the University:

- Misceo, corner Ilam and Clyde Roads, Tel 351 8011
- Ancestral, Ground Floor/35 Riccarton Road, Tel 348 0808
- At Tonys Japanese Restaurant, 85 Riccarton Road, Tel 341 6608
- Arjee Bhajee, 13 Riccarton Road, Tel 365 6633
- Trevinos Restaurant & Bar, 22 Riccarton Road, Tel 343 5378
- Rotherhams of Riccarton, 42 Rotherham Street, Tel 341 5142

Useful link: www.eatout.co.nz/Christchurch/Restaurants/

Excursions

Time has been allocated on Wednesday afternoon (June 23) for delegates to take time out and explore Christchurch!

For your convenience, we have arranged two outstanding tours, one showcasing the Canterbury region and the other taking you to our most internationally acclaimed attraction, the International Antarctic Centre. Alternatively, you are welcome to make your own arrangements.

It is essential that you pre-book and pre-pay for the arranged tours. Do this by contacting Discovery Travel, email info@discoverytravel.co.nz or tel 3578262

Waipara Wine Tour

Cost: NZ$105 per person (lunch included)
Tour includes: pickup from University, comfortable return transport (drop off at your hotel), visits to 4 wineries, wine tastings, winery lunch platter, informative commentary
Departure: 12.15pm from University
Return: approximately 5.45pm to your hotel

International Antarctic Centre

Located just minutes from Christchurch airport, the Antarctic Centre provides an unforgettable interactive snow and ice experience. Meet the gorgeous little blue penguins, enjoy a leisurely and informative walk through the Centre, experience the added thrill of riding the hagglund!
Cost: NZ$60 per person (lunch not included)
Tour includes: pickup from University, return transport (drop off at the University or the City Centre), entry to the Centre.
Lunch: own expense, available at the Antarctic Centre
Departure: 12.15pm from University
Return: 3.45pm

Workshop Catering

All catering will be served in the Coppertop, adjacent to the workshop space, as follows. Tea, coffee and juice will be served with food at all breaks, and water will be available throughout.

Those who have advised special dietary requirements, please make yourselves known to the wait staff.

Tuesday: Welcome lunch, afternoon tea, light evening meal

Wednesday: Morning tea

Thursday: Morning tea, lunch, afternoon tea

Workshop Dinner

The Workshop Dinner will be held at the beautiful, historic venue of Mona Vale, on Thursday 24 June. This is just a few minutes' walk from the Chateau on the Park accommodation, and approximately five minutes' drive from the University.

The cost is $67.50 per person, please pay your account to Mona Vale at the end of the evening. This includes a set entrée, choice of 2 main courses and a set dessert. A cash bar will operate for tea, coffee and beverages.

Contact List

Name	Institution	Email
Prof Nicholas Abbott	University of Wisconsin-Madison	abbott@engr.wisc.edu
Assoc Prof Maan Alkaisi	University of Canterbury	maan.alkaisi@canterbury.ac.nz
Dr Jennifer Becker	US Army Research Office	jennifer.j.becker@us.army.mil
Prof Paul Calvert	University of Massachusetts Dartmouth	pcalvert@umassd.edu
Advisory Scientist Jennifer Coughlin	Strategic Analysis, Inc	jcoughlin@sainc.com
Prof Alison Downard	University of Canterbury	alison.downard@canterbury.ac.nz
Prof Conan Fee	University of Canterbury	conan.fee@canterbury.ac.nz
Prof Juliet Gerrard	University of Canterbury	juliet.gerrard@canterbury.ac.nz
Deputy Director Hans Griesser	Ian Wark Research Institute, UniSA	kathryn.prohaska@unisa.edu.au
Prof Teresa Head-Gordon	University of California, Berkeley	TLHead-Gordon@lbl.gov
Prof David Kaplan	Tufts University	david.kaplan@tufts.edu
Prof Kristi Kiick	University of Delaware	kiick@udel.edu
Assoc Prof Kate McGrath	Victoria University of Wellington	kate.mcgrath@vuw.ac.nz
Dr Charlene Mello	US Army Natick Soldier Research, Development and Engineering Center	Charlene.Mello@us.army.mil
Prof Anton Middelberg	University of Queensland	a.middelberg@uq.edu.au
Prof Ganesan Narsimhan	Purdue University	narsimha@purdue.edu
A. Prof Kim Pickering	University of Waikato	klp@waikato.ac.nz
Dr Patricia Shaw	Defence Technology Agency	p.shaw@dta.mil.nz
Ms Lisa Smith	US Army Research Office	lisa.n.smith@us.army.mil
Dr Kathryn Stokes	Defence Technology Agency	k.stokes@dta.mil.nz
Dr Margaret Sunde	University of Sydney	margaret.sunde@sydney.edu.au
Prof Sankaran Thayumanavan	University of Massachusetts Amherst	thai@chem.umass.edu
Prof David H Thompson	Purdue University	davethom@purdue.edu
Assistant Prof Raymond Tu	The City College of New York - CUNY	tu@ccny.cuny.edu
Dr Lauren Webb	The University of Texas at Austin	lwebb@cm.utexas.edu
Prof Tony Weiss	University of Sydney	tony.weiss@sydney.edu.au
Dr Yi-Yan Yang	Institute of Bioengineering and Nanotechnology	yyyang@ibn.a-star.edu.sg

Presenters

Abbott, Nicholas

Abstract

Self-Assembly of β-Peptide Oligomers

Helical oligomers of β-peptides represent a particularly promising type of building block for directed assembly of organic nanostructures because the helical secondary structure can be designed to be very stable and because control of the β-amino acid sequence can lead to precise patterning of chemical functional groups over the helix surfaces. This presentation will report on two aspects of the self-assembly of this class of oligopeptides that we have pursued over the past several years.

First, experimental studies of sequence-dependent assembly of oligomers of β-peptides will be described, revealing the pronouced impact of subtle variations in nanoscopic chemical patterns on intermolecular interactions leading to self-assembly in solution. In particular, the use of small angle X-ray scattering measurements (SAXS) to characterize nanostructures formed by the directed assembly of β-peptide A with sequence, H2N-β3hTyr-β3hLys-β3hPhe-ACHC-β3hPhe-ACHC-β3hPhe-β3hLys-ACHC-ACHC-β3hPhe-β3hLys-CONH2 and its sequence isomers will be described. For the parent isomer, analysis of SAXS data suggests a model in which individual β-peptides assemble to form long cylindrical nanofibers with a hollow core radius of 15 Å (polydispersity of 21%) and a shell thickness of 20 Å.

Second, this presentation will describe the use of force spectroscopy to quantify the interactions of single β-peptide oligomers, each of which display stable and well-defined three-dimensional chemical nanopatterns. Whereas many prior reports of single molecule force measurements of oligo-β-peptides and macromolecules exist – the secondary and/or tertiary structures of these species are not preserved during their interactions at interfaces, and thus the three-dimensional chemical patterns that underlie previously reported force measurements are generally not known. By using β-peptide oligomers that display the same chemical functional groups in stable and distinct spatial nanopatterns, we have demonstrated that it is possible to relate changes in measured forces to changes in three-dimensional chemical nanopatterns. Overall, these results and others to be discussed in this presentation show how β-peptide oligomers can be used to study intermolecular interactions that arise from precisely defined chemical nanopattern. The results also provide fundamental insights into the mechanisms through which changes in chemical patterns presented by organic nanoscopic objects can dramatically affect their self-assembly behavior.

This research is part of a collaborative project between the research groups of Nicholas Abbott and Sam Gellman (Chemistry, University of Wisconsin-Madison). It is funded by the US National Science Foundation through the Nanoscale Science and Engineering Center (NSEC) program.

Bio

Nicholas Abbott received a Bachelor of Engineering (Chemical Engineering) from University of Adelaide, Australia in 1985, and a PhD in Chemical Engineering from Massachusetts Institute of Technology, USA in 1991. He was a postdoctoral fellow in the Chemistry Department at Harvard University from 1991-1993. He is currently the Sobota Professor and Department Chair in the Department of Chemical and Biological Engineering at University of Wisconsin-Madison, USA. His research interests revolve around colloid and interfacial phenomena, and include (i) surface-induced ordering of liquid crystalline materials, (ii) molecular and colloidal self-assembly, and (iii) interfacial engineering of wound beds.

Alkaisi, Maan

Abstract

Patterns and biological cells

Interactions between engineers and biologists have increased because mechanical forces from the microenvironment surrounding the cells are found central to the functioning of the biological cells.

Patterns formed from interactions between individual cells contribute to natural pattern formation of tissues and biological systems. Experiments suggest that nanostructured materials which mimic the topography of the native tissue improve biological responses and result in better tissue integration in medical implants .The control of the cell alignment and growth on a surface is called cell patterning and it is eliciting much research activity. Understanding interactions between cells and adjacent surfaces is therefore becoming very important.

We have recently developed a novel technique using rapidly curing polymer for replicating biological cellular and sub cellular structures. This method termed Bioimprint, facilitates imaging individual cells at unprecedented resolution down to the nanometer scale. It offers a snap shot record of a cell's dynamic response to stimuli, including features of fusion pores in cells. We can therefore visualise the topology of a single cell or the physical shape of interactions between cells with extremely high fidelity.

We are also able to use nanolithography to create substrates containing grooves, pits or pillars at the nanometre scale with the precision and resolutions that mimic the physiological environment of living cells and have develop methods for replicating these structures on biocompatible materials to make them bioactive and potentially organ specific.

Recent results from our work will be presented and potential applications will be discussed.

Bio

Dr Alkaisi is a Principal Investigator of the MacDiarmid Institute for Advanced Material and Nanotechnology. He is the founder and coordinator of the MacDiarmid Institute BioNanoNetwork. He holds an Associate Professor position at the Department of Electrical & Computer Engineering, University of Canterbury, Christchurch, New Zealand.

He is a founding member of the Nanostructure Engineering Science and Technology NEST research group formed back in 1998 at Canterbury University and was the core group that introduced nanotechnology to New Zealand.

Dr Alkaisi carried out his postgraduate studies in the UK where he received his MSc degree from Salford University in 1976 and PhD degree from Sheffield University in 1981 both in Electronic Engineering.

His current research interest including high resolution imaging of biological cells, BioMEMs, Interactions of biological cells with surfaces and patterns, Nanoimprint lithography and Surface texturing.

He has over 100 refereed articles, holds two patents and over 120 publications, and has given a number of invited and plenary talks at international conferences on nanotechnology. Prof Alkaisi is a Member of the Royal Society of New Zealand (MRSNZ).

Calvert, Paul

Abstract

Printing bionic devices: electronic-biological hybrids

While biology largely depends on chemical signals and energy sources, the man-made world is electronic. Bionic devices must therefore have an electrochemical interface, similar to that in a battery. We envisage that bionic devices will require flexible, stable electrodes embedded in a stable gel that can release or respond to chemical signals. To this end we have been inkjet printing metal and conducting polymer electrodes onto porous substrates and overprinting these with self-assembling hydrogels based on cationic and anionic polyelectrolytes. I will report on work at UMass and University of Wollongong on these printed bionic devices.

Bio

Paul Calvert is a professor in the Materials and Textiles Department at the University of Massachusetts Dartmouth and Associate Dean of Engineering, recently on sabbatical leave with the bionics group at University of Wollongong. He studied materials science at the University of Cambridge and the Massachusetts Institute of Technology. Calvert then joined the School of Molecular Sciences at Sussex University in 1972, where he taught polymer science. In 1988, he joined the Department of Materials Science and Engineering at the University of Arizona. In 2003, Calvert went to University of Massachusetts Dartmouth as chair of what was the Textile Sciences Department. In this position, he oversaw the department's conversion into a materials department with a focus on soft materials. Calvert's research interests have migrated through polymer crystallization, composite materials, crystal-induced joint diseases, ceramics processing, biomimetic materials, and processing. His current research is focused on methods to print soft electronics and biological materials.

Downard, Allison

Abstract

Simple and versatile new methods for surface functionalisation and patterning

Controlled surface functionalisation can be an essential step in design of surfaces for applications such as chemical and biological sensing, tissue engineering, proteomics research, molecular- and bio-electronics and biofuel cells.

In the past decade, new radical-based methods for surface-grafting have gained popularity. The key advantage of these methods over other approaches to thin film preparation is that the film is attached to the surface via (usually) strong covalent bonds, leading to a very stable attachment.

This presentation will review radical-based modification methods and highlight some applications relevant to biological systems. Recent results from our studies of film structure and dynamic behaviour will be described, and strategies for patterning modifiers onto the surface will be illustrated.

Bio

Alison Downard is a Professor of Chemistry at the University of Canterbury and a Principal Investigator with the MacDiarmid Institute for Advanced Materials and Nanotechnology. She gained her PhD at the University of Otago and undertook postdoctoral research at the University of Southampton with Prof. Derek Pletcher and at UNC-Chapel Hill with Prof. T. J. Meyer. Since joining the staff at the University of Canterbury in 1988, Alison's research interests have expanded to include electrochemistry combined with surface science, most recently with a nanotechnology focus. Currently her research is funded by the MacDiarmid Institute, and a grant from the Marsden Fund.

Fee, Conan

Abstract

Poly(ethylene glycol)-grafter proteins: conformation, separation and analysis

Poly(ethylene glycol)-grafted proteins (PEGylated proteins) are an important class of biopharmaceuticals. PEG is a neutral, heavily hydrated polymer that, when covalently attached to a protein, protects it from proteolytic degradation by shielding the protein surface and slows glomerular clearance by increasing its net size. The resultant increase in the in vivo circulation half-life of therapeutic proteins decreases dosage frequency and dramatically increases clinical efficacy. Despite the presence of a number of FDA-approved drugs on the market and many more in the development pipeline, the conformation of PEGylated proteins and the effects of PEG conjugation on electrostatic, hydrophobic and biospecific interactions are not yet fully understood. Size exclusion chromatography behaviour suggests a "shell" of PEG surrounding the protein, while ultrafiltration experiments suggest that PEG chains can trail behind the protein as it moves through membrane pores. Protection from proteolysis yet preservation of biospecific interactions is another puzzling characteristic of PEGylated proteins. Furthermore, PEG-grafting of surfaces is a well-known technique for reducing non-specific protein adhesion, which raises the question of how a surface-bound PEGylated protein is able to engage in biospecific interactions with solution-phase analytes. In this paper, some of the characteristics of PEGylated proteins will be described with reference to size, conformation, electrostatics, hydrophobicity and purification strategies, and new data will be presented on their analysis by surface plasmon resonance.

Bio

Conan Fee is Professor of Chemical Engineering and Co-Director of the Biomolecular Interaction Centre at the University of Canterbury. He gained his BE and PhD degrees in chemical engineering from Canterbury and, after a postdoctoral fellowship at the University of Waterloo, took up a joint position as a biochemical engineer at the Meat Research Institute of NZ (MIRINZ) and as a lecturer at the University of Waikato. He moved full-time to Waikato in 1996, gaining a Diploma in Strategic Management and Leadership along the way, and took a leading role in developing new engineering programmes there, eventually ending up as Chairperson of the Materials & Process Engineering Department. In 2006, he was appointed as professor at Canterbury. He is a Fellow of the Institution of Professional Engineers NZ (IPENZ) and was awarded the 2007 Australasian Fonterra Award of Excellence for outstanding contributions to the bioprocessing field of chemical engineering. His research interests lie mainly in the areas of bioseparations and biomolecular engineering, currently focusing on protein PEGylation, surface interactions and surface plasmon resonance.

Gerrard, Juliet

Abstract

Proteins as supramolecular building blocks?

The last decade has witnessed a huge gain in understanding of the way in which small molecules can be assembled into discrete and polymeric 1, 2 and 3D architectures. Key challenges remain before this knowledge can be harnessed in nanoscale devices. Integral to these challenges is the question of scale: well characterised self-assembling systems typically use components of 1-2 nm dimensions, whilst nanoscale devices demand 10-100 nm. In this research, we aim to bridge the scale gap by using proteins as our building blocks.

We are using the methods of protein engineering to assemble non-native quaternary structures and active nanoscaffolds. Two model systems are being explored: a TIM barrel enzyme, representing the most common protein fold and therefore scaffold for activity; and the peroxiredoxins, a family of proteins that have already revealed themselves to have unique self-assembly properties controlled by a redox switch. Non-native architectures have been obtained and progress is being made in the controlled assembly of these structures using ligand triggered assembly or changes in redox properties of the solvent. Specifically: the assembly of the TIM-barrel protein may be controlled by the binding of pyruvate; and the assembly of an expressed peroxiredoxin can be controlled by a single mutation at the interface.

There is much work left to do, but this is a promising approach for the assembly of active materials on the nanoscale, with many potential applications downstream as we refine the triggered assembly and disassembly of these structures and expand the repertoire of chemical and biological activities incorporated into the scaffold.

Bio

Professor Juliet Gerrard is a Co-Director of the Biomolecular Interaction Centre (BIC), a multimillion dollar research institute at the University of Canterbury which seeks to understand the molecular interactions vital to biology and harness them in a wide range of applications. Her personal research is interdisciplinary, cutting across biochemistry, chemistry, health, agricultural and food science and biomaterial design. It also incorporates a full spectrum of applied and fundamental research, focused on proteins and how they assemble. This research has potential application in the design of novel therapeutic agents and in the assembly of novel materials. Juliet is the author of 100 publications, including three books.

Griesser, Hans

Abstract

Cell attachment to surface-grafted oligopeptides

We report on the covalent attachment onto solid materials surfaces of grafted layers of various oligopeptide molecules to control and direct the colonisation of biomaterials surfaces (or tissue engineering scaffolds) by cells and tissue via specific integrin binding. We will also describe surface analytical data to characterise the grafted layers physico-chemically, and the biological characterisation by attachment and spreading of anchorage-dependent cell lines.

The concept of providing integrin-binding oligopeptides on biomaterials surfaces is not new; the novelty lies in our approach of utilising specific oligopeptides designed to be resistant to enzymatic cleavage during wound healing yet capable of interacting with known integrins. In the acute initial wound trauma stage, cells such as neutrophils arrive at the implant surface and release proteolytic enzymes to break down and recycle damaged biological material. We thus hypothesise that surface-coated protein or oligopeptide layers are rapidly removed from the implant / TE scaffold surface by such aggressive proteolysis. As a result, the bare synthetic implant surface is exposed and recognised as a foreign object, triggering a phagocytosis response that leads to fibrous encapsulation; thus the absence of significant improvements in studies with surface-immobilised RGD. Our hypothesis is that this problem can be countered by providing a proteolysis-resistant bioactive coating that "hides" the synthetic material from the body's defense system and at the same time engages in integrin-mediated cell binding.

Our approach is to achieve resistance to proteolytic degradation by utilising dextro amino acids instead of the natural laevo amino acids that proteolytic enzymes are designed to recognise. Thus, our focus is on synthetic oligopeptides containing d-amino acids. However, integrin recognition by ligands is thought to be conformationally sensitive, and when inverting the amino acid stereochemistry, we also need to invert the amino acid sequence to achieve the same conformation.

Oligopeptides have been immobilised onto plasma polymers with epoxide surface groups and the resultant grafted layers characterised by XPS and ToF-SIMS, the latter technique being excellent for detecting such small molecules. Cell binding assays using 3T3 mouse fibroblasts in serum-free medium showed that surface-grafted GRGDSP led to good cell attachment, as expected, whereas the sequence-inverted GDGRSP did not (both these oligopeptides consisting of "natural" laevo amino acids). When surface-immobilising GdGrSP (lower case d and r denoting dextro amino acids), on the other hand, cell attachment was obtained.

While the GdGrSP oligopeptide used here is a hybrid comprising both types of amino acids (mainly because each d amino acid adds considerable cost) and thus is not resistant to proteolysis, our data demonstrate the principle that using appropriate molecular design with d-amino acids, binding sequences can be designed that achieve the same bio-functionality as oligopeptide recognition sequences consisting of "natural" l-amino acids. This approach is expected to open up avenues for the design of coatings that may survive the initial acute wound healing stage.

S.S. Griesser 1, M. Jasieniak 1, J. Ramshaw 2, J. Werkmeister 2, J.J. Cooper-White 3, H.J. Griesser 1
1 Ian Wark Research Institute, University of South Australia, Mawson Lakes, SA 5095, Australia
2 CSIRO Molecular and Health Technologies, Clayton, Vic. 3168, Australia
3 Australian Institute for Bioengineering and Nanotechnology, University of Queensland, St. Lucia, Qld 4072, Australia

Head-Gordon, Teresa

Abstract

Experimental and simulation studies of bulk water and hydration water at interfaces

My talk describes an experimental and theory/simulation study of water studied as bulk, solution, and under spatial confinement. Using x-ray scattering, quasi-elastic neutron scattering, and/or atomistic and coarse-grained chemical models combined with simulation, we address fundamental questions about the origin of waters thermodynamic and dynamic anomalies, the microscopic features of the potential energy landscape that define the origin of these

anomalies, and ways to modify interfacial chemical properties to exploit these anomalies for nanoscale function.

Bio

Professor, University of California, Berkeley; born 1960 in Akron, Ohio; B.S., Case Western Reserve University (1983); Ph.D., Carnegie Mellon University (1989); Postdoctoral Member of Technical Staff, AT&T Bell Laboratories (1990-1992); Scientist and Faculty Scientist, Lawrence Berkeley National Laboratory (1992-present); IBM SUR Award (2001); Schlumberger Professor and Medal, Cambridge University UK (2005-2006); Clare Hall Faculty, UK (2006-present); Li Ka Shing Foundation Women in Science (2009); Panel member of the U.S. National Academies Study on Potential Impact of Advances in High-End Computing in Science and Engineering (2006-2008); Panel member of the NIH Study Section on Modeling and Analysis of Biological Systems (2007-2012); Editorial Advisory Board Member for the Journal of Physical Chemistry B (2009-present); Editorial Advisory Board Member for the Journal of Computational Chemistry (2004-present); Editorial Board Member for the SIAM book series on Computational Science and Engineering (2004-2009); Editor for Biophysical Journal (2003-2006).

Kaplan, David

Abstract

Bioengineering Silk Proteins to Instruct Cells and Tissues

Biopolymers provide a useful platform for the detailed study of structure-function relationships in materials science. Our research focus has primarily been on fibrous proteins, collagens and silks, and the exploration of modes to manipulate protein chain features and processing strategies, with the goal to control the assembly of these systems. This control has led to options to regulate cell and tissue functions in response to the material features (structure, chemistry, morphology). Genetic engineering, chemical modifications and aqueous-based processing techniques are exploited to alter material features. These approaches have provided fundamental insight into the basis for the self-organization of these protein polymer systems. This insight has led to new options to modify material architectures, structural features, morphology and chemistry. These features have been exploited in a variety of ways to direct stem cell functions and to generate functional tissues in vitro and in vivo. For example, the unique attributes of silk biomaterial systems, including controllable degradability, biocompatibility, structural polymorphism, and all aqueous processing, provide important options into new modes of tissue formation, controlled drug delivery, novel biomaterial coatings, materials patterning and device formation. Some of these issues will be discussed in the context of the protein biomaterial features that provide the platform for these opportunities. In all of these studies, the ability to manipulate and control surface and bulk features drive control of cell and tissue functions in vitro and in vivo.

Bio

David Kaplan holds an Endowed Chair, the Stern Family Professor of Engineering, at Tufts University. He is Professor & Chair of the Department of Biomedical Engineering and also holds faculty appointments in the School of Medicine, the School of Dental Medicine, Department of Chemistry and the Department of Chemical and Biological Engineering. His research focus is on biopolymer engineering to understand structure-function relationships, with emphasis on studies related to self-assembly, biomaterials engineering and functional tissue engineering. He has published over 400 papers and edited eight books. He directs the NIH P41 Tissue Engineering Resource Center (TERC) that involves Tufts University and Columbia University, and the Bioengineering and Biotechnology Program at Tufts University. He serves of the editorial boards of numerous journals and is Associate Editor for the journal Biomacromolecules. He has received a number of awards for teaching, was Elected Fellow, American Institute of Medical and Biological Engineering (2003) and received the Society for Biomaterials Clemson Award for contributions to the literature in 2007.

Kiick, Kristi

Abstract

Multivalent polypeptides in the organization of functional materials

The design of multivalent polypeptides offers important approaches for mediating biological events and also in the development of hybrid materials. We have employed a combination of biosynthetic tools, bioconjugation strategies and biomimetic assembly in the design of a variety of polypeptides and polypeptide-polymer conjugates. In particular, alanine-rich helical polypeptides have proven a versatile class of macromolecules. In addition to their demonstrated use as potent multivalent toxin inhibitors, they are capable of assembly into multiple types of nanostructures via simple modifications of polymer architecture and variations in solution pH and temperature. A combination of spectroscopic, microscopy, and scattering methods suggests their selective assembly into soluble and fibrillar structures that are being explored for drug delivery applications and in the organization of inorganic structures.

Bio

Kristi Kiick is an Associate Professor of Materials Science and Engineering at the University of Delaware. She received a BS in Chemistry from the University of Delaware in 1989, an MS in Chemistry as an NSF Predoctoral Fellow from the University of Georgia in 1991. She began doctoral studies in 1996 under the direction of David Tirrell, graduating with a PhD in Polymer Science and Engineering from the University of Masschusetts Amherst in 2001 after completing her research as an NDSEG Fellow at the California Institute of Technology. Her current research programs are focused on combining biosynthetic techniques, chemical methods, and bioinspired assembly strategies in the production of polymeric materials with novel multifunctional behavior. Her work in this area has been recognized by faculty awards from the Dreyfus Foundation, the Arnold and Mabel Beckman Foundation, DuPont Corporation, and the National Science Foundation.

McGrath, Kathryn

Abstract

Carbohydrate hydrogels: a basis for synthetic nacre

Butterfly wings, egg shells, coral and crayfish shell all seem decidedly disparate and yet may all be classified together. The guise for which this holds true is that the organisms partake in the manufacture of materials that have highly defined complex hierarchical structures with length scales spanning the sub-nanometre to metre. Even restricting ourselves to those materials based on minerals (the so-called biominerals) presents us with a plethora of choice including mammalian bone, sea urchin spines and paua shell. All are calcium-based

materials. The former is an amorphous phosphate-based system while the latter two are crystalline carbonate-based minerals in the form of calcite and aragonite, respectively.

Looking more closely at this subset we see that while biominerals are chemically similar to geological minerals, they are in fact tailor-made with specific size characteristics, have enhanced physical properties, such as resistance to corrosion, durability and toughness and perhaps most importantly from the perspective of efficient utilisation of resources, are synthesized under benign conditions. The level of structural control demonstrated is unrivalled in the synthetic world with many of the materials characteristics of these biominerals being highly coveted, particularly if they can be recreated in other chemically and physically diverse materials such as semiconductors and photoelectronic materials or replicated for use for example as biomedical implant materials. The question of how, has inspired many studies in the field of biomineralisation, yet our understanding remains limited, though it is widely believed that biopolymers and proteins are fundamental control agents for achieving the complex hierarchical structures.

Our research focusses on understanding how the organic framework mediates the inorganic crystal growth and in particular in developing synthetic nacre and its analogues. The insoluble organic matrix of nacre is the carbohydrate chitin, while present in low amounts it plays an important role in both the growth of the calcium carbonate and also the final characteristics of the material. With this in mind we have investigated the use of self-assembly of biopolymers and have developed a responsive biopolymer scaffold that enables control of calcium carbonate platelet formation and association. The final material has a structure and length scale comparable to that seen for the aragonitic plates of p□ua shell/nacre. This opens the possibility of utilising high molecular polymers, waste products of the fishing industry to generate inorganic/organic composite materials with hierarchical structure comparable to that found in native biominerals.

Bio

Kathryn McGrath is an Associate Professor in the School of Chemical and Physical Sciences, Victoria University of Wellington, a Principal Investigator in The MacDiarmid Institute for Advanced Materials and Nanotechnology and an Associate Investigator in the Riddet Institute. She gained her PhD from The Australian National University (Department of Applied Mathematics), Canberra, Australia, before taking up a post-doctoral position at L'Université de Pierre et Marie Curie – Paris VI (Laboratoire de Mineralogie et Cristallographie), in Paris, working with Maurice Kléman, followed by a second post-doc in the Physics Department at Princeton University, Princeton, with Sol Gruner. This was followed by her joining the Department of Chemistry, University of Otago, as a lecturer. In January 2004 she moved to Victoria University of Wellington. Kate received the Easterfield Medal, awarded jointly by the New Zealand Institute of Chemistry and The Royal Society of Chemistry, UK (2003) and the Research Medal awarded by the New Zealand Association of Scientists (2007).

Her research expertise is in the areas of soft matter and biomineralisation. In particular she is interested in the fundamental molecular-level control of 3D pattern formation in liquids and solids as inspired by Nature.

Mello, Charlene

Bio

Dr Mello's research interests have centered around the interaction of proteins and peptides with themselves and other systems in their surroundings. Specific research areas of interest include antimicrobial peptides, protein chemistry, biomolecular recognition, naturally (biologically) derived structural materials and the interfacing of biological materials with inorganic materials. Through research conducted within her group unique expertise and understanding of complex, repetitive structural protein systems capable of self assembly and incorporation into composite materials for multifunctional membranes/ films/ coatings for chemical and biological decontamination, biosensing and remediation has been acquired. In addition the demonstration of an environmentally robust class of antimicrobials are under rigorous investigation to better understand the chemical and physical properties that drive specificity of binding to target microorganisms for a range of biosensing applications. Finally, her group is working at the cutting edge of sensor development, coupling biosensing elements to signal amplifying, conducting polymers for direct detection of analyte binding. They are also developing nanofibers incorporating engineered antimicrobial peptides to decontaminate against sporal agents. My research results have been presented in over 75 technical articles in scientific journals, nine patents, and numerous technical presentations at scientific/professional meetings.

Middelberg, Anton

Abstract

Stimuli-responsive peptide nanostructures at the fluid-fluid interface

Biology provides us with a myriad of complex and precisely formed nanostructures having a wealth of functions. These nanostructures often posses unique properties, for example the ability to be switched between metastable states, yet they remain largely a research curiosity. Generation of new and valuable products of benefit to society will require a more fundamental understanding of how these nanostructures can be directed to form, in a controlled and economic way, and under the influence of the complex physical forces that occur throughout biological and manufacturing systems. In this seminar I will outline our research into the design, use and manufacture of switchable peptide biosurfactants. These molecules are able to self-assemble at air-water and oil-water interfaces to create an ordered and crosslinked film of designed strength. The film is reversibly dissipated in response to pH triggers, offering unprecedented control over the stability of foams and emulsions.

Bio

Anton Middelberg is the Professor of Chemical and Biomolecular Engineering at The University of Queensland, Australia. His research focuses on the science of chemical self-assembly processing, with the ultimate aim of defining new functional products and new process routes for the manufacture of existing products. His research on Biorenewables focuses on new methods for functional bio-inspired materials, and enhanced processing routes to bioenergy and chemical building blocks. His research in Biomedical Engineering focuses on platform technology for rapid-response vaccines, specifically targeting bacterial infection and influenza. Professor Middelberg has previously held tenured academic positions at Adelaide and Cambridge Universities, a Fulbright fellowship at UC Berkeley, and was elected Fellow of Selwyn College Cambridge and Fellow of the Cambridge-

MIT Institute. He has received a number of awards including the Brodie and Shedden-Uhde medals of the Institution of Engineers Australia, has published more than 150 refereed papers at the interface between biology and engineering, and has editorial roles on journals including Chemical Engineering Science (Executive Editor), Trends in Biotechnology (Advisory Editorial Board Member) and Biochemical Engineering Journal (Associate Editor). He is currently Chair of the Program Advisory Committee for the Bragg Institute at the Australian Nuclear Science and Technology Organisation. His research on biorenewables led to the award-winning Pepfactants technology, which is the basis of the first spinout company (www.pepfactants.com.au) from the Australian Institute for Bioengineering and Nanotechnology.

Ganesan Narsimhan

Abstract

Characterization of Conformation of proteins/polypeptides immobilized at liquid-solid interface using Molecular Dynamics Simulation

Molecular Dynamics (MD) simulation is a powerful technique that can be employed to describe the evolution of energy landscape of protein/polypeptide accounting for the detailed interatomic interactions during folding/unfolding and is now widely used as a tool to investigate structure and dynamics of biological molecules under a variety of conditions. Salient features of MD simulation will be discussed. Force field parameters to describe bonded and non-bonded interatomic interactions in protein/polypeptide systems will be described. Implicit solvent models and enhanced conformational sampling techniques will be discussed. Simulation results of secondary and tertiary conformations of lysozyme and model polypeptides in solution will then be presented. The secondary structure, potential energy and end-to-end distance for an antimicrobial peptide Cecropin P1 C in solution as well as for the polypeptide that is physically adsorbed onto silica surface or anchored to the surface with a polyethylene oxide linker molecule will be presented. The effect of polypeptide-polypeptide interaction for tethered Cecropin P1 C on its conformation will be discussed. The principle of coarse grain to reduce computation time in such system will be discussed and the results of tertiary conformation of trp-cage and lysozyme in solution obtained by coarse grain will be compared with those of all atom simulation. Tertiary conformation of lysozyme adsorbed on silica surface obtained by coarse graining will then be presented.

Bio

Dr Ganesan Narsimhan is a Professor in the Department of Agricultural and Biological Engineering at Purdue University. He obtained his Ph.D. in Chemical Engineering from Indian Institute of Technology, Kanpur. He is a Fellow of American Institute of Chemical Engineers. His main area of research is Colloidal and Interfacial Phenomena applied to biological systems with emphasis on the formation and stability of foams, emulsions and dispersions. He has developed mechanistic models (i) for the formation, drainage and stability of foams (ii) for the stability of thin films subjected to thermal and mechanical perturbations (iii) to relate the adsorption behavior of proteins at interfaces to their size, shape, structure and other molecular properties and (iv) to elucidate the role of proteins on the formation and stability of emulsions. He is currently investigating the secondary and tertiary conformational changes of proteins/enzymes adsorbed on surfaces using spectroscopy as well as molecular dynamics simulation. He has authored 70 refereed research publications and 15 book chapters. In addition to undergraduate classes in process engineering, he teaches two graduate level courses, Transport Phenomena in Bioprocess Engineering and Colloidal and Interfacial Phenomena in Biological Systems.

Kim Pickering

Abstract

Biologically Based Composites: Interfacial modification

The structural performance of any composite is strongly influenced by fibre/matrix interfacial strength. In natural fibre composites, the inherent incompatibility of the components has presented a challenge regarding the need for good interfacial strength to enable transfer of fibre properties into those of the overall composite. This talk presents basic models for composite strength and highlights mechanisms involved in the failure of composite materials, supporting the need for interfacial modification. Attention is given to chemical and biological treatments used for natural fibres and the different mechanisms that are involved with these. Results from work using white rot fungi as an alternative to more established alkali treatment to remove non-cellulosic material are presented which have given benefit with respect to the production of relief for mechanical interlocking as well as lignin removal. Fungal treatment is shown to increase fibre crystallinity as well as its thermal stability. Consideration of issues relating to bioderived matrices is included as well as the influence on interfacial bonding on development of structure within a crystallisable matrix.

Bio

I graduated in Metallurgy and Materials Science from Imperial College, London, UK then took up a research position with an electronics company (was Plessey now GEC), during which time I led a team that developed and patented a flip chip interconnect bond process for advanced semiconductor devices. I returned to university (Surrey) to undertake a PhD investigating failure mechanisms of carbon fibre/epoxy composites. In 1994 I joined the embryonic Centre for Technology at the University of Waikato, which has since evolved and been incorporated into the School of Engineering and founded the Waikato Composites Research Group. Research highlights include the development of composites based on various novel materials including natural cellulose based fibres and bioderived matrix. Research emphasis has focussed on interfacial engineering and fracture mechanics. In 2008 I was elected as a fellow of the Institute of Professional Engineers of New Zealand. FIPENZ, IntPE, CPEng, MIMMM

Sunde, Margie

Abstract

Building amphipathic monolayers from self-assembling proteins

The hydrophobins are a family of small proteins found in all filamentous fungi. They are able to self-assemble at hydrophilic:hydrophobic interfaces and form amphipathic monolayers. These protein monolayers are extremely robust and can be formed on either hydrophobic or hydrophilic surfaces in a way that reverses the polarity of the surface. Hydrophobin assemblies share many of the structural characteristics of amyloid fibrils, the insoluble, ordered protein assemblies that are associated with many disease states, including Alzheimer's

disease and Type II diabetes. The monomeric forms of hydrophobin proteins are small beta barrels, constrained by four conserved disulfide bonds, and displaying a distinct separation of polar and hydrophobic regions on the surface. We are interested in the structures of the monomeric forms of various different hydrophobins from medically and agriculturally significant fungi. We are also studying the process of conformational change that occurs at interfaces when the proteins assemble into stable amphipathic polymers and have identified residues important for intermolecular association. Hydrophobin coatings offer the possibility of improving the chemico-physical properties of important bionanomaterials. We are able to engineer hydrophobins to display functional groups and aim to exploit the self-assembly properties and the amphipathic nature of hydrophobin proteins for the generation of biocompatible solid substrates and the synthesis of functional nanosurfaces.

Bio

Margie Sunde completed her undergraduate degree in Biochemistry at the University of Cape Town and then went on to Cambridge for a PhD. Her first postdoctoral position was with Colin Blake in the Laboratory of Molecular Biophysics in Oxford, when she became interested in the structure of amyloid fibrils and used X-ray fibre diffraction and electron microscopy to study many different disease-related fibrils. She also solved the crystal structures of two amyloidogenic lysozyme variants and started to use other biophysical techniques to probe the stability and folding of these proteins. Following a period with Chris Dobson, also in Oxford, Margie moved back to Cambridge in 1999 to set up a small research group. In 2001 she moved to Australia and after a career break has started working on natural functional amyloids, in particular the rodlets formed by fungal hydrophobin proteins. These form an amphipathic monolayer composed of amyloid fibrils.

Thayumanavan, S. Thai

Abstract

Responsive Nanoassemblies

Non-covalent encapsulation of guest molecules and their triggered release is of paramount importance in the filed of drug delivery. Achieving such release characteristics using proteins as trigger would have significant implications in both drug delivery and bio-sensing, since protein imbalances are primary bases for the most of human diseases. Custom-designed facially amphiphilic dendrimers have been utilized for this purpose due to their unique ability of sequestering guest molecules through of aggregation of several dendritic molecules.

Micellar assemblies, such as the ones above, are promising scaffolds to overcome many of the problems faced with traditional chemotherapies, because of their capacity for non-covalent, hydrophobic guest molecule binding. However, the stability of encapsulation with such self-assembled systems is limited during blood circulation because of a requisite concentration for assembly formation. Thus, deliberate molecular design for stable encapsulation, targeting and triggered release is required. For this purpose, we have developed a facile synthetic method for highly stable, polymeric nanogels using a simple intra/inter-chain crosslinking reaction. We show a simple, emulsion free method for the preparation of biocompatible nanogels that provides the ability to encapsulate hydrophobic guest molecules. The resulting nanogels show sizes of several hundred nanometers with well-defined shapes. The nanogel surfaces can be functionalized with specific groups, allowing for potential functionalization for targeted delivery. We show that the non-covalently encapsulated guest molecules can be released in response to a biologically relevant stimulus. The release of the guest molecules can be tuned by crosslinking density and in situ release was observed through in vitro fluorescence resonance energy transfer (FRET) experiments. Hence, the reversible nanogel formation using self crosslinking polymers and the corresponding method of surface modification are a promising platform for creating polymer nanogels for a range of biomedical applications, from drug delivery to bionsensing.

Bio

Professor S. “Thai” Thayumanavan is a professor in the Department of Chemistry at the University of Massachusetts Amherst. He obtained his Ph.D. in Organic Chemistry at the University of Illinois at Urbana-Champaign. After a postdoctoral stint at Caltech in Optical Materials Chemistry, he started his independent career at Tulane University in New Orleans. After 4 years at Tulane, he moved to UMass Amherst in 2003. Thayumanavan’s research interests are highly interdisciplinary. His research group is involved in designing novel molecules and materials, especially nanoscale materials, which are of interest in biomedical and renewable energy applications. In the biologically relevant nanomaterials area, he is interested in designing nanoscale assemblies that respond not only to secondary biological stimuli such as pH, temperature and redox conditions, but also to the primary imbalances in biology, i.e. enzymatic activities and protein concentrations.

Thompson, David

Abstract

Oriented Insertion of phi29 N-Hexahistidine-tagged gp10 Connector Protein Assemblies into C20BAS Bolalipid Membrane Vesicles

Vectorial transplantation of N-his6-gp10 assemblies from phi29 virus into liposome membranes was sought as a means to confer controlled DNA packaging capabilities within a carrier system that can be optimized for in vivo use. A major challenge in this effort is the accommodation of the 2 nm hydrophobic domain of the phi29 connector protein assembly within a stable host membrane with controlled orientation and assembly of the packaging motor components. Glass surfaces grafted with Ni2+:nitrilotriacetic acid-poly(ethylene oxide[14]) (Ni2+:NTA-PEG600) were prepared to enable N-his6-gp10 capture and vectorial presentation of the connector protein assembly to 1 mol% POPE-rhodamine B-labeled 9:1 C20BAS:cholesterol (Rh:C20BAS:Chol) liposomes whose membrane thickness is well-matched to the hydrophobic domains of gp10. Confocal fluorescence microscopy images show a punctate red fluorescence at the solid-liquid interface after addition of sonicated Rh:C20BAS:Chol liposomes to Ni2+:NTA-PEG600-immobilized N-his6-gp10; the red fluorescence at the interface was lost upon addition of imidazole. Analysis of the fluid phase after imidazole addition revealed red fluorescent liposomes in the bulk phase above the surface. The membranes from these liposomes were observed to possess nanopore features consistent with the known dimensions of gp10 connector protein assemblies. We infer from these experiments that N-his6-gp10 assemblies were inserted into C20BAS:Chol liposomes in a directional manner that placed the narrow stem of the connector at the outer surface. These liposomes, bearing vectorially-oriented N-his6-gp10 assemblies, also were displaceable upon Ni2+ scavenging, thus

enabling subsequent solution-phase assembly of the other DNA motor components on the surface of these particles.

Bio

Professor Thompson received Bachelor degrees in Chemistry and Biology from the University of Missouri-Columbia (1978) and a Ph.D. degree in Organic Chemistry from Colorado State University (1984) for his work with Louis S. Hegedus. After postdoctoral studies with James K. Hurst (1984-1987), he joined the Department of Chemical & Biological Sciences at the Oregon Graduate Institute as Assistant Professor (1987-1994). He then moved to Purdue University where he currently holds the position of Professor & University Faculty Scholar. Prof. Thompson has served as Visiting Professor at the University of British Columbia (1992), University of Florida (2003), Japan Advanced Institute of Science & Technology (2005), and Osaka University (2006). He was/is a member of the Editorial Advisory Boards of Langmuir (2000-2005) and Bioconjugate Chemistry (2004-present) and presently serves as Associate Editor of WIRES: Nanomedicine & Nanobiotechnology (2005-present). Dr. Thompson's research interests are focused on the synthesis of bioresponsive self-assembling materials, interfacial templating of protein crystallization, and membrane protein sensors for high-throughput screening.

Tu, Raymond

Abstract

Self-assembled periodically sequenced peptides: A biomimetic platform for materials synthesis

Periodically sequenced peptides can be confined to interfaces and assembled into patterns that present chemical functionalities with exceptional spatial precision. The role of dynamics during the assembly of these peptides appears to be very important for inorganic nucleation and growth. Our work applies periodically sequenced sheet-forming peptides at interfaces to explore the dynamics of assembly. The peptide molecules are rationally designed to have amphiphilic properties and a propensity for sheet-like secondary structure. These designed peptides are deposited at the air-water interface to explore the dynamics of self-assembly and investigate their 2D order. To characterize the phase behavior, we apply Langmuir Blodgett techniques and Brewster angle microscopy. Thermodynamic analysis of structure formation with increasing pressure allows us to understand the nature of self-assembly with iterative changes in the peptide sequence. Additionally, we look at the dynamics of the self-assembled state, where the organic phase switches between short- and long-range order as a function of surface pressure. This model system allows us to explore our underlying hypothesis that the time scale of the confined peptide phase-transitions defines the length-scale of the crystalline phase. This is in contrast to a system that starts with a well-ordered preformed template that defines the mineral phase. We have shown that our model peptides can effectively be used to control the polycrystallinity in gold by controlling the surface pressure and diffusive time scales at the interface.

Bio

Raymond Tu received his PhD in chemical engineering from the University of California - Santa Barbara in 2004, studying the design and self-assembly of peptide functionalized molecular architectures. He completed a post-doctoral fellowship in 2005 at Georgia Institute of Technology investigating rheological properties of biologically functionalized polymer-based materials. Currently, he is an assistant professor at The City College of The City University of New York. The focus of his research program is the synthesis of surface active molecular building blocks, which are derived from the combination of elements that direct interfacial assembly with components responsible for selective binding. This methodology is proving to be an effective tool for engineering complex composite materials that contain structures with multiple length-scales.

Webb, Lauren

Abstract

Electrostatic Control of Protein-Surface Interactions

Proteins display a tremendous range of specific biological function. Applying this function to sensing, chemical catalysis, and biofuel generation would profoundly expand and change these traditional fields. This goal requires that the protein of interest be effectively integrated with inorganic materials such as a crystal surface in a controlled and oriented manner without altering its three-dimensional fold or compromising function, a challenging biomaterials problem. In the complex environment of a living cell, however, proteins assemble into robust functional structures by relying almost exclusively on noncovalent interactions directed by the presence of strong, localized electrostatic fields. This provides the inspiration for an entirely new paradigm for preparing protein-functionalized inorganic surfaces and substrates. In the research described here, we chemically functionalize gold surfaces to create a substrate electrostatic environment that mimics a protein's natural binding interaction. This is expected to lead to an entirely new mechanism through which biological and inorganic materials can be coaxed to interact.

Bio

Lauren Webb received her A.B in Chemistry (Music minor) from Bowdoin College in 2000. She entered graduate school at the California Institute of Technology as an NSF Graduate Research Fellow and earned her Ph.D. in Chemistry in 2005. She did her graduate work in the laboratory of Prof. Nathan Lewis, where she studied chemical and electronic properties of functionalized atomically flat silicon(111) surfaces. From 2005 – 2008 she was an NIH Postdoctoral Research Fellow in the Chemistry Department at Stanford University, working in the laboratory of Prof. Steven Boxer. Her research focused on quantifying electrostatic fields in proteins using vibrational Stark effect spectroscopy. As a postdoc she received the Burroughs Wellcome Fund's Career Award at the Scientific Interface. Lauren joined the Department of Chemistry and Biochemistry at The University of Texas at Austin in the fall of 2008. Her research interests are centered around understanding and manipulating the mechanisms of interaction, organization, and self-assembly of biological macromolecules that lead to the complex and emergent properties of living systems.

Weiss, Tony

Abstract

Human tropoelastin and covalent metal interfaces: multifaceted biocompatibility

We developed a plasma-activated coating that covalently binds recombinant human tropoelastin, a major regulator of vascular cells in vivo, to enhance endothelial cell interactions. The plasma-activated coating has exceptional adhesion to metallic substrates, withstanding expansion without delamination when applied to a stent. The plasma-activated

coating is profoundly less thrombogenic than 316L stainless steel. When the coating is used to bind recombinant human tropoelastin, the surface retains its non-thrombogenic property and enhances endothelialization.

Bio

Tony Weiss, BSc (Hons I), PhD (University of Sydney), FAICD, MRACI CChem is a biochemist and research scientist who leads human tropoelastin research in parallel streams focusing on tropoelastin function, elastic biomaterials and cardiovascular treatment. A multiple University prize winner, Fulbright Scholar and learned society medallist, he is currently Professor of Biochemistry and Molecular Biotechnology and Chair SMB Proteomics and Biotechnology at the University of Sydney (where he was Foundation Chair of Molecular Biotechnology). He established the leading international human tropoelastin research laboratory and has 15+ years experience in research on elastin, the protein that is essential for cardiovascular, lung and skin elasticity and cell interactions. Awards include the Roslyn Flora Goulston Prize, NIH Fogarty International Fellow, Fulbright Fellow, CSIRO Postdoctoral Scholar, Thomas and Ethel Mary Ewing Scholar, Australian Academy of Science and Royal Society Exchange, David Syme Research Prize and Medal and Amersham Pharmacia Biotechnology Medal for elastin research, NSW Commercialisation Expo Prize. He is Chair, Biological Sciences and Biotechnology, Australian Research Council College of Experts. He is an inventor with over eighteen awarded international patents in Australia, New Zealand, the USA, Canada and Europe, and a further twenty-two patents pending, where he is listed as the main or sole inventor in ten patent families. These patents are all in the field of elastin and applications of elastin technologies. Modified elastin materials range from carbon-containing polymers to metal surfaces, from monomer nano-bio to multimer assemblies.

Yang, Yi Yan

Abstract

Self-Assembled Peptide Nanostructures as Drug Delivery Carriers and Antimicrobial Agents

Supramolecular nanostructures self-assembled from biodegradable and biocompatible amphiphilic macromolecules have emerged as safe and efficient nanocarriers for delivery of therapeutics. Synthetic peptides are attractive biomaterials due to their biodegradability. In addition, the availability of 20 naturally occurring amino acids provides a wide array of platform for multifunctional properties desirable for designing functional nanostructures as carriers for various drug molecules and as therapeutics.

In this talk, a number of cationic amphiphilic peptide molecules will be introduced. These amphiphiles can be easily synthesized through a solid phase synthesis approach, and can readily self-assemble into cationic micelles with nanosize in water. They have been used as carriers for delivery of genes, and simultaneous delivery of small molecular drug and gene [1-3]. In addition, the peptide micellar nanostructures with a cell-penetrating peptide sequence on the surface are efficient antimicrobial agents that can cross the blood-brain barrier and kill the fungi in the brain tissues of a rabbit model [4,5]. We have demonstrated that the amphiphilic peptide molecules can be designed to achieve high efficacy with minimal toxicity.

Nikken Wiradharma, Weiyang Seow, Lihong Liu and Yi-Yan Yang

Institute of Bioengineering and Nanotechnology, 31 Biopolis Way, Singapore 138669

E-mail: yyyang@ibn.a-star.edu.sg

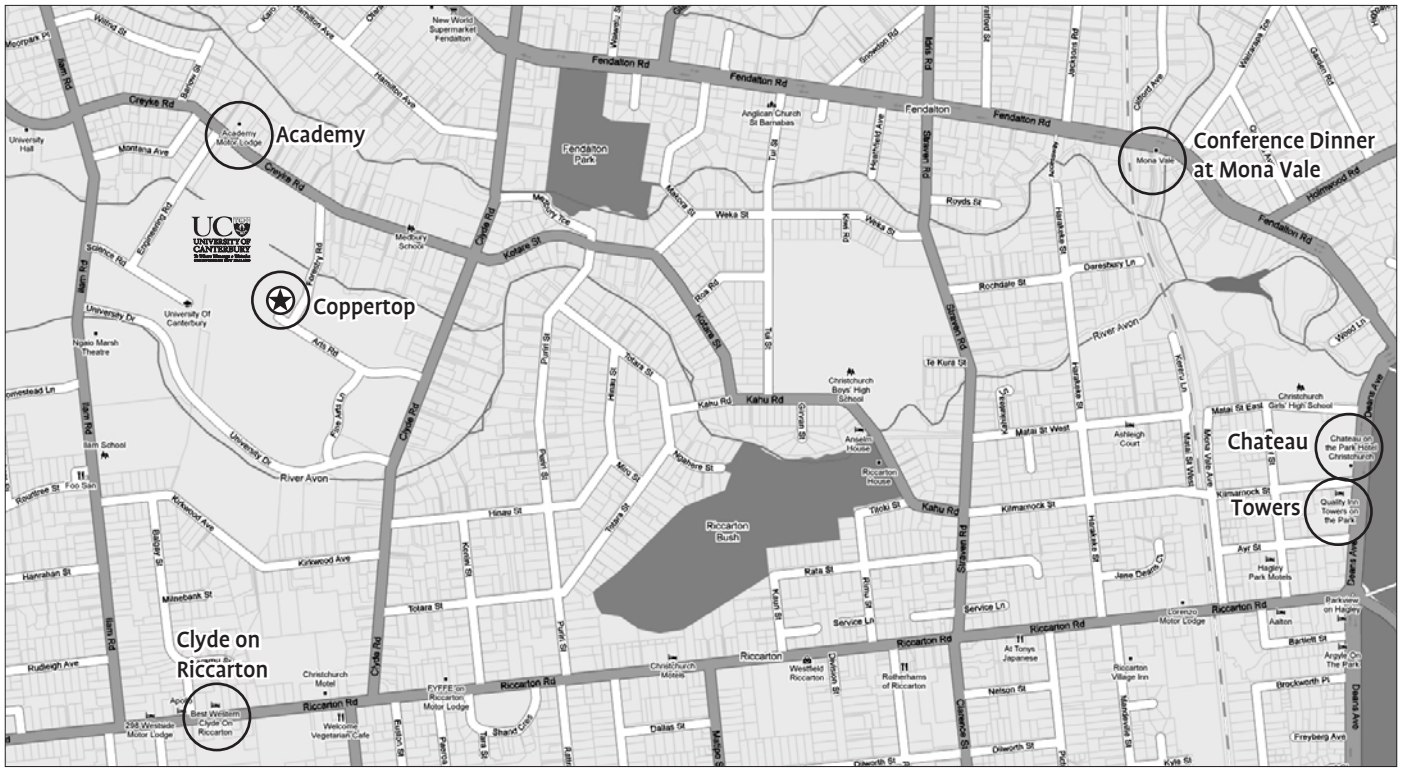
References:
[1] N. Wiradharma, M. Khan, Y. W. Tong, S. Wang and Y. Y. Yang. Advanced Functional Materials 18 (2008) 943-951.
[2] W. Y. Seow and Y. Y. Yang. Advanced Materials 21 (2009) 86-90.
[3] N. Wiradharma, Y. W. Tong and Y. Y. Yang, "Self-Assembled Oligopeptide Nanostructures for Co-Delivery of Drug and Gene in Achieving Synergistic Therapeutic Effect", Biomaterials 30 (2009) 3100-3109.
[4] L. H. Liu, K. J. Xu, H. Y. Wang, J. P. K. Tan, W. M. Fan, S. S. Venkatraman, L. J. Li and Y. Y. Yang. Nat. Nanotech. 4 (2009) 457-463.
[5] H. Wang, K. Xu, L. Liu, J. P. K. Tan , Y. Chen, Y. Li, W. Fan, Z. Wei, J. Sheng, Y. Y. Yang and L. Li. Biomaterials 2009 31 (2010) 2874–2881.

Bio

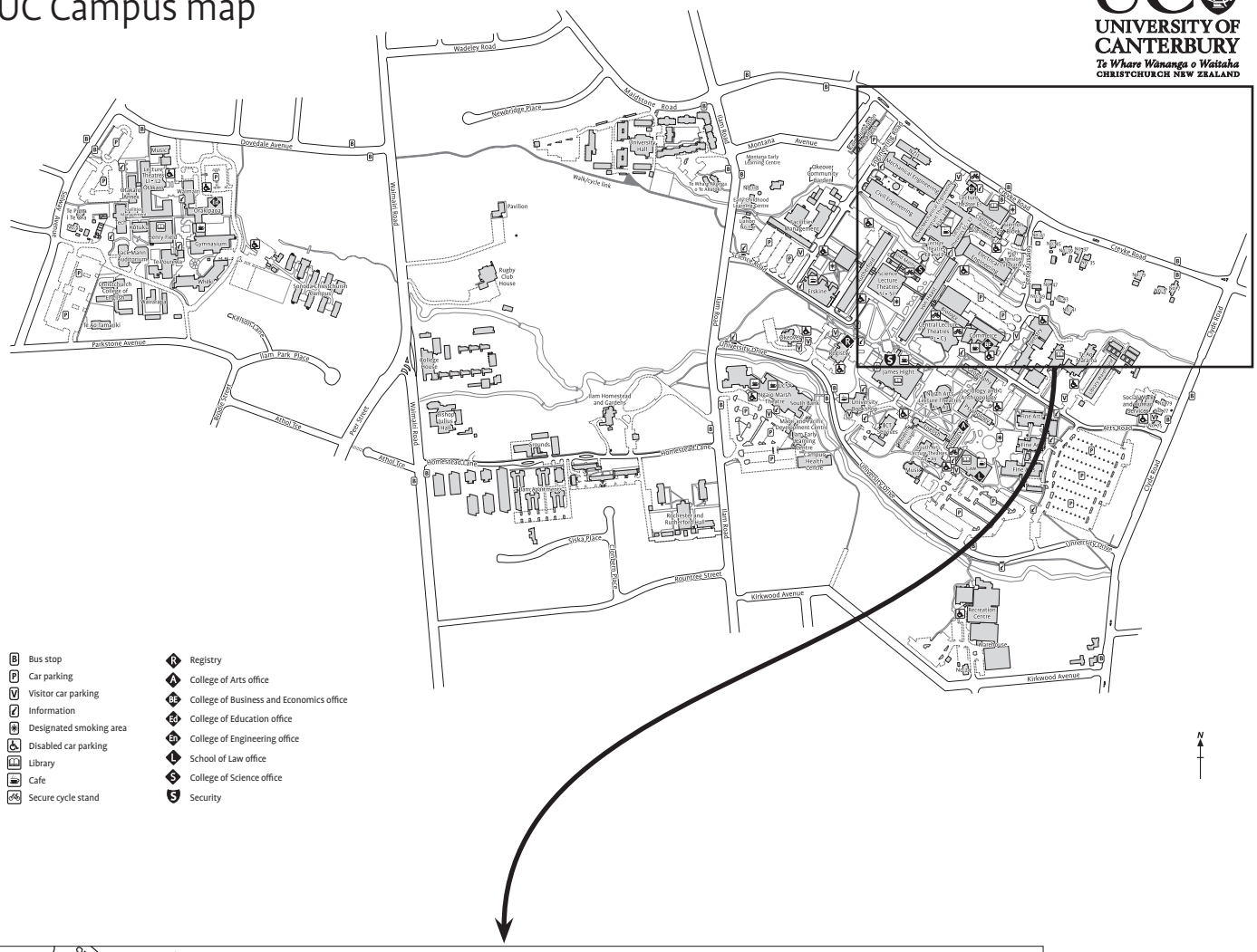
Yi Yan Yang is a Group Leader at Institute of Bioengineering and Nanotechnology, Singapore. She received her Ph.D. in Chemical Engineering from Tsinghua University, P.R. China in 1990. After working as an assistant and associated professor in Tsinghua University for 3 and 5 years respectively, she came to Singapore in 1998 and worked in Institute of Materials Science and Engineering. In 2003, she moved to Institute of Bioengineering and Nanotechnology as a Group Leader. Since 2008, she has been an adjunct associate professor in Department of Pharmacy, National University of Singapore. She is a co-inventor for 11 patents, and has authored more than 85 peer-reviewed journal publications. Her research is mainly focused on self-assembled nanostructures for drug/cell delivery and for applications in cancer and infectious disease therapies as well as cartilage repair.

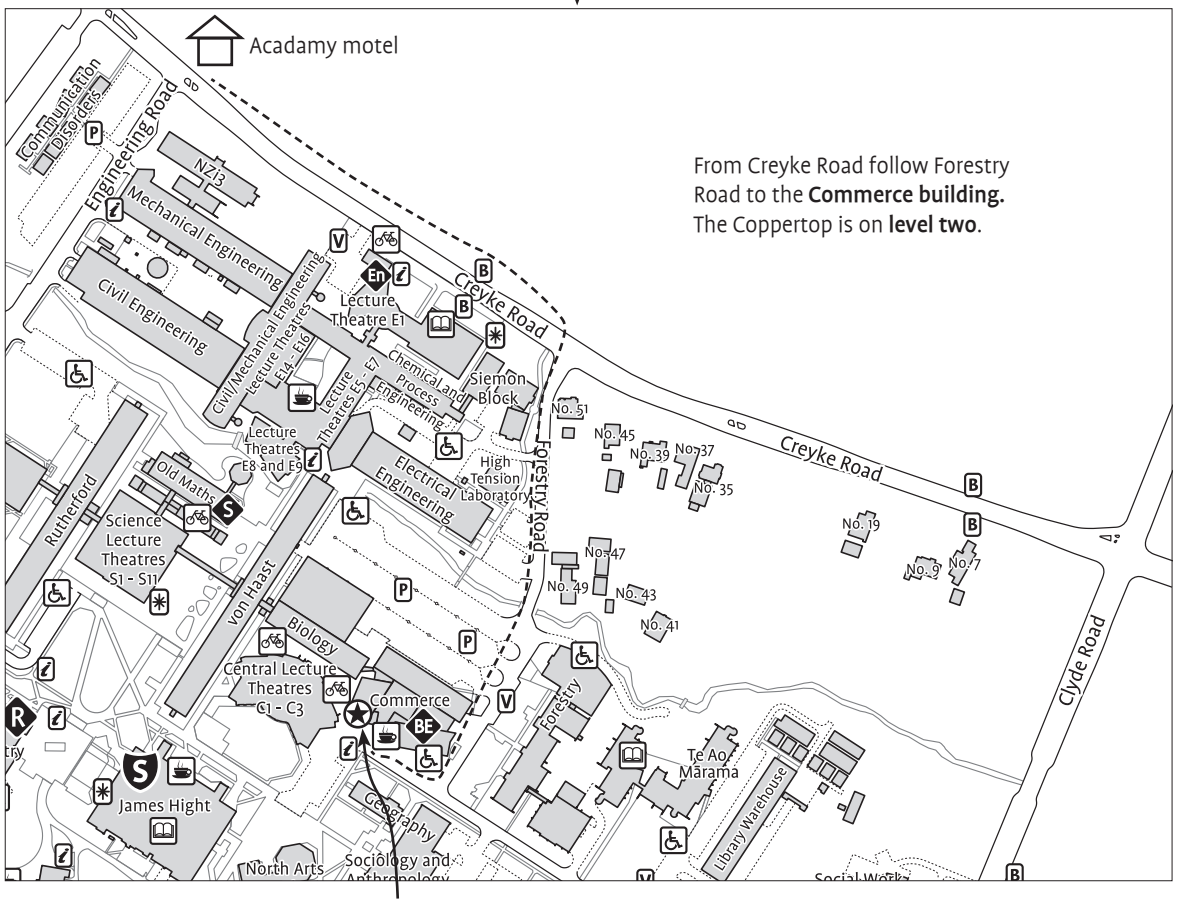
Notes

Accommodation Map



UC Campus map





Programme

Recent Advances at the Bio/Abio Interface Workshop

Tuesday June 22	
11:00	Registration from 11; Coppertop, Level 2 Commerce building
12:20–1:15 Lunch	Lunch and welcome mixer, opening (by DVC Ian Town); Opening Remarks (Juliet Gerrard, Charlene Mello)
Afternoon session 1:15 1:55 2:35 3:15 Afternoon Tea 3:45 4:25 5:05	***Chair – Charlene Mello*** **1. David Kaplan** – Bioengineered silk proteins to control cell and tissue functions **2. Antony Weiss** – Human tropoelastin and covalent metal interfaces: multifaceted biocompatibility **3. Raymond Tu** – Self-assembled periodically sequenced peptides: A biomimetic platform for materials synthesis **4. Teresa Head-Gordon** – Experimental and simulation studies of bulk water and hydration water at interfaces **5. Margie Sunde** – Building amphipathic monolayers from self-assembling proteins **6. Juliet Gerrard** – Proteins as supramolecular building blocks?
5:45–7:15 Dinner	Dinner, provided
Evening Session 7:15 7:55 8:35	***Chair – Nick Abbot*** **7. Lauren Webb** – Electrostatic control of protein-surface interactions **8. Ganesan Narsimhan** – Characterisation of conformation of proteins/polypeptides immobilised at liquid-solid interfaces using molecular dynamics simulations **9. Kim Pickering** – Biologically Based Composites: Interfacial modification

Wednesday June 23	
Morning session 9:10 9:50 10:30 Morning Tea 11:00 11:40	***Chair – Charlene Mello*** **10. Conan Fee** – Poly(ethylene glycol)-grafted proteins: conformation, separation and analysis **11.Maan Alkaisi** – Patterns and biological cells **12. Hans Griesser** – Cell attachment to surface-grafted oligopeptides consisting of retro or inverso analogues of GRGDSP **13. Alison Downard** – Simple and versatile new methods for surface functionalisation and patterning
12:20–1:15 Lunch	***Excursion*** – delegate own cost – pick up from coppertop at 12:15
5:45–7:15 Dinner	Dinner – own arrangements
Evening Session 7:15 7:55	***Chair – Juliet Gerrard*** **14. Paul Calvert** – Printing bionic devices: electronic-biological hybrids **15. Tim Woodfield** – tba

Thursday June 24	
Morning session 9:10 9:50 10:30 Morning Tea 11:00 11:40	***Chair – Nick Abbott*** **16. Kristi Kiick** – Multivalent polypeptides in the organization of functional materials**19. David Thompson** – Novel Strategies for Packaging DNA Within Bioresponsive Carrier Systems **17. David Thompson** – Novel Strategies for Packaging DNA Within Bioresponsive Carrier Systems **18. Mehmet Sarikaya** – tba **19. Nick Abbot** – Self-Assembly of β-Peptide Oligomers
12:20–1:15 Lunch	Lunch, provided
Afternoon session 1:15 1:55 2:35 3:15 Afternoon Tea 3:45 4:25 5:05	***Chair – Conan Fee*** **20. Kate MacGrath** – Carbohydrate hydrogels: a basis for synthetic nacre **21. Anton Middelberg** – Stimuli-responsive peptide nanostructures at the fluid-fluid interface **22. Sankaran Thayumanavan** – New Stimuli Responsive Supramolecular Assemblies **23. Charlene Mello** – tba **24. Yi Yan Yang** – Self-Assembled Peptide Nanostructures as Drug Delivery Carriers and Antimicrobial Agents **25/26. Jen Becker and Trish Shaw** – Funding opportunities, ARL/ARO programmatic, opportunities for funding international collaborations.
Dinner	***Conference dinner*** – delegate own cost. Closing comments by Jen Becker and Charlene Mello