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Society of Electron Microscope Technology

SEMT
One Day Meeting

Wednesday 19th December 2012

at

UCL School of Pharmacy

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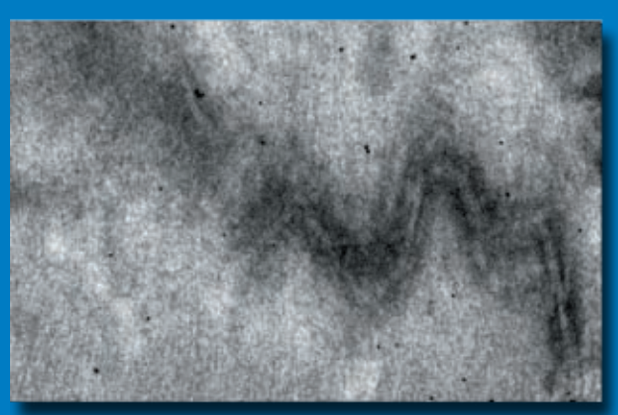
Future Programme
One day Meeting, 18th December 2013

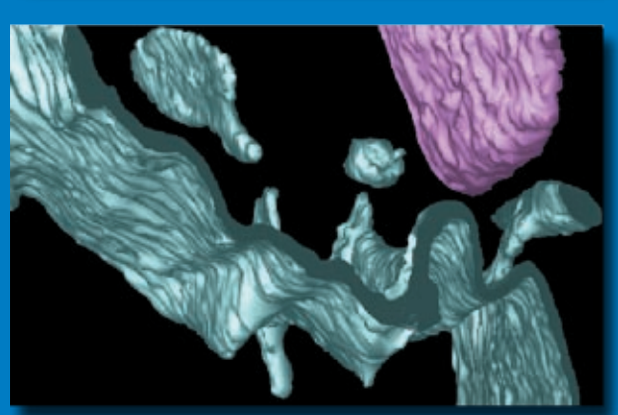
09.15	Registration, Tea/Coffee, Trade Exhibition
09.55	Introduction: Chair, Heather Davies.
10.00	**"The role of microscopy in development of pharmaceuticals"?** **Dr. Simon Gaisford - UCL School of Pharmacy.**
10.35	**"Serial Block Face SEM - 3D modeling of specimens".** **Hannah Armer – UCL Inst. Ophthalmology**
11.10	Tea, Coffee, Trade Exhibition.
11.30	"**A multi-tool approach to characterizing the effects of hypervelocity impact"** **Dr. Penny Wozniakiewicz – Kent Univ.**
12.05	The Don Claugher Bursary Winner (2011) "**Do periodontal pathogens contribute to synaptic changes preceding aging and cognitive decline"** **Dr. Sim Singharo – UCLAN**
12.15	***RMS Beginners Competition*** "***A nerve repair conduit containing differentiated adipose-derived stem cells within engineered neural tissue can support and guide neuronal growth in vitro and in vivo"*** ***Melanie Georgiou - Open University*** ***"The use and abuse of electron micro-beams on lunar apatite grains"*** ***Jessica Barnes - Open University*** **"*Pushing the nuclear envelope: investigation of nuclear invaginations using Confocal, Super-resolution and electron microscopy"*** ***Charlotte Melia – CRUK*** **"*Quantitative Imaging of Plasmid DNA in Human Airway Epithelial Cells Following Non-viral Gene Transfer using Electron and Confocal Microscopy"*** ***Charanjit Singh – Imperial College*** **"*New insights into the limbal epithelial stem cell niche revealed by high-resolution microscopy"*** ***Marc Dziasko - UCL Inst. Ophthalmology*** ***"Haemophilus influenzae induced cellular and ciliary changes in epithelial cells"*** ***Janna Collier – Southampton General Hospital***
13.05	Buffet Lunch, Trade Exhibition.
14.30	"**Using confocal and electron microscopy to study myxozoans, a bizarre group of parasitic animals"** **Dr. Alex Gruhl – NHM**
15.05	"**Eurobioimaging, Bioimaging UK, EM roadmap"** **Dr. Paul Verkade – Bristol University**
15.40	Tea, Coffee.
16.00	"**Development of Surgical Implants Using Nanotechnology and Stem Cells"** **Dr. Brian Cousins - Royal Free Hospital**
16.35	**"X-ray imaging on the Fly"** **Daniel Schwyn - University of Oxford**
17.10	AGM - Wine Reception – *Sponsored by Carl Zeiss Ltd.*
18.30	Conference Dinner

Society of Electron Microscope Technology

The Don Claugher Bursary

Funding up to £1000 for Electron Microscopy Projects





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The role of microscopy in the development of drug products

Simon Gaisford
UCL School of Pharmacy
s.gaisford@ucl.ac.uk

Modern medicines are often complex, highly engineered and heterogeneous 3-dimensional structures. Formulation of such intricate structures is much easier if at all stages during development it is possible to visualise how the materials have changed or are interacting. In addition, imaging crystal structures is often a rapid method to determine the physical form that has been created during processing. In this talk, the role that microscopy has played in the development of several formulations will be discussed, with case examples of;

- Ink-jet printing for isolation of crystal forms (Figure 1)
- Preparation of excipient-free inhalable particles (Figure 2)
- Development of personalised-dose oral films

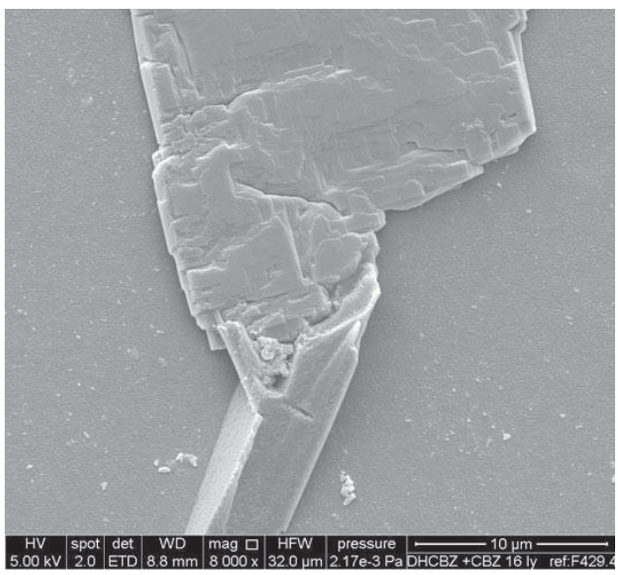


Figure 1: SEM image of carbamazepine form V grown on a dihydrocarbamazepine seed crystal by ink-jet printing

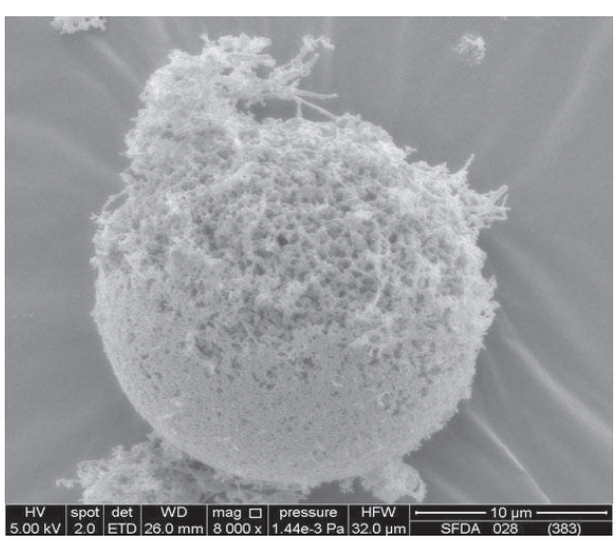
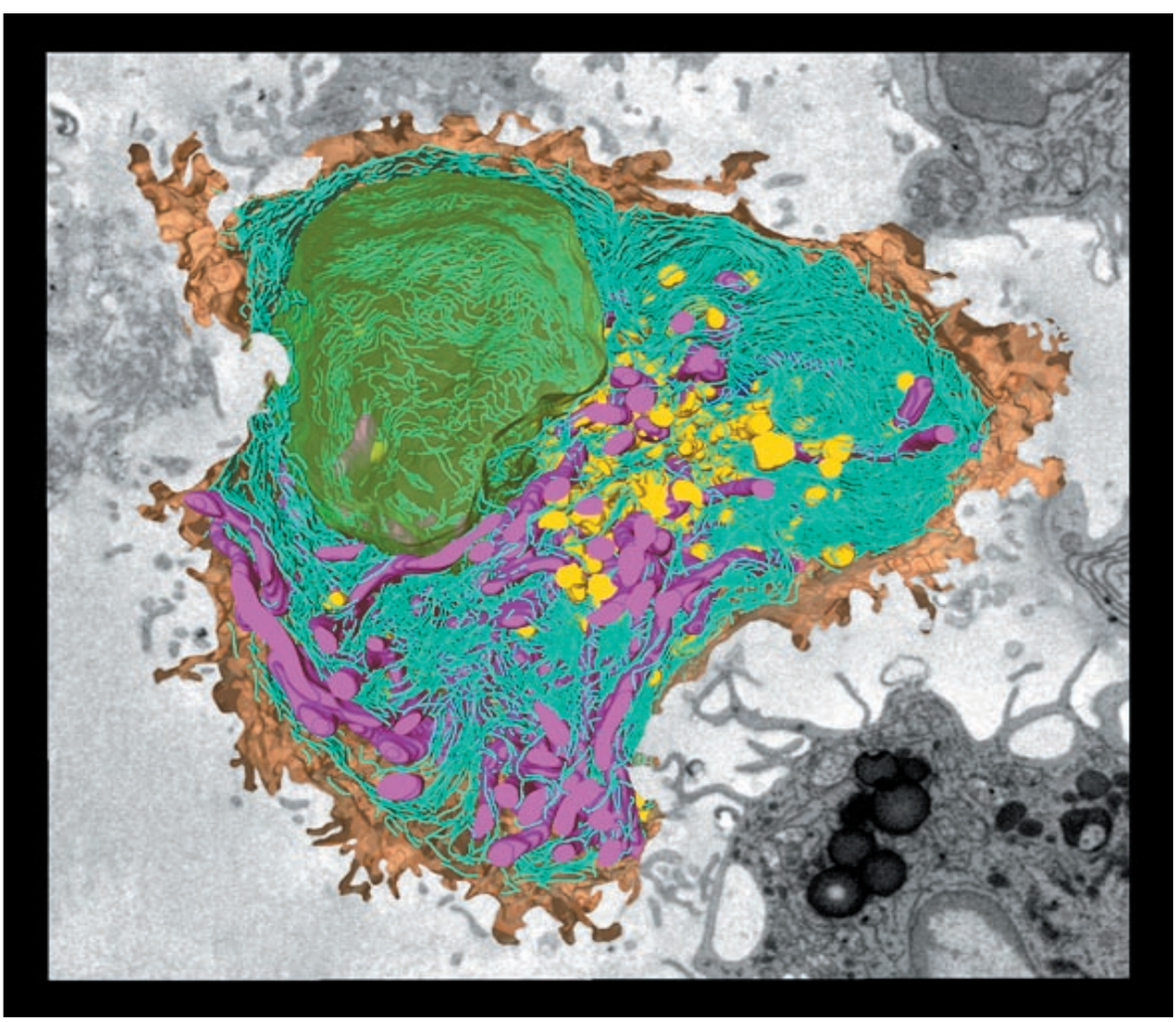


Figure 2: SEM image of an excipient-free particle of beclometasone dipropionate

Serial Blockface Scanning Electron Microscopy: 3D Modelling of Specimens.

H. Armer and P. Munro
Imaging Unit, UCL Institute of Ophthalmology

Serial blockface scanning electron microscopy (SBFSEM) provides a novel and automated alternative to the process of serial section transmission electron microscopy to obtain 3-Dimensional (3D) information from biological and material science specimens embedded in epoxy resins. With SBFSEM sections are discarded and the region of interest, on a freshly cut blockface, imaged using a low voltage backscatter electron detector within a variable pressure field emission scanning electron microscope. Repetitive cutting and imaging can build up a stack of ≥1000 axially registered xy images that can be orthosliced, edited or exported to 3D software packages for segmentation. By these means the 3D relationships within and between cells and structures can be elucidated in a time efficient manner. This presentation will review the technology, illustrate its potential and report on some challenges encountered with various specimens.



A snapshot from a 3D reconstruction created by extensive segmentation to highlight the various organelles of a cell grown in culture that has been imaged using SBFSEM

A multi-tool approach to characterizing the effects of hypervelocity impact

Dr Penelope Wozniakiewicz
School of Physical Sciences
University of Kent

In February 2004, NASA's Stardust spacecraft flew through the coma of comet 81P/Wild 2, capturing cometary grains as they impacted into the silica aerogel cells and aluminium (Al) foils of its collector. These samples, returned to Earth in 2006, represented an opportunity to study and significantly advance our understanding of these minor solar system bodies. They also had the potential to provide a wealth of information regarding the materials available and conditions and processes that operated in the early solar system since cometary materials are believed to have remained largely unaltered since their incorporation into these small icy bodies. However, having been captured at such high speed via impact, it was unknown what characteristics of the cometary samples would be preserved in, or could be interpreted from, the returned samples. In order to ensure correct interpretations of comet 81P/Wild 2 grain characteristics, an understanding of the effects of capture was required. Using a two-stage light gas gun, we have recreated Stardust encounter conditions and generated a series of impact analogues for a range of minerals of cometary relevance into flight spare Al foils.
Through a combination of whole-crater analyses by scanning electron microscopy and high-resolution analyses by transmission electron microscopy, we are exploring the processes that occur during capture and determining what and how impactor characteristics can be interpreted from the captured materials.

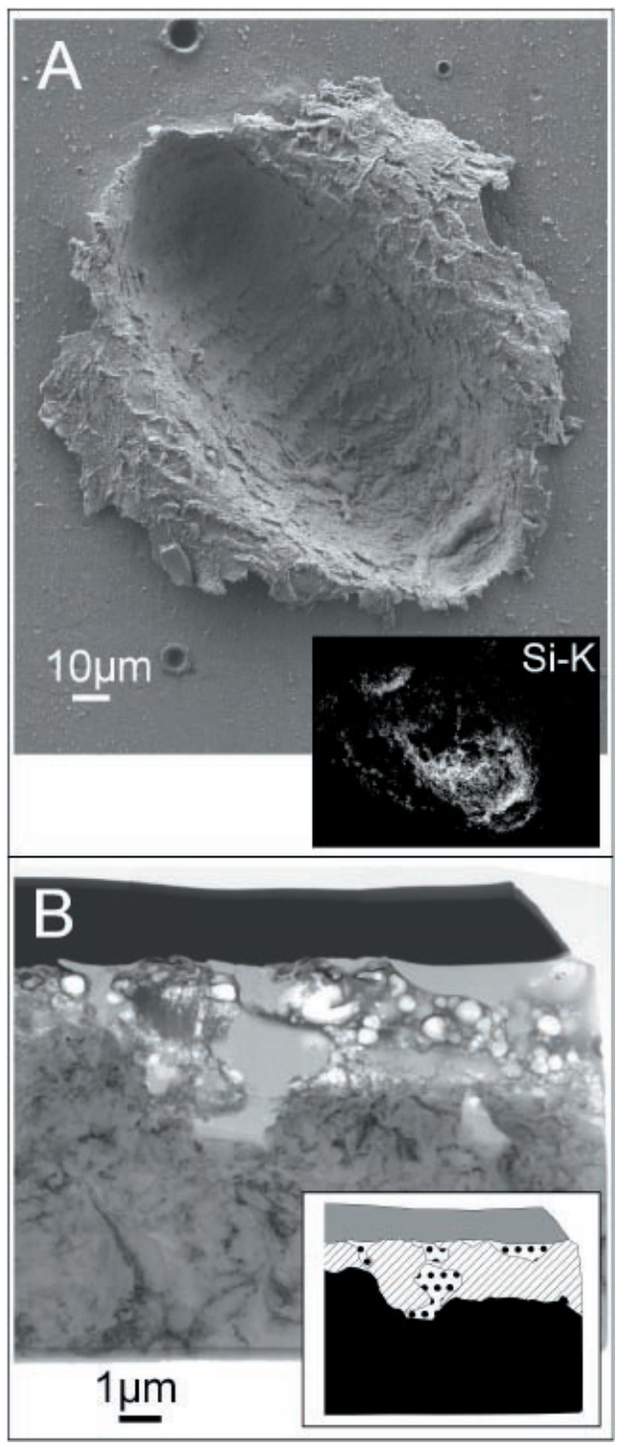


Fig. 1: A. *SEM SE image of a crater generated by a grain of wollastonite impacting Al foil. SEM imaging of craters can provide details of the impacting grain's morphology (e.g. grain size, density and structure) and impact angle. SEM EDX analyses can provide information regarding the location of residue (e.g. Si X-ray map of the crater inset) and the impactor's bulk chemistry.* ***B.*** *TEM section taken from an area of residue in a crater produced by a grain of lizardite impacting Al foil. TEM imaging and EDX analyses allow identification of the residue's composition and structure which can be used to interpret the original mineralogy of the impacting grain. Inset is a map highlighting the location of residue (striped) and target Al foil (black). Pt (grey) and resin (spotted) are remainders of sample preparation processes.*

The Don Claugher Bursary Winner

Is periodontal disease a risk factor for developing poor memory?

Dr S. K. Singhrao,
Oral & Dental Sciences Research Group,
School of Medical & Dental Education,
University of Central Lancashire

One of our research themes is devoted to the focal infection theory of Willoughby Miller-William Hunter from the late 1891 to early 1900's. The Human Mouth as a focus of Infection theory states that oral microbial infections contribute to the developing pathologies of distant body organs some of which may result in a specific disease such as dementia. The link being the systemic circulation whereby oral pathogens infiltrate into the vascular channels and become a potential source of infection in the brain as well as anywhere else in the body.
The Miller-Hunter hypothesis therefore, suggests a possible cause and effect relationship in conditions of unknown aetiology such as Alzheimer's disease. So far, we have analysed a total of 10 Alzheimer's disease brains and 5 brains from age matched controls (Brains for Dementia Research) which even from this small sample size have shown that 40% of the diseased brains contained lipopolysaccharide (LPS, a component of the outer membrane wall of bacteria), from the chronic gram negative periodontal pathogen Porphyromonas gingivalis. Although we are still engaged in evaluating the relevance of finding virulence factors from periodontal pathogen(s) in Alzheimer's disease brains, there is little doubt that LPS is the principal initiator of host innate immune responses. It is therefore, likely that during life, there is potential for this pathogen to initiate inflammation in the Alzheimer's disease brain. Since dental records are not usually available from the brain data bank and Alzheimer's disease being a very complicated disorder, we are exploring the possibility of specific oral pathogens having influence over normal functioning of the brain using experimental animal models with periodontitis. These brain specimens were obtained by established international collaboration with Professor L. Kesavalu (Department of Periodontology, College of Dentistry, and University of Florida, USA) who is a specialist in generating periodontal disease animal models. So far the results from animal brain tissue sections with established periodontal disease are both encouraging and appear to support cellular morphological changes that are reported for human Alzheimer's disease. These features are suggestive of synaptic alterations although we have been unable to clearly demonstrate if there are differences in the levels of synaptophysin (a marker for synaptic vesicles) present in the infected and control animal brain specimens.

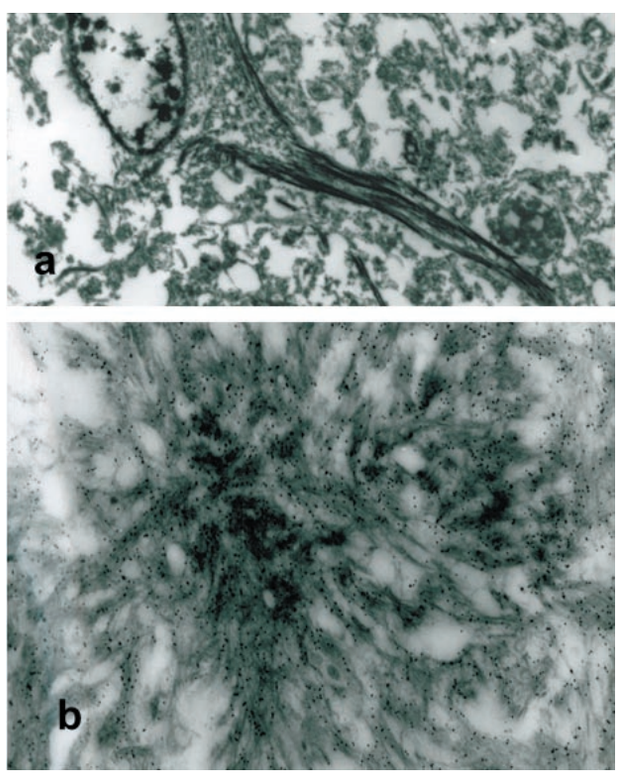


Figure 1 Tissue from a human Alzheimer's disease brain (c/o Brains for Dementia Research). The sections were embedded in LR White resin, and examined in the CM12 Philips TEM.

a) shows the intra neuronal tau positive neurofibrillary tangles.
b) the amyloid beta plaque immunogold labelled (20nm) using anti-amyloid beta antibody.

A nerve repair conduit containing differentiated adipose-derived stem cells within engineered neural tissue can support and guide neuronal growth in vitro and in vivo

1.

Melanie Georgiou
Paul Kingham, Jon Golding, Jane Loughlin and James PhillipsThe Open University

There is a clear unmet need for the repair of injured peripheral nerves with a long gap defect (more than 4cm in length). The current clinical 'gold standard' is to use an autograft which causes donor site morbidity, has limited availability and often leads to poor functional outcome. Tissue-engineered cellular bridging devices for surgical implantation into peripheral nerve injury sites could provide an attractive alternative to autografts. A patient's own adipose tissue can be used as a source of cells that provide the trophic support and pro-regenerative behaviour elicited by Schwann cells in an autograft. Adipose-derived stem cells can be differentiated towards a Schwann cell-like phenotype in vitro (dADSC). Here we report the development of a living replacement tissue using these therapeutically relevant cells within a collagen matrix. This Engineered Neural Tissue (ENT) is made by tethering a cellular collagen gel at each end to permit the cells to self-align; this aligned cellular construct is then subjected to a compression process to produce a stable biomaterial. Our results show that dADSCs can be successfully incorporated within ENT. The dADSCs survive and maintain their alignment following the stabilisation process to form sheets of an aligned cellular biomaterial (ENT). Primary rat neurons growing on the surface of ENT extended neurites that were guided by the orientation of the aligned dADSCs. These sheets of ENT were rolled into columns and then packed together within a clinically approved tube, NeuraWrapTM. Testing this ENT in the rat sciatic nerve model followed by quantitative confocal and electron microscopy showed that neuronal growth was supported and guided by ENT. This demonstrates the potential of the device to offer an alternative to nerve autografts.

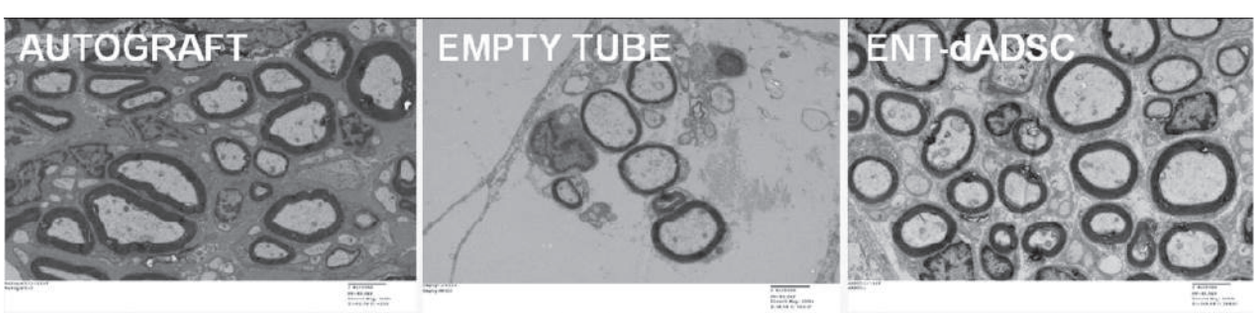


Figure 1: Electron micrographs showing myelinated and unmyelinated axons in the mid-point of devices used to bridge a 15mm gap in the rat sciatic nerve for 8 weeks *in vivo*

RMS Beginner's Competition

The use and abuse of electron beams on apatite grains in Apollo samples.

2.

J. J. Barnes[1,2], R. Tartese[1], M. Anand[1,2], N. A. Starkey[1], I. A. Franchi[1], S. P. Schwenzer[1], A.Tindle[1], D. Johnson[1] and Y. Sano[3]. [1]Planetary and Space Sciences, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK. [2]The Natural History Museum, Cromwell Road, London, SW7 5BD, UK. [3]Atmosphere and Ocean research institute, The University of Tokyo, 5-1-5, Kashiwanoha, Kashiwa-shi, Chiba, 277-8564, Japan. Email: jessica.barnes@open.ac.uk

The initial studies of Apollo rock samples con-cluded that the Moon was an anhydrous planetary body [1]. Recently there has been a change of opinion with several research groups detecting variable amounts of H2O in lunar mare glass beads [2], melt inclusions [3] and hydroxyl in lu-nar apatites [4-9]. The maximum amount of hy-droxyl detected thus far has been from mare basalt 12039 with 12,000 ppm OH [10].

Apatite grains are the most commonly occur-ring hydrous minerals in lunar samples, and are typically located within Apollo thin sections by X-Ray mapping with a secondary electron micro-scope (SEM). These minerals are identified based on their elevated concentrations of phosphorous and calcium (Fig. 1). Energy dispersive spectros-copy (EDS) is then employed to tell apart apatite and merrlite the latter of which is anhydrous. However there has been discussion in the litera-ture of the potential migration of volatile species (F, Cl, OH) within grains and possible dehydro-genation (loss of H) of apatite grains after expo-sure to an electron beam, those typically em-ployed for electron probe microanalysis (EPMA) [11-14].

Apollo thin sections have been available for study since the late 1960s and have seen poten-tial exposure to EMP beams through elemental mapping. As we routinely use coupled SEM-EDS to locate apatite grains within Apollo thin sections prior to analysis by secondary ion mass spec-trometry (SIMS), we designed several experi-ments to test the effects, if any, of using the electron beams of the SEM and EMP on apatites.

Our results show that the SEM conditions typi-cally used to map Apollo thin sections do not change the D/H ratio or OH content of the apatite. Hence we believe that the electron beam conditions we typically employ for elemental mapping using the SEM are suitable for the Apollo thin sections and will not compromise our isotopic data.

However in the case of the 20 nA beam condi-tions (typically used for EMP analyses) we see marked change in the OH content of the grain. It remains unclear if this is due to the excitation and removal of F and Cl during analysis and the sub-sequent migration of OH into vacancies from elsewhere in the sample. Another possibility is the introduction of atmospheric OH. To test the latter hypothesis we are currently working on an exper-iment to test the same effects in an Apollo basalt sample, within which the possibility of terrestrial contamination should be obvious.

What is clear is that the use of typical analyti-cal EMP conditons (20 nA, 20.0 kV) may signifi-cantly compromise the OH concentrations ob-tained for apatites. It is important therefore to know the analytical history of selected samples and to avoid those which have been exposed to EMP mapping.

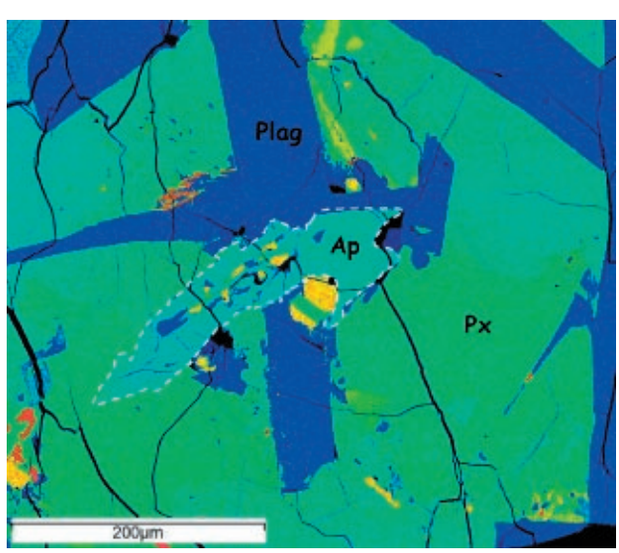


Fig 1. False-colour backscatter image of an apatite (Ap) crystal within Apollo basalt sample 10044. (Px – pyroxene, Plag – plagioclase).

"Pushing the nuclear envelope: investigation of nuclear invaginations using confocal, super-resolution and electron microscopy"

3.

Charlotte Melia
London Research Institute
Cancer Research UK

The characterisation of the nuclear envelope is essential for a complete understanding of how its protein and lipid composition relates to its functions. In sea urchin cell-free assays, investigation of nuclear envelope remnants, a sub-domain of the sperm pro-nucleus, has demonstrated how lipid and phospholipid composition can vary across the nuclear envelope. This discovery has interesting implications for somatic cells, and particularly for nuclear invaginations; projections of membrane into the nuclear envelope that have been observed in both normal and cancerous cells. Through studying mammalian nuclei at interphase and mitosis, the morphology, structure and composition of these nuclear invaginations has been investigated.
Given the inherent limitations of any single imaging technique, characterisation of cellular features requires multiple modes of analysis. In this study, fluorescent protein and lipid probes were used in combination with confocal and Structured Illumination Microscopy imaging. In addition to the endoplasmic reticulum and nuclear envelope, these probes localised to nuclear invaginations. Correlative light and electron microscopy was used to illustrate the ultrastructure of these invaginations, revealing a double-membrane morphology continuous with the nuclear envelope. In addition to increasing our understanding of this intriguing nuclear structure, this study highlights the relative strengths of the different imaging techniques used and suggests useful alternatives and developments.

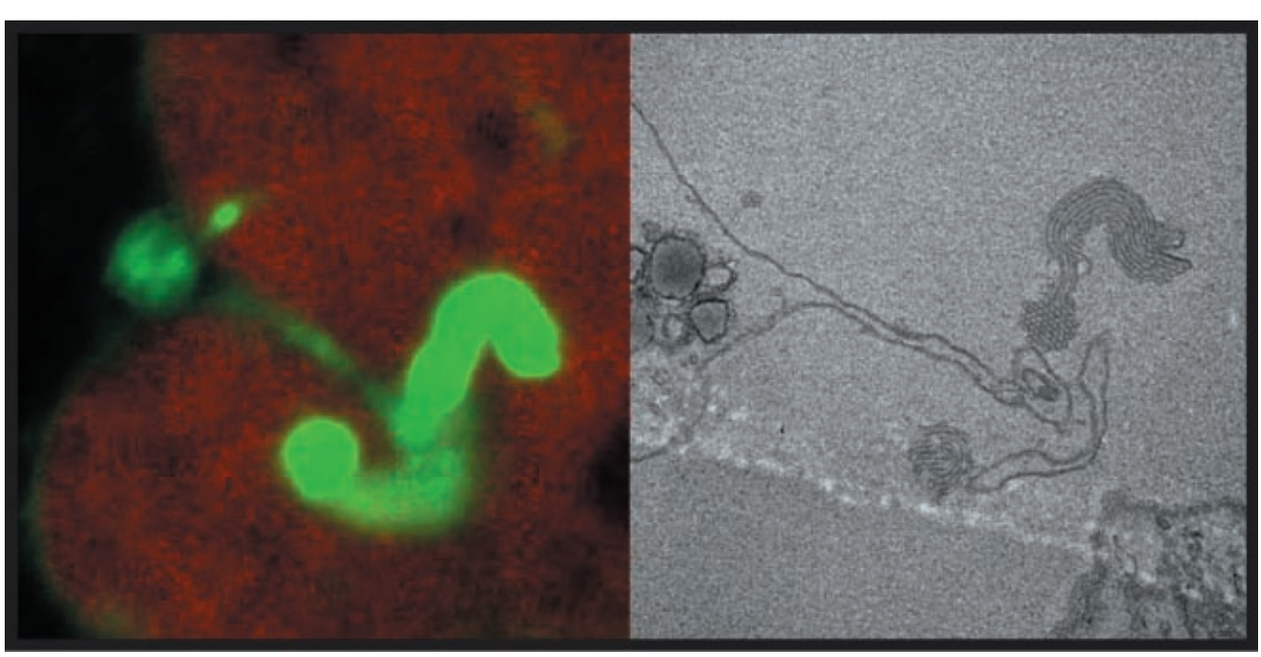


Figure 1 Correlative light and electron images from within a COS-7 cell nucleus. Green fluorescence (GFP-C1) relates to the presence of diacylglycerol, and red fluorescence (mCherry-H2B) is localised to chromatin. The regions of dense green fluorescence and corresponding tubular structures seen in the electron micrograph represent an aberrant phenotype induced by GFP-C1 overexpression.

RMS Beginner's Competition

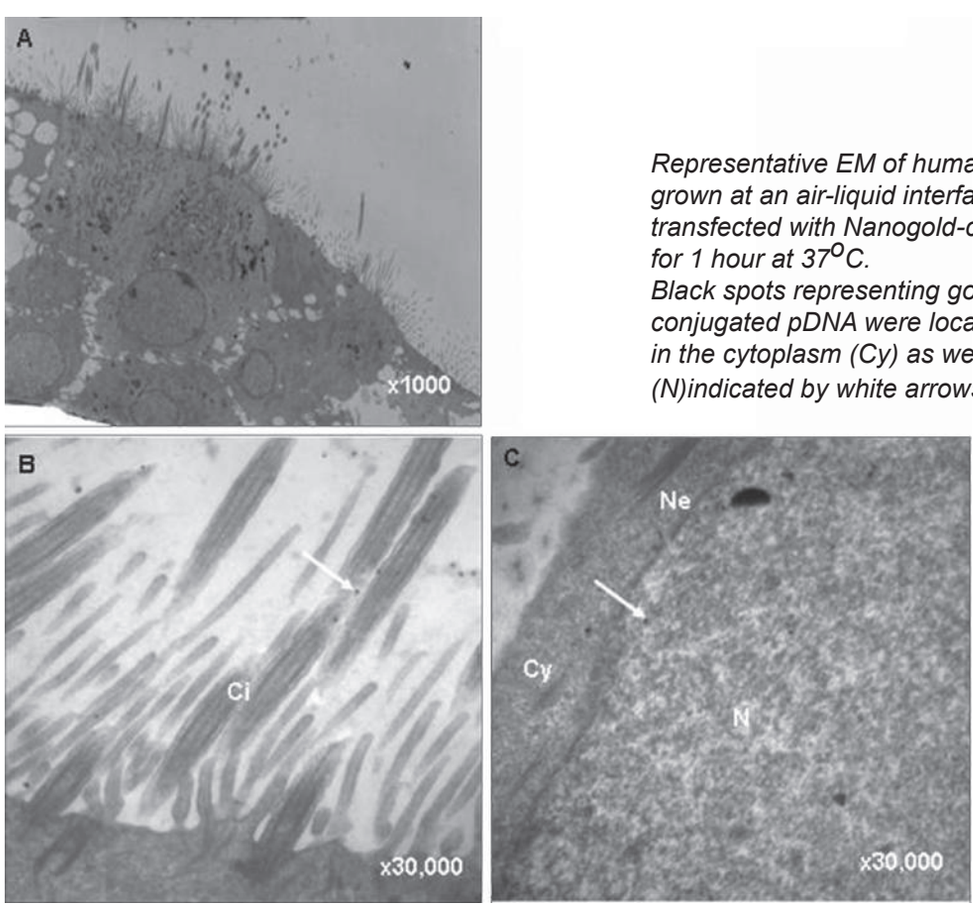
Quantitative Imaging of Plasmid DNA in Human Airway Epithelial Cells Following Non-viral Gene Transfer using Electron and Confocal Microscopy

4.

Singh, C[1,2]; Munkonge, FM[1,2]; Smith, SN[1,2]; Griesenbach, U[1,2]; Carzaniga, R[3]; Pape, T[3]; Cheng, S[4]; Rogers, A[5]; Dewar, A[5]; Alton, E.W[1,2]

[1]. Gene Therapy, Imperial College, London, United, Kingdom; [2]. The UKCF Consortium, London, United Kingdom;
[3]. Electron Microscopy Centre-SK Campus, Imperial College, London, United Kingdom;
[4]. Genzyme Corporation, Framingham, MA, USA; [5]. Electron Microscopy Unit, Royal Brompton Hospital, London, United Kingdom

The UK CF Gene Therapy Consortium is interested in non-viral gene therapy for cystic fibrosis (CF). To provide insight into the intracellular bottlenecks plasmid DNA (pDNA) encounters on its way to the nuclei of airway epithelial cells, we sought to quantitatively describe the intracellular fate of non-virally transferred pDNA using a clinically relevant human airway epithelial cell air-liquid-interface (ALI) model. Plasmid DNA was tagged with nanogold particles or fluorescent quantum dots (Qdots) for use in transmission electron microscopy (TEM) or confocal microscopy studies, respectively. Conjugation of pDNA with either nanogold or QDots did not affect the biological activity. The number of cells showing cytoplasmicaly localised nanogold-conjugated pDNA increased with increasing transfection time. Interestingly, there was an equal distribution of pDNA in cytoplasm and nuclei of cells transfected for 60 minutes. In the parallel confocal study, QDot-pDNA was visible in nuclei, consistent with the earlier observations. In conclusion, the results from the TEM and confocal studies showed good agreement for the numbers of nuclei containing pDNA at early transfection times (15, 30 and 60 minutes). These data, in a clinically relevant model, should help focus efforts on increasing gene transfer efficiency.



Representative EM of human airway epithelial cells grown at an air-liquid interface (ALI) transfected with Nanogold-conjugated plasmid DNA for 1 hour at 37^{o}C.
Black spots representing gold-enhanced nanogold-conjugated pDNA were localised on the Cilia (Ci), in the cytoplasm (Cy) as well as in the nucleus (N)indicated by white arrows.

New insights into the limbal epithelial stem cell niche revealed by high-resolution microscopy.

5.

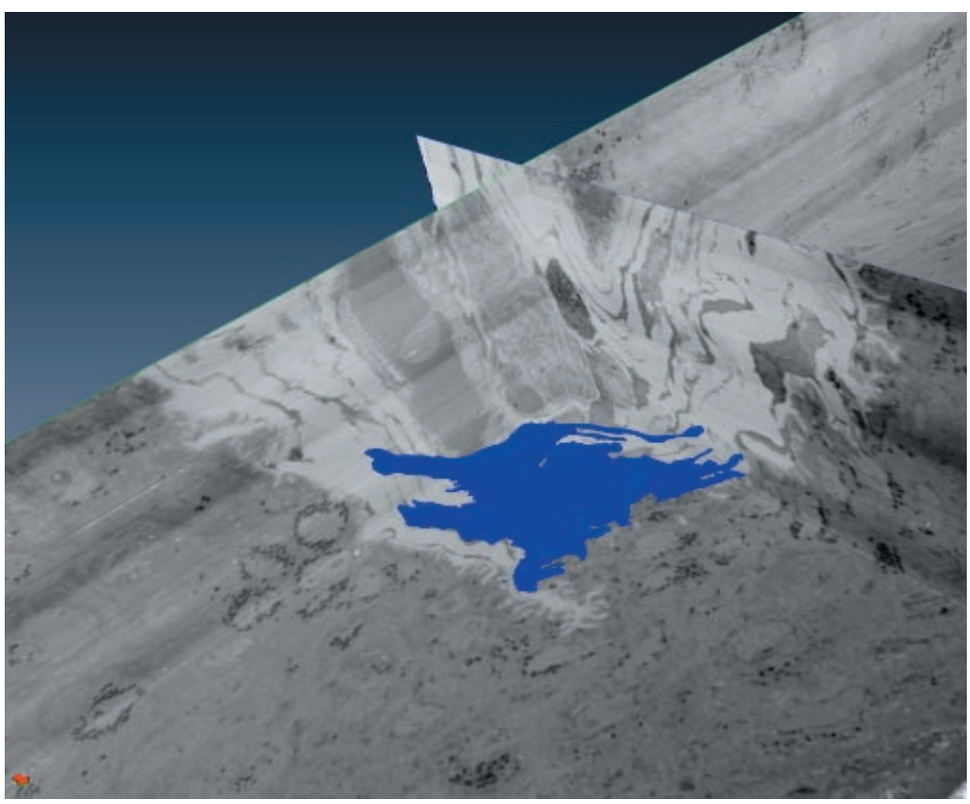
M. Dziasko[1], H.Armer[2], H.Levis[1], S.Tuft[3], J.T Daniels[1,3]
[1]Ocular Biology and Therapeutics Division, [2]Imaging Unit, UCL Institute of Ophthalmology, Bath Street, London, EC1V 9EL, UK
[3]Moorfields Eye Hospital NHS Foundation Trust, 162 City Road, London, EC1V 2PD, UK

Purpose: Maintenance of the ocular surface by limbal epithelial stem cells (LESCs) is essential to preserve the corneal transparency required for vision. Recently our group has identified within the limbus (the transition zone between the central cornea and the conjunctiva) a candidate for the LESC niche: the limbal crypts (LCs). The aim of this study was to demonstrate that the LCs are the reservoir for LESCs but also to identify the putative crosstalk between LESCs and stromal cells taking place in this specific area.

Methods: In vitro clonal analysis was performed to assess the growth potential of LC epithelial cells in comparison to epithelial cells from non-crypt rich areas isolated from human corneal-scleral rims. Transmission electron microscopy followed by serial block face SEM, manual segmentation and 3D reconstruction were used to image and characterize putative LESCs within their niche.

Results: LC epithelial cells were able to generate holoclones in vitro demonstrating their high growth potential and stem cell characteristics. Imaging LCs by transmission electron microscopy revealed a small size and poorly differentiated "stem-like" cell population closely associated with the underlying stromal fibroblast-like cells, suggesting a possible cell-cell interaction. These observations were confirmed by serial block face SEM that highlighted, for the first time, a direct contact between putative LESCs and the surrounding stromal fibroblast-like cells.

Conclusion: These observations directly support the emerging concept that cellular crosstalk maintains cell stemness at the corneal limbus as seen in other epithelial stem cell niches.



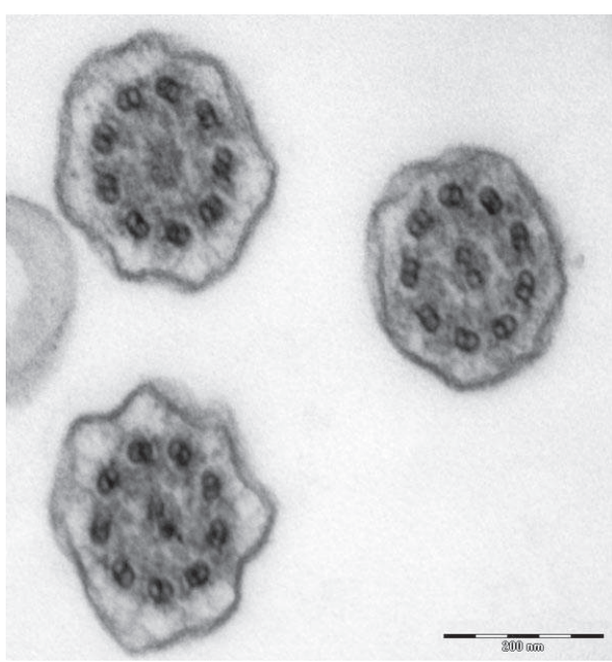
Haemophilus influenzae induced cellular and ciliary changes in epithelial cells

6.

Janna Collier
Biomedical Imaging Unit
General Hospital, Southampton

Primary Ciliary Dyskinesia (PCD) is a rare autosomal recessive hereditary disorder caused by genetic mutations in the ciliary axoneme. Diagnosis of PCD is made using a combination of clinical history, phenotype and laboratory tests conducted at specialist centres. Electron microscopy is used to diagnose ultrastructural defects of the cilia. However, secondary changes, caused by bacterial infection and environmental factors, can be misinterpreted as primary defects. Haemophilus influenzae is the most common pathogen found in the sputum of paediatric PCD patients. Studies show that this organism adheres to damaged areas of the epithelium as well as releasing a factor(s) which can slow or stop ciliary beating. This can lead to a build-up of mucus and a suitable environment for further bacterial growth.
Secondary ciliary ultrastructural changes are widely accepted as a result of recurrent infection or injury to the respiratory epithelium. The distinction between primary and secondary defects is sometimes difficult to make using current methods of high-speed video microscopy and electron microscopy. Previous studies have shown that bacterial infection causes ciliary dyskinesia and that defects occur in the axoneme after infection or exposure to environmental factors, however, the precise correlation between pathogenic cellular changes and ciliary ultrastructure has not been fully investigated.

By simulating a respiratory infection in epithelial cells using Haemophilus influenzae the extent of cellular damage and ciliary defects can be determined using validated diagnostic methods. The extent of cellular damage will be assessed quantitatively and directly correlated with the number of ciliary defects present. Characterisation of the outcome of a Haemophilus influenzae infection will facilitate a better understanding of secondary defects, providing a more secure diagnosis, leading to better patient outcomes and reduced costs.



Electron micrograph of cilia showing normal and abnormal ultrastructure

Using confocal and electron microscopy to study myxozoans, a bizarre group of parasitic animals

Dr. Alexander Gruhl
Department of Life Sciences
Natural History Museum

Myxozoans are small endoparasitic organisms with a complex life cycle that involves alternation between aquatic invertebrate primary hosts, mostly annelid worms or freshwater bryozoans, and vertebrate secondary hosts, mostly teleost fishes. Because myxozoans are morphologically extremely simple, lacking even basic animal features like gametes, gonads, intestinal tract, and nervous system, their position in the tree of life has long remained elusive. Although initially regarded as protists we now have good evidence that myxozoans belong to the Cnidaria, an animal group that includes jellies, corals and hydras, and must have undergone remarkable modifications in the course of the evolution towards endoparasitism.
In this talk I will give examples of the application of SEM, TEM, CLSM as well as combinations of these approaches to investigate morphological and cytological details in myxozoans.

I will focus especially on the architecture of the so-called polar capsules, myxozoan-specific cell organells that are likely to be modifications of cnidarian stinging capsules (nematocysts) and on the development and morphology of Buddenbrockia plumatellae, an unusual myxozoan that shows a worm-like habitus.

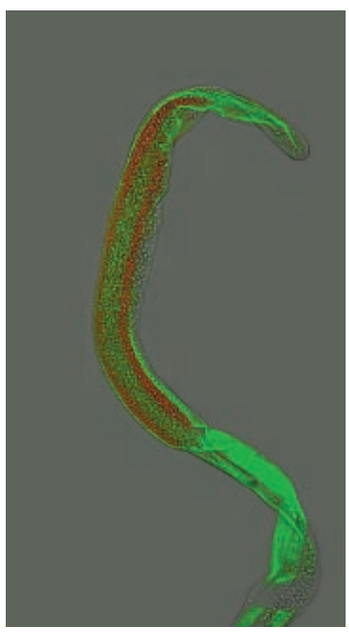


Figure 1: Buddenbrockia plumatellae worm, nuclear (red) and f-actin staining (green)

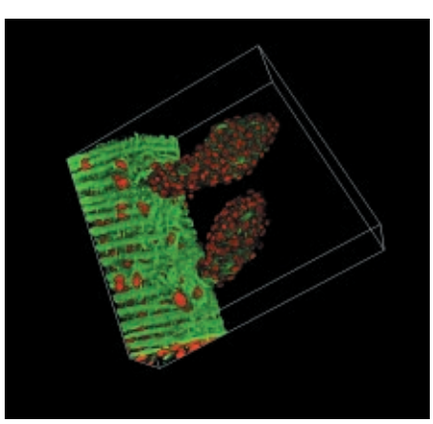


Figure 2: Developing Buddenbrockia worm attached to the gut of a bryzoan host, 3D volume

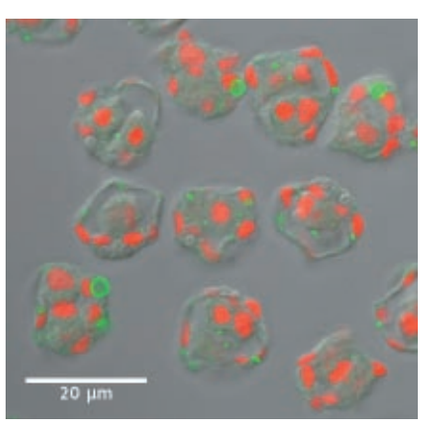


Figure 3: Myxozoan spores with polar capsules labeled (green)

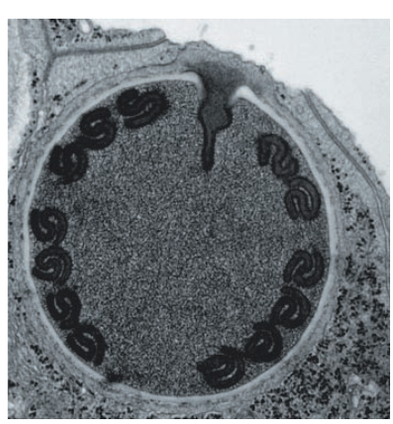


Figure 4: TEM micrograph of Buddenbrockia polar capsule (photograph by Alan Curry, Univ. Manchester)

Eurobioimaging, Bioimaging UK, EM roadmap.

Paul Verkade
Wolfson Bioimaging Facility
University of Bristol

These may be terms that are still relatively unfamiliar but they may become more important in determining how the future EM community is going to be funded.
I will give an introduction into the different projects and present the current status of some of them and in addition there will be time to discuss the strategy that the EM community (YOU!) should follow to ensure a solid base of funding for now and the future of EM.

Useful links:

- http://www.eurobioimaging.eu/
- http://www.bioimaginguk.org/index.php/Main_Page
- http://www.bioimaginguk.org/images/4/4b/EM_Roadmap_011012.pdf

Development of Surgical Implants Using Nanotechnology and Stem Cells

Brian G. Cousins[1], Achala de Mel[1], Arnold Darbyshire[1] & Alexander M. Seifalian[1,2]
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[2]Royal Free Hampstead NHS Trust Hospital, London, NW3 2QG.

There is increasing demand for synthetic materials that resist thrombosis for surgical implants and artificial organs for regenerative medicine. The application of nanotechnology, nanocomposite materials and stem cells are a new generation of tools used in the development of human organs. Their research and development is based on a multidisciplinary team approach from basic science to clinical application.

We have developed a family of nanocomposite materials (POSS-PCU) in the development of cardiovascular implants and artificial organs using stem cells to enhance organ function. In this talk, we address the manufacture of nanocomposite materials for cardiovascular implant design such as bypass grafts (fig 1), as well as other organs using the above materials. These include the transplantation of the world's first synthetic trachea using the patient's own stem cells, lower limb bypass graft, which will go to clinical trial in 2013, and the use of lacrimal duct conduits. In addition, several projects are undergoing pre-clinical trials, which include heart valves, coronary artery stent coatings, dermal skin scaffolds and nerve conduits. We also highlight the translation of this technology from the laboratory to the clinic.

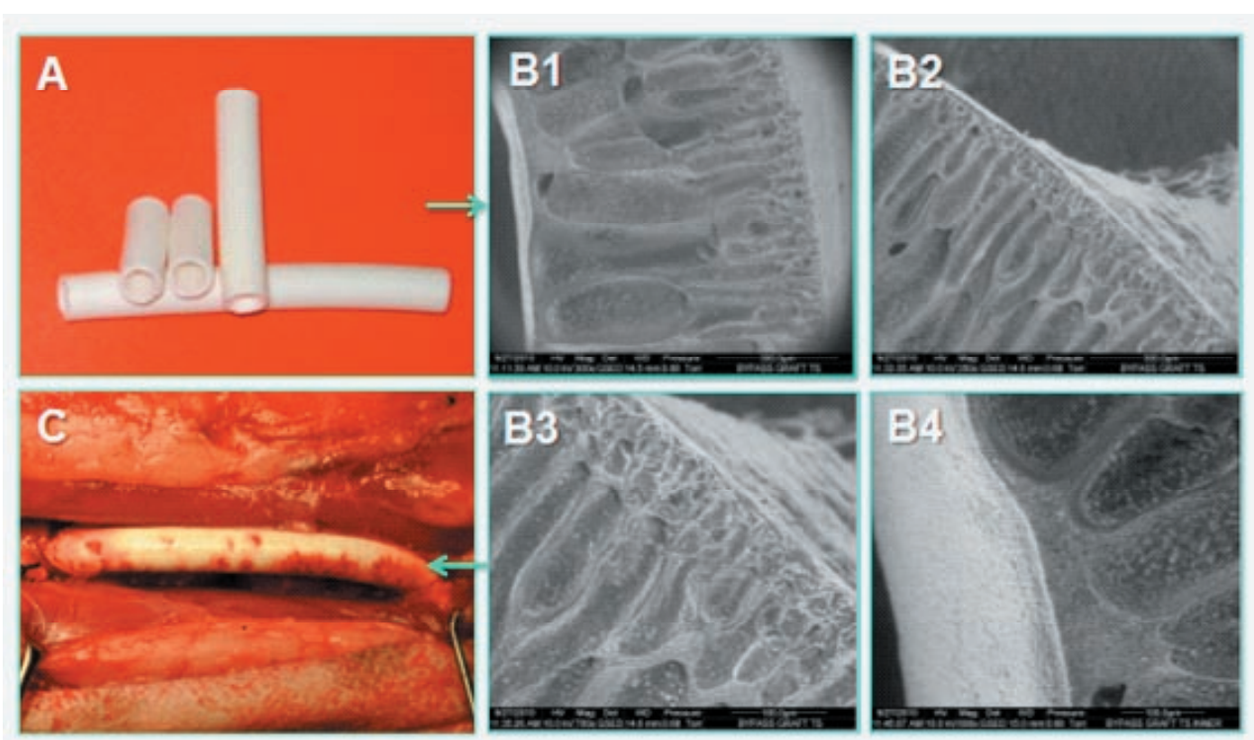

Fig 1. (A) Digital image showing the development of bypass grafts using nanocomposite materials. (B1-4) Highlights environmental scanning electron microscopy (ESEM) cross-sectional images, and (C) represents the implantation of the graft sutured in to the carotid artery following a large animal study under GMP/GLP guidelines.

X-ray Imaging on the Fly

Daniel Schwyn
Department of Zoology,
University of Oxford

X-rays provide an imaging probe complementary to electrons that allows for transmission imaging of both fixed and live specimens. Computed x-ray microtomography (micro-CT) enables the three-dimensional reconstruction and virtual dissection of small animals, and thus supports a variety of research fields ranging from taxonomy to biomechanics. Exceedingly fast acquisition speeds offer the potential to increase throughput and to perform time-resolved studies.

In collaboration with the Natural History Museum London, we performed iodine-enhanced micro-CT scans of ethanol-fixed insects and studied the trade-off between throughput and image quality. Together with the Swiss Light Source and the Department of Bioengineering, Imperial College London, we exploited the high coherence and flux of synchrotron-generated x-rays to perform 2D and 3D imaging of insects at high speeds. In this presentation I will provide a short introduction to microtomography using laboratory-based CT systems, and dedicated synchrotron beamlines. I will compare our results from both facilities and discuss our current work involving fast in situ and in vivo imaging of flying insects.

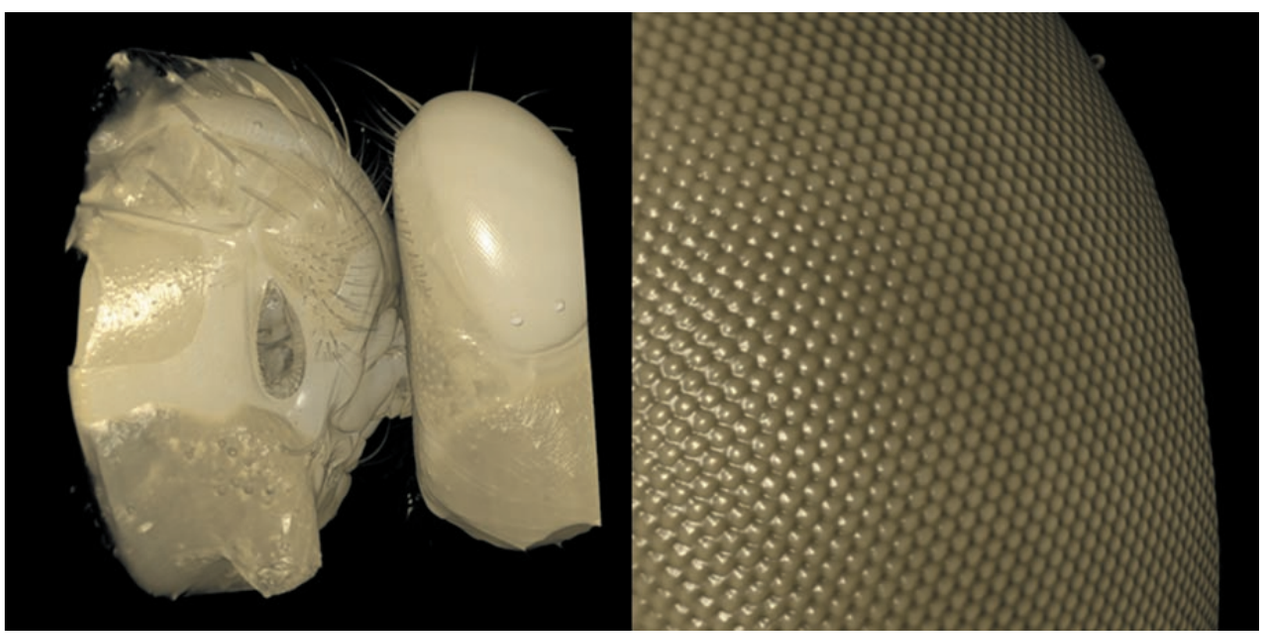

Figure: Renderings of the head-neck system and the compound eye surface of a female blowfly based on a scan of 150 seconds duration at the TOMCAT beamline of the Swiss Light Source.

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