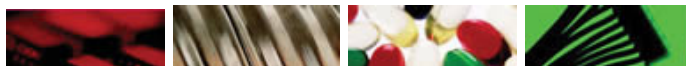


EuroNanoForum 2005



Session Descriptions

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NanoMedicine: The Bigger Picture

Future techniques in medical diagnosis and treatment have often been the subject of science fiction literature and cinema. The approaches are surprisingly consistent. In Star Trek, for example, the diagnosis of illness and its treatment is generally non-invasive and mostly painless. In 'The Six Million Dollar Man', an individual who has undergone serious accidental damage is given replacement organs and tissues that function as well, or even better than the originals.

What was once the stuff of science fiction is now closer to becoming a reality. Nature operates at the nanoscale, and today we are acquiring an increasingly profound understanding of natural processes at this scale, enabled by a new generation of scientific instruments. From this knowledge, we are able to design devices that can either directly interact with, or influence, the behaviour of living cells.

Nanotechnology has a trump card to play when applied to medicine. At the nanometre scale, materials often exhibit surprisingly different physical, chemical, and biological properties when compared with the same material in bulk form. The properties of nanoparticles, such as increased chemical activity and the ability to cross tissue barriers, are leading to new drug targeting and delivery techniques. In the future, it is within the realms of possibility that a nanoparticle may be designed to search for, find and destroy a single diseased cell, taking us even closer to realising the ultimate goal of disease prevention.

Nanotechnology is also making possible other techniques, such as the stimulation of the body's own mechanisms to successfully repair diseased or damaged tissues, replacing the need for transplants and artificial organs. In the foreseeable future, allied to advances in information and communication technologies, nanotechnology as applied to medicine, will lead to advances in remote monitoring and care, where a patient may be treated at home - a less expensive option, and one that is more conducive to a successful medical outcome than treatment in a surgery or hospital.

Continued research into disease processes at the molecular level is essential for the development of nanomedicine, and involves teams of scientists from across 'conventional' disciplines, such as physics, chemistry, surgery and mathematics, as well as those from the 'new' fields of genomics, proteomics, metabolomics, pharmacokinetic modelling and even microscope design. Challenges exist in training and managing these multidisciplinary teams and partnerships, and importantly, in finding new solutions to the intellectual property issues that presently hinder the speedy commercialization of new knowledge.

Research challenges also relate to understanding and modelling the toxicity of engineered nanoparticles, and requires that toxicologists work alongside medical scientists wherever nanoparticles are involved in drug targeting and contrast agent development.

There are technological challenges, too, in the areas of molecular manufacturing, quality assurance and the eventual programmability of nanodevices. Nanomedicine will also bring its own set of new legal and ethical challenges to be resolved.

Cost benefit analyses are also critical. Where money can be best invested for the greatest social and economic benefit needs to be carefully decided. Should investment be made in prevention or treatment; in diseases of the poor or the rich; in long term hospitalization or costly drug development and deployment? Any strategy for nanomedicine must also be influenced by the facts that resources are finite and demands are great. Within these constraints the health needs of an ageing population need to be managed, cures found for major lifestyle 'killer' diseases, such as cancer, and for the diseases of the less-developed world, such as HIV / aids, malaria and tuberculosis.

In conclusion, nanoscience and nanotechnology are leading to extraordinary new breakthroughs in medicine that were once the stuff of dreams. EuroNanoForum aims to provide a small but representative snapshot of these exciting opportunities.

Tissue Engineering, Nanoscaffolds, and Interfaces

Session 2A Day 2: 14.00-17.30

What is this session about?

Science is moving from transplanted organs to implanting of substitute or artificial organs to stimulating the body to do its own repairs. Tissue regeneration is about enabling the body to ultimately regenerate its own diseased or failed organs. The market worldwide for tissue engineered products already worth \$18bn, and many hundreds of thousands of people are awaiting transplants worldwide. This has led to an illegal market in donor organs from the poor to the rich, so the development of effective regeneration techniques offers a multitude of benefits.

So how does tissue regeneration work?

Instead of being surgically repaired, transplanted, or even fixed using prosthetics, tissue or organ failure could be solved by **implanting natural tissue** and **organ mimics** which can be fully functional from the start, or grow into the required functionality. Nanotechnology helps to **recruit the body's natural healthy cells** to promote the **regeneration** of tissue on or around a damaged area. It can also act as a 'scaffold' to provide a framework for developing tissues to latch onto and penetrate.



This application of nanotechnology will result in reconstructed tissue and wound treatments that are **superior**, longer lasting and more acceptable to everyone involved, most notably the patient.

The beauty of the process is that it is arguably the **most natural way of healing**, as it is the body's own healthy cells which are regenerating - as they were meant to do - albeit with a small push to get started.

Tissue regeneration would be almost unthinkable without development in nanoscience and nanotechnology. It underpins the design of scaffolds on which the cells are grown, which are composed of special nanocomposite materials that contains cell growth stimulants, and have nanoscale, cell-friendly surface topographies. There is even the potential for **whole organs to be grown** to replace those that have failed through disease or old age.

Tissue regeneration offers a revolution in healthcare, with huge benefits for doctors who will be using the technology, to the government who will save money, and most importantly to the patients who are the ultimate beneficiaries.

<u>Time</u>	<u>Title</u>	<u>Speaker</u>
14.00-14.15	Nanotechnology in Regenerative Medicine: An Industrial Perspective	<i>Dr Alessandra Pavesio</i>
14.20-14.35	Reconstruction of Human Corneas by Tissue Engineering	<i>Dr David J S Hulmes</i>
14.40-14.55	Gentle Handling of Individual and Groups of Animal and Human Cells	<i>Dr Guenter Fuhr</i>
15.00-15.20	Discussion	
15.50-16.05	Tissue Engineering, A Lead User Perspective	<i>Dr Francesco Curcio</i>
16.10-16.25	Scaffolds for Tissue Engineering	<i>Prof. Jons Hilborn</i>
16.30-16.45	Novel 'Injectable Bone' Technology for Implant Placement	<i>Prof. Minoru Ueda</i>
16.50-17.05	Biomimetic Engineering of Cell Scaffolds for Tissue Templates	<i>Prof. Robert Brown</i>
17.10-17.30	Discussion	

Drug Delivery and Pharmaceutical Development

Session 2B Day 2: 14.00-17.30:

What is this session about?

A long standing issue for pharmaceutical companies is to deliver the right amount of drug to the site of disease. The inability to achieve this has means that drugs need to be administered in excessively high doses, increasing the likelihood that patients may suffer from toxic side effects.

So how can nanotechnology help?

Nanotechnology enables drugs to be targeted more effectively to the site of the disease, and activated ‘on arrival’. Drug can be prepared in such a way that they can cross epithelial barriers, and differentiate between healthy cells and diseased ones. Very small drug particles (nanoparticles) are coated with special molecules and travel round the body until they reach the disease site. Once there, the molecules ‘decorating’ the drug particles recognise the disease site, bind to it, and the drug is then activated.

This targeting means the drug will work efficiently and more effectively, and **side-effects dramatically decrease**. For example, chemotherapy in cancer usually means healthy cells are also killed off during the attempt to kill the cancerous cells. Targeted drug delivery circumvents this, and offers the potential for a quicker recovery.

Further Benefits

Nanotechnology has other benefits for therapy. In nanoparticulate form, drugs are less prone to degradation, meaning they will have a **longer shelf-life**. Nanoparticulate drugs can be coated to delay their activation, resulting in the drug remaining **in the body longer**, reducing the frequency of dosage required. Some drugs may be linked to particles which fluoresce when they reach diseased cells. This is a special technique known as **find, fight and follow**, and is leading to early detection and treatment. The area of disease can be identified by imaging the fluorescent particles, which then deliver their payload of drugs, and the effectiveness of the drugs can be then monitored.

In essence, the application of nanotechnology to drug targeting and delivery offers more effective treatments, lower toxicity and side-effects and reduced cost from reduced dosage. Drug delivery and targeting are areas which are already offering real patient benefits.

<u>Time</u>	<u>Title</u>	<u>Speaker</u>
14.00-14.15	Recent Developments in Targeted Drug Delivery Systems	<i>Prof. Costas Kipparissides</i>
14.20-14.35	Polymer Therapeutics: Nanomedicine in Routine Clinical Use	<i>Prof. Ruth Duncan</i>
14.40-14.55	Biomolecule Coated Microcrystals - Nanostructured Particles for Delivery of Therapeutics Biomolecules	<i>Dr Barry D Moore</i>
15.00-15.20	Discussion	
15.50-16.05	Nanobiodrugs – Applications For Cancer Therapy	<i>Dr Laurent Levy</i>
16.10-16.25	Protein Drug Delivery Systems	<i>Dr Peter Venturini</i>
16.30-16.45	Nanostructured Semiconductor Technology for Drug Delivery	<i>Prof Leigh Canham</i>
16.50-17.05	Intelligent Nanocapsules for Controlled Drug Encapsulation and Release	<i>Prof D Helmuth Mohwald</i>
17.10-17.30	Discussion	

Cell Structure and Function

Session 2C Day 2: 14.00-17.30

What is this session about?

Humans are essentially a collection of cells! The better we understand how cells work, the more likely it is we can create effective cures, understand the cause of disease better and produce better drugs. Nanotechnology is enabling this understanding. This session is concerned with understanding of cell structure and function and how a cell manifests disease, and the new tools that are being developed to identify early signs of disease at the cellular level, monitor of healthy and diseased cells and the progress of therapy, and measure the effects of different drugs.

Monitoring Cell Activity and Diagnosing Disease

Once we know the signals that a cell gives when it is diseased we can look for that signal. Hand-in-hand with the growing understanding of cell function, is the technology for measuring and identifying changes that indicate disease. The development of 'lab-on-a-chip' is one such technology which has many applications in disease identification. These include enabling cells to be studied independently of the body, the speedy screening patients for infection, and the analysis of the hereditary propensity to disease.

A lab-on-a-chip is a miniature laboratory that uses techniques developed from the electronics industry, that offers speed, sensitivity, accuracy and portability, compared with more traditional techniques, which are slow, expensive resource intensive and may be inaccurate as samples deteriorate with time.

In the future, this technology is leading to patient-centred medicine, with patients conducting tests in at their own homes, and downloading the results via their computer to a medical monitoring centre. Lab-on-a-chip technology also has important applications in being able to quickly screen a large population for disease or potentially killer infections, such as avian flu.



(Picture courtesy of Caliper Life Sciences)

Lab-on-a-chip techniques and a knowledge of the human genome is leading to pre-symptomatic disease treatment through identify the individual genetic propensities say to breast or colon cancer or heart disease, so appropriate preventative action can be taken.

This technology is also important for the developing world specifically in some African countries where disease is at epidemic rates. In areas where very little money, or even healthcare is available, the provision of cheap, fast-acting LOCs could offer **early identification of disease**, and enable more appropriate effective and cheaper treatment options.

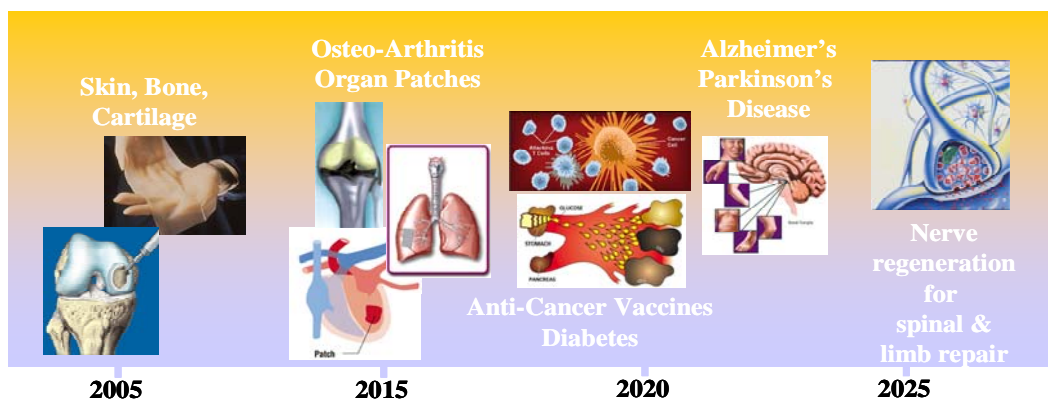
The cost effectiveness of what is basically a tiny microchip is another selling point; it can be mass produced incredibly cheaply.

<u>Time</u>	<u>Title</u>	<u>Speaker</u>
14.00-14.15	Nanosensors for Genomics, Proteomics, Cell Screening, and Diagnostics	<i>Prof. Jonathan M Cooper</i>
14.20-14.35	Mastering the Nanoscale with Visible Focused Light	<i>Prof. Stefan W Hell</i>
14.40-14.55	Nano Analysis and Detection of Gastrointestinal Tumour Cells	<i>Dr Juergen Schnekenburger</i>
15.00-15.20	Discussion	
15.50-16.05	Protection Mechanisms in Biomembranes	<i>Dr Kvetoslava Burda</i>
16.10-16.25	Real Time Study of Membrane Binding Events	<i>Dr Electra Gizeli</i>
16.30-16.45	Investigation of Cellular and Molecular Activity by AFM	<i>Prof Manfred Radmacher</i>
16.50-17.05	Probing Protein Trafficking and Interactions Using Optical Nanotechnologies	<i>Dr Mauro Giacca</i>

The Promise Of Nanomedicine Session 3 Day 3: 09.00-11.00

What is this session about?

Nanomedicine offers a huge spectrum of benefits for the better treatment of disease – from early diagnosis to better therapies to eventually preventative medicine; from stimulating the body to regenerate its own diseased tissues to the targeting and activating drugs at the site of disease. It also offers the possibility of developing better drugs faster, that have fewer side effects and are customised to the patient's own genome.



(Image Courtesy of Fidia Bipolymers)

This session examines three particular areas where nanotechnology will have a major impact: in relation to cancer; in relation to reducing animal testing, and in the commercial impact of new nano-based therapies:

Cancer treatment in the past has suffered from a lack of understanding the mechanisms of the disease at the cellular level, late diagnosis, and treatments based on attacking the whole body rather than the disease site. Nanotechnology is offering a totally new approach; from a better understanding of the root causes of disease, to quicker diagnosis and science-based treatments. Today, to quote Dr Mauro Ferrari ' we are seeing the tip of the iceberg' in terms of the potential nanotechnology offers for cancer treatment.

Another area where we are using a hammer to crack a nut is in the area of animal experiments for the validation of drugs. This has obviously produced some benefits in the past, but these are relatively small in relation to the large body of research (and cost) as many apparently good results could not be adequately replicated in humans, or produced unexpected side effects. With a better knowledge of individual responses to chemicals, nanotechnology is leading to a refinement of techniques for drug discovery that are accurate and meaningful for the individual patient, based on the use of living cells.

The session concludes with a compelling economic argument. Because nanotechnology is leading to better treatments based on our knowledge of proteomics and genomics, this is leading to a win-win situation for drug companies and patients as well as huge economic benefits for those countries where the State provides healthcare. Drugs are becoming more efficient as they are increasingly **designed** to treat specific diseases, patients are cured more rapidly, less care is needed to counteract reactions (the fourth largest cause of death in the western world is adverse reaction to pharmaceutical drugs!).

General Applications of Nanotechnology in Medicine

Nanotechnology is leading to **faster diagnosis** and more effective treatment, the early signs of disease, and its exact location. One such application uses quantum dots to locate the disease site.

Quantum dots are semiconductor nanoparticles which can **glow** very brightly under certain criteria. The quantum dots can be attached to chemicals which link to diseased cells. When the link is made, the quantum dots glow. This allows the **sites of disease to be accurately pinpointed, and also malignant and non-malignant tumours can be differentiated.**

Quantum dots may help in identifying cells which may develop problems in the future. By recognising certain indicators that cannot be detected using conventional technologies, quantum dots can call attention to potential disease sites, leading to the ideal of **disease prevention.**

Improved drug targeting and delivery is another highly promising area of nanomedicine, which is actually happening now. Coated drugs in nanoparticulate form can be **delivered directly** to the diseased cells. This means smaller or less frequent doses are required, and toxicity is reduced as the targeted drug works more effectively. Therefore nanomedicine is leading to the reduction of undesirable and costly **side-effects** of drugs, as the customisation and targeting of treatment would allow for more control over where the drug goes and what it affects in the body.

Nanotechnology is set to revolutionise healthcare through moving us towards **preventative**, or pre-emptive medicine, with many health and cost benefits, both to the State and the patient. Impacts are especially envisioned for the ageing and other hitherto disadvantaged populations.

<u>Time</u>	<u>Title</u>	<u>Speaker</u>
09.00-09.30	Nanotechnology and New Cancer Research in the USA	<i>Dr Mauro Ferrari</i>
09.30-09.40	Discussion	
09.40-10.10	Whole Cell Biosensors: Chip Canaries for Health Protection	<i>Dr Shimshon Belkin</i>
10.10-10.20	Discussion	
10.20-10.50	Nanomedicines – A Significant Share of the Non-Generic Market by 2020	<i>Prof. Mike Eaton</i>
10.50-11.00	Discussion	

Converging Technologies For Medicine and Healthcare

Session 4A Day 3: 11.30-13.00

What is this session about?

Limits and barriers on medical research are being rapidly broken down by the convergence of many disciplines, such as nanotechnology, molecular biology with physics, information technology and even, at last, the humanities! Together, this is resulting in rapid advances in new techniques, processes and tools which are completely changing the way we have approached healthcare in the past.



It is not only researchers from different disciplines that are working together. Networks like Nano2Life are bringing private firms, scientists and research institutes together to solve the problems of treating disease. Strong partnerships are being formed that are providing a range of skills across the board, generating disruptive technologies and completely innovative solutions to old problems. These could include non-invasive diagnostics (who likes biopsies?), individual-specific drugs, identifying disease at the cellular level, faster validation of new drugs, and stimulating the patient's own body to regenerate diseased or failed organs.

This session will examine convergence and its benefits on a European level. It is case study-based, describing networks and their component organizations, and the benefits that have accrued to industry from EU-supported partnerships and initiatives that connect complementary skills from a wide range of disciplines.

<u>Time</u>	<u>Title</u>	<u>Speaker</u>
11.30-11.45	Multifunctional Polymer Systems designed for Biomedical Applications	<i>Prof. Andreas Lendlein</i>
11.50-12.05	A New Landmark in European Nanobiotech: Nano2Life	<i>Dr Patrick Boisseau</i>
12.10-12.25	Biomimetic Approaches to Soft Nanotechnology	<i>Prof Richard L Jones</i>
12.30-12.45	Medical Devices and Converging Technologies	<i>Prof Patricia Connolly</i>
12.50-13.00	Discussion	

Nanotechnology for Congenital & Degenerative Diseases

Session 4B Day 3: 11.30-13.00

Nanotechnology is expected to play an increasing role in the battle against congenital and degenerative diseases. As we live longer, many more diseases become manifest over a larger proportion of the population, such as Alzheimer's and Parkinson's. We are also experiencing an epidemic of lifestyle diseases, from diabetes to cancer to heart and vascular disease.

Firstly, early diagnosis is critical to many of these diseases, which is enabled by the miniaturization, user-friendliness, cheapness and wide availability of diagnostic techniques to such an extent that patients can monitor their own symptoms. Examples include self-testing for diabetes and cholesterol levels. The spectrum of possibilities will expand dramatically; test results can be transmitted to a central health bureau, and therapies prescribed remotely.

Working at the nanoscale has produced new hope for disease of the brain, for example. If the therapy is drug-based, drugs in nanoparticulate form can now cross the blood-brain barrier. If the therapy requires regeneration of diseased tissue, new research is enabling the growth of the patient's own cells on nano-inspired scaffolds that can be then implanted into the brain.

Other areas where Nanotechnology offers hope is in the delivery of drugs in a way that emulated the body's own systems. For example, in diabetes, insulin is required by the body at irregular intervals. Using techniques derived from the electronics industry, this need can be monitored using a small, silicon chip-based implant, and insulin delivered only as required.

Electronics combined with nanotechnology is also the basis of better retinal and cochlear implants. Today, new retinal implants have been developed that enable people previously classified as blind (through disease, such as macular degeneration) to be reclassified as sighted. Present cochlear implants are crude, difficult to insert, awkward to wear and give poor performance. Future implants will use nanocomposite materials, be small and easy to insert and be cheap to produce. This also has very promising implications for the poor.

Nanoimaging and Diagnostics

Session 4C Day 3: 11.30-13.00

What is this session about?

Medical imaging has advanced from a marginal role in healthcare to becoming an essential tool of diagnostics over the last 25 years. Molecular imaging and image-guided therapy is now a basic tool for monitoring disease and in developing almost all the applications of in-vivo nanomedicine. Originally, imaging techniques could only detect changes in the appearance of tissues when the symptoms were relatively advanced.

Later, contrast agents were introduced to more easily identify and map the locus of disease. Today, through the application of nanotechnology, both imaging tools and marker / contrast agents are being dramatically refined towards the end goals of detecting disease as early as possible, eventually at the level of a single cell, and monitoring the effectiveness of therapy.

The convergence of nanotechnology and medical imaging opens the doors to a revolution in molecular imaging (also called nanoimaging), leading eventually to the detection of a single molecule or a single cell in a complex biological environment.



<u>Time</u>	<u>Title</u>	<u>Speaker</u>
11.30-11.45	Nanomedicine – Moving From The Bench To The Patient	<i>Professor Ueli Aebi</i>
11.50-12.05	Radioactive Nanoclusters for Medical Applications	<i>Professor Stéphane Lucas</i>
12.10-12.25	Microbubble as Targeted Contrast Agents and Drug Delivery Systems	<i>Dr Andreas Briel</i>
12.30-12.45	Nanoparticles in Future Medical Applications	<i>Dr Werner Hoheisel</i>
12.50-13.00	Discussion	

Engaging The Community

Session 5A Day 3: 14.30-16.30

What is this session about?

Nanomedicine offer many benefits for healthcare in the future. It is a complex subject, and additionally suffers from many misconceptions about the potential of Nanotechnology for medicine, arising out of a confusion between science fiction and fact, even amongst highly educated people. Considering governments and institutions the world over are spending many billions on nanotechnology research and development, a small amount of that funding would be beneficially channelled to wider public awareness and engagement.

Engaging The Public

As with any new technology, there are risks as well as benefits. Too frequently the downsides of an innovation are publicised, out of proportion to the benefits.

A survey carried out last year by researchers at the University of North Carolina established that the more people knew about nanotechnology, the more they thought the benefits would greatly outweigh the risks. The opposite was also true. This is a key point which indicates a well-informed public is likely to embrace nanotechnology and, whilst remaining wary of some of the risks, if they see it as bringing a major benefit to their lives.

This session aims at exploring how best to inform the public, so they can make reasoned and reasonable decisions, and what needs to be put in place to provide reassurance that potential risks are receiving the right level of attention and response.

Note: The UK Government is alive to the need for open debate, and commissioned the Royal Society and the Royal Academy of Engineering to investigate the potential benefits of Nanotechnology and the likely risks, and what if any actions should be taken regarding each.

A survey, commissioned as part of the above report, found that the public held both positive and negative views about nanotechnology. They were excited by the idea of new advances particularly in medicine and in the creation of new materials; they had a sense that the developments were part of natural progress; and had the hope that they would improve the quality of life. Concerns were expressed about financial implications; the impact on society; the reliability of new applications; long-term side effects and whether the technologies could be controlled. The issue of the governance of nanotechnologies was also raised, as to which institutions could be trusted to ensure that nanotechnologies would be socially beneficial. Comparisons were made with earlier issues with genetically modified organisms and nuclear power.

Based on the survey and a wide dialogue with many stakeholders, the RA / RAE report made several recommendations. These included a more sustained and extensive programme of research into public attitudes, a debate about the future of nanotechnologies should be undertaken now, to inform key decisions, and that there should be public dialogue around the development of nanotechnologies. It emphasized that governance would also be an appropriate subject for early dialogue.

The report is recommended to all who wish a wider understanding of the issues involved, an proposed action. It can be accessed at www.nanotech.org

<u>Time</u>	<u>Title</u>	<u>Speaker</u>
14.30-14.45	Applied Nanosciences and Environmental Health and Safety	<i>Prof David M Berube</i>
14.50-15.05	Innovation, Risk and Stakeholder Engagement: Framing Nanotechnology	<i>Prof Joyce Tait</i>
15.10-15.25	Nanologue: A Europe-Wide Dialogue on the Social, Ethical and Legal Implications of Nanotechnology	<i>Dr Volker Turk</i>
15.30-15.45	Enhancing Dialogue on Nanotechnologies and Nanosciences in Society at the European Level: NanoDialogue	<i>Dr Jennifer Palumbo</i>
15.50-16.30	Discussion	

Affordable Cures – Addressing Diseases of the Developing World

Session 5B Day 3: 14.30-16.30

What is this session about?

Technological advances invariably exacerbate the divide between the rich and the poor. Can nanomedicine be the exception that proves the rule?

This session examines areas of opportunity where nanomedicine may make a real difference to the poor and disadvantaged in the developing world.

The Developing World

According to a study by the Canadian Program on Genomics and Global Health (CPGGH) at the University of Toronto Joint Centre for Bioethics (JCB) - a leading international medical ethics think-tank - nanotechnology may provide the means to help developing countries across a spectrum of areas including improvement in water quality, reduction in environmental and early diagnosis and treatment and even prevention of killer diseases such as malaria, tuberculosis and HIV/AIDS.

The Benefits of Nanotechnology to the Developing World

Diagnosis of disease. About a quarter of all Africans are infected with AIDS. It kills millions each year and 95% of all new cases of AIDS occur in developing countries. Nano-based devices are leading to **easy and fast analysis** of a range of diseases that can be undertaken cheaply and easily.

Treatment of Disease. Nanomedicine also has the potential to ensure **longer shelf life for drugs**, easier administration, and lower dosage requirements. New high throughput screening techniques are leading to cheaper drug discovery; and cell based assays should lead to faster introduction of these drugs into the population.

Sources of Disease. Nanotechnology-enabled systems have application for water purification through membrane filters, which would have the knock-on effect of reducing infection.

Other:

Apart from benefiting medicine directly, nanotechnology is also offering access to cheap renewable energy using new polymer based solar power collectors that are lightweight, cheap and efficient.

<u>Time</u>	<u>Title</u>	<u>Speaker</u>
14.30-14.45	Nanotechnology and The Developing World	<i>Dr Fabio Salamanca-Buentello</i>
14.50-15.05	Can Nanotechnologies Deliver Better Vaccines for Developing Countries?	<i>Dr Thierry Coche</i>
15.10-15.25	Evaluation of Nanoparticles Delivering Anti-Tuberculosis Drugs	<i>Dr Hulda Shaidi Swai</i>
15.30-15.45	A Review of Current Trends in Technological Development	<i>Dr John Julian Rwendeire</i>
15.50-16.30	Discussion	

Impacting Society – Addressing the Needs of the Ageing Population

Session 5C Day 3: 14.30-16.30

What is this session about?

Nanotechnology could finally mean that growing old does not necessarily mean loss of faculties and a rapid reduction in quality of life.

Nanotechnology is supporting the rehabilitation of the infirm and elderly through the development of **intelligent learning prosthetic devices**. These include retinal and cochlear implants. Through the development of nanocomposites, nanoelectronics, nanosensors, nanotransducers and biomaterials, the next generation of implants will be more effective, body friendly and less traumatic to insert. They will reinvigorate the faculties of patients whose hearing or sight has been affected by accident, disease or age.

Organ replacement is increasingly common across the generations. Transplantation is fraught with dangers such as rejection and side effects from drugs. As discussed under Tissue Engineering, research is leading to the growth of new organs from a patient's own tissues. The ultimate objective is to produce innovative scaffold materials which can be seeded with the patient's own cells, which, when implanted will regenerate bone, cartilage and skin tissues in the most natural way possible. Medical textiles is an exciting field of innovation. **'Smart clothes'** are being developed which will regulate temperature and even monitor the health of the wearer.

This remarkable new technology poses even more questions regarding ethics – the ethics of who should benefit, if there is a choice to be made, where the line should be drawn, if any, at enhancing human performance (especially in relation to military and sports applications), and whether new technology will lead to a further widening of the gap between rich and poor, advantaged and disadvantaged.

Time	Title	Speaker
14.30-14.45	Non-invasive Nanoparticulate Delivery Systems for the Treatment of Chronic Diseases	<i>Dr Frank Sinner</i>
14.50-15.05	Deep Brain Stimulation for Movement Disorders and Pain	<i>Prof Tipu Aziz</i>
15.10-15.25	Bio-engineered Meniscus Substitute: Community Added Value	<i>Dr Enrico Tognana</i>
15.30-15.45	Intelligent Scaffolds for Tissue Engineering of Bone, Skin and Cartilage: Intelliscaf	<i>Dr Naseem Theilgaard</i>
15.50-16.30	Discussion	

From the Lab To The Clinic – Commercialising Nanomedicine

Session 5D Day 3: 14.30-16.30

What is this session about?

Investment in nanoscale research has grown from around €1 billion p.a. in 2000 and is expected to reach €10 billion p.a. worldwide by 2006. The use of nanotechnology is accelerating, and a prediction made in the USA in 2000 that one trillion dollars in products worldwide would be affected by nanotechnology in 2015 has now been brought forward by five years to 2010.

Nanotechnology applied to medicine is a key area of economic potential, but in some areas suffers from a regulatory bottleneck, with a long lead in time from lab to application. This means huge costs of development, the possibility of financially catastrophic failure, and expensive products by the time the successful ones reach the market.

Taking NanoProducts to the Marketplace

Nanotechnology has already been commercialised in products ranging from **anti-ageing creams** to **hearing aids** to **anti-scratch coatings** to **DVD's**. In healthcare, silver nanoparticles are being incorporated in wound dressings to provide improved biocidal properties – the **common everyday sticking plaster** has now been **vastly improved by the application of nanotechnology!**



A major problem besetting nano innovators is that their technology may be generic, i.e. have more than one application. For example, Oxonica is a small company with expertise in creating and functionalising nanoparticles. They have developed nanoparticles for imaging and diagnostic applications, as well as for sunscreens and as fuel additives. One problem for similar small companies is making the decision on which market to attack first, and how to effectively penetrate each one.

Another problem is dealing with a public backlash against nanotechnology; no matter how unreasonable that might be with regard to most products. Government may demand even more regulation that will further slow the progress of a Nanotechnology breakthrough to full commercialization.

<u>Time</u>	<u>Title</u>	<u>Speaker</u>
14.30-14.45	Commercialising Issues Around Health Applications	<i>Dr Kees Eijkel</i>
14.50-15.05	Applied Entrepreneurship: From Science To Profitable Business	<i>Dr Richard G Caro</i>
15.10-15.25	Fast Track Incorporation of Nanotech in Medical Products	<i>Dr J Malcolm Wilkinson</i>
15.30-15.45	Transferring Early Stage Nanotechnologies from the Lab to the Healthcare Marketplace	<i>Dr Luis Mejia</i>
15.50-16.30	Discussion	

Novel Implants and Devices

Session 6A Day 4: 14.00-17.30

What is this session about?

Nanotechnology, new materials and nanoelectronics are the basis of novel retinal and cochlear implants. New retinal implants have been developed that enable people previously classified as blind (through disease, such as macular degeneration) to be reclassified as sighted. Present cochlear implants are crude, difficult to insert, awkward to wear and give poor performance. Future implants will use nanocomposite materials, be small and easy to insert and be cheap to produce. This also has very promising implications for the poor.

What can Nano do for implants and devices?

Over \$30bn is spent on implants yearly (hip, knee, dental etc.). Nanotechnology can help bring about **better implants**. For example, Proteins at the body-implant interface play a decisive role in the acceptance or rejection of the implant. Using nanotechnology we can produce '**body-friendly**' coatings and also create topographies that cells like, to increase the likelihood of acceptance. These biocompatible coatings are even being used in devices like hearing aids, reducing the likelihood of irritation or skin reaction.

Around 1,000,000 hip and knee-joint replacements are carried out in the EU each year. However, the lifespan of the implants is only around 10 years, shorter if the patient is particularly active or overweight.

This poses both a quality of life problem, and a cost effectiveness issue. Revisionary surgery adds about €520m a year to the EU's medical costs.



Nanocomposites are also being developed that form **ceramic implants** which are stronger and longer-lasting, with potential life-spans of more than 30 years.

Some of this session is also devoted to Tissue Engineering, see session 2A, page 2 for further details.

<u>Time</u>	<u>Title</u>	<u>Speaker</u>
09.00-09.15	Implants Based on Cellulosics	<i>Professor Dieter Klemm</i>
09.20-09.35	Nanocomposites for Biomedical Applications	<i>Dr Ramon Torrecillas</i>
09.40-09.55	Towards Learning Retina Implants for the Blind	<i>Prof Rolf Eckmiller</i>
10.30-10.45	Genomic Nanoprocessors: A Platform for Future Healthcare?	<i>Dr John Beattie</i>
10.50-11.05	Integration of Bio, Micro, Nano, and Information Technology for Medical Diagnostic Systems: Challenges and Opportunities	<i>Dr Andrew Campitelli</i>
11.10-11.25	Tissue Engineering of Cartilage and Bone – State of the Art and Future Challenges	<i>Dr Jochen Ringe</i>
11.30-12.00	Discussion	

Nanosensors and Diagnostics

Session 6B Day 4: 09.00-12.00

In **nanodiagnostics**, the ultimate goal is to identify disease at the earliest stage possible, ideally at the level of a single cell. When testing for disease, nanotechnology offers better sensitivity, specificity and reliability. Several steps from sample preparation to detection can be integrated into a single, tiny device. An important application is in cheap, reliable devices, based on nanotechnology, that can be used at the “point of care” in clinics by non-expert technicians, and eventually by individuals themselves.

Advances in in-vivo diagnostics will rely mainly on imaging. In molecular imaging, the goal is to create sensitive, reliable agents that can detect, deliver and monitor therapy. This is the “find, fight and follow” concept, sometimes also known as *theranostics*. The likely diseased tissue is firstly imaged, using target-specific contrast agents (see quantum dots, p9). These contrast agents can be combined with a drug; and the results of therapy can then be monitored, again using imaging techniques.

The advances in diagnostics have presented major opportunities for healthcare, including a plethora of new personalised treatments and early diagnosis for individuals suffering from a wide variety of illnesses such as cancer, diabetes, and heart disease.

Nanotechnology has even made a tiny ‘nano needle’ possible which can provide important information on disease at the level of a single cell. Other types of nanosensors include cantilevers which are sensitive, simple and cheap and able to accurately detect tiny biochemical changes.

<u>Time</u>	<u>Title</u>	<u>Speaker</u>
09.00-09.15	Recent Advances In Biosensors	<i>Prof Chris Lowe</i>
09.20-09.35	Cantilever-Based Sensing Devices for Diagnostics	<i>Dr Anja Boisen</i>
09.40-09.55	Requirements and Benefits of a High Resolution Imaging Strategy	<i>Dr Rolf Guenter</i>
10.30-10.45	Drug and Gene Nano-balls: Applications in Genomics, Proteomics, Diagnostics and Personalized Medicine	<i>Professor Matt Trau</i>
10.50-11.05	Interfacing Biology and Physical Science Through Nanoscale Protein Engineering	<i>Professor Jeremy Lakey</i>
11.10-11.25	Nanoscale Devices for Proteomics and Drug Discovery	<i>Dr Ahmet Senoglu</i>
11.30-12.00	Discussion	

Nanoparticle Risk Assessment

Session 6C Day 4: 14.00-17.30

In nanomedicine, risks seem to be associated only with some nanoparticles. The risk factor is also the source of the medical opportunity! For example, research is presently excited by the possibility of using fluorescent nanoparticles, called quantum dots, as unique disease markers, helping differentiate between malignant and non- malignant growths, and also in the detection and treatment of disease at the very earliest stage. However, the toxicity of these nanoparticles is incompletely understood, and work is needed to determine how these particles can be safely used in achieving important diagnostic and therapeutic goals. Europe is fortunate in having notable strengths in this area, but new research is needed both into modelling nanoparticle behaviour, and cell, rather than animal-based testing, as a way forward.

This session explores the potential risks of nanoparticles, including levels of exposure, where and the kind of data that exists already, and the conclusions that can be drawn from earlier research; and where more work needs to be undertaken

<u>Time</u>	<u>Title</u>	<u>Speaker</u>
09.00-09.15	An Introduction to the Toxicology and Risk Assessment of Particles	<i>Prof Ken Donaldson</i>
09.20-09.35	Translocation and Cardiovascular Effects of Nanoparticles	<i>Prof Paul J F Borm</i>
09.40-09.55	Nanoparticle Exposure – Risk Relationship between Exposure and Health Effects	<i>Dr Rob Aitken</i>
10.30-10.45	Percutaneous Uptake of Nanoparticles: The Nanoderm Project	<i>Professor Tilman Butz</i>
10.50-11.05	The Central Nervous System as a Target for Inhaled Nanoparticles	<i>Professor Gunter Oberdorster</i>
11.10-11.25	A Global Strategy for Safe Production and Use of Nanoparticles: Nanosafe 2	<i>Dr Frederic Schuster</i>
11.30-12.00	Discussion	

Nanomedicine, Ethics, and Society

Session 7 Day 4: 13.30-17.30

What is this session about?

Nanotechnologies are said to offer great promise for medicine, but much of this lies in the future. Nanomedicine, like any other technological advance, will pose its own set of ethical questions. Who will choose who receives new treatments? Will nanomedicine exacerbate the rich-poor divide? What are the ethics regarding enhanced physical performance for military or sports application?

At this session questions will be asked and discussed regarding the uncharted future which nanotechnologies may offer medicine. How society seeks answers to these emergent technologies will be of crucial importance, so that the right benefits may be achieved for humankind.

This session offers a free and open opportunity for wide ranging discussions on this highly controversial and exciting area

<u>Time</u>	<u>Title</u>	<u>Speaker</u>
13.30-13.45	Nanotechnologies Today and Tomorrow: Ethical Aspects	<i>Prof. Goran Hermeren</i>
13.45-14.00	Dreams, Hopes and Uncertainties in the Nano Revolution	<i>Prof. Emilio Mordini</i>
14.00-14.15	Can Nanotechnologies Make Humans Better? – Ethical Issues in Nanomedicine	<i>Dr Donald Bruce</i>
14.15-14.30	TBC	<i>Dr Rogerio Gaspar</i>
15.00-17.30	Discussion	

What Can We Do At International Level?

Session 8 Day 5: 09.30-13.00

What is this session about?

Many countries of the world are making important advances in the area of nanomedicine. This session, the final one of the conference, examines international strategies in Europe, India, South Africa, China and Japan. The US approach to nanomedicine specifically in cancer research will have been presented by Dr Mauro Ferrari on Wednesday 7th.

The aim of this session is to become better acquainted with international activities in nanotechnology, with the aim of avoiding duplication, and of identifying potential areas of collaboration across national boundaries.

<u>Time</u>	<u>Title</u>	<u>Speaker</u>
09.30-09.55	The Case For Multinational Research Infrastructures	<i>Herve Pero</i>
10.00-10.25	Nanoscience and Technology Initiatives In India	<i>Prof Venkatesh Rao Aiyagari</i>
10.30-10.55	Nanosciences and Nanotechnology In South Africa: Challenges and Opportunities	<i>Dr Molefi Mokutu</i>
11.30-11.55	Chinese Approach –Nanotechnology in Regenerative Medicine	<i>Professor Jianhong Zhu</i>
12.00-12.25	Nanotechnology and Nanomedicine in Japan	<i>Dr Akiyoshi Taniguchi</i>
12.30-13.00	Discussion	