ibec Institute for bioengineering of Catalonia

3rd IBEC SYMPOSIUM ON BIOENGINEERING AND NANOMEDICINE

BARCELONA 1-2 JUNE 2010

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3rd IBEC SYMPOSIUM ON BIOENGINEERING AND NANOMEDICINE

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1st June

13:00	**Registration**		
15:00	**Opening Ceremony**		
15:30	**Keynote lecture**	**Prof. Paolo Dario** From Miniature to Nano Robots for Diagnostic and Therapeutic Applications	Chair: Prof. A. Casals
16:05	**Flash Poster Presentations I**		
16:55	**Coffee-Break & Poster Session**		
17:35	**Keynote lecture**	**Prof. Yuji Miyahara** Detection of biomolecular recognition using bio-transistors	Chair: Prof. J.A. Planell
18:10	**Keynote lecture**	**Prof. Vincent Torre** Detection and Characterization of Elementary Events Underlying Force Generation in Neuronal Lamellipodia	Chair: Dr. P. Gorostiza
18:45	**Keynote lecture**	**Prof. Daniel Navajas** Cellular and Respiratory Biomechanics: from bench to bedside	Chair: Dr. D. Lacroix

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2nd June

9:00	**Keynote lecture**	**Prof. Viola Vogel-Scheidemann** Mechanotransduction: Design Principles of Mechano-Chemical Signal Converters	Chair: Prof. M. Garcia-Parajo
9:35	**Keynote lecture**	**Prof. Santiago Marco** Chemical Information Processing: Biology or Statistics	Chair: Prof. R. Jané
10:10	**Flash Poster Presentations II**		
11:00	**Coffee-Break & Poster Session**		
11:50	**Keynote lecture**	**Prof. Guenter W. Gross** High throughput microelectrode array platforms for quantitative pharmacology, toxicology, and drug development using spontaneously active neural tissue	Chair: Dr. E. Claverol
12:25	**Keynote lecture**	**Prof. Toshihiro Akaike** Application of Chimera Protein Matrices for Stem Cell Engineering and Regenerative Medicine	Chair: Prof. G. Altankov
13:00	**Lunch & Poster Session**		
15:00	**Keynote lecture**	**Prof. Bernt E. Uhlin** Expression and biomechanical features of fimbrial adhesin organelles by pathogenic Escherichia coli	Chair: Prof. A. Juarez
15:35	**Flash Poster Presentations III**		
16:30	**Coffee-Break & Poster Session**		
17:15	**Keynote lecture**	**Prof. Günter R. Fuhr** In vitro-Culture of animal cells – a biological and technical challenge	Chair: Prof. J. A. Del Rio
17:50	**Keynote lecture**	**Prof. Samuel Stupp** Supramolecular Engineering of Bioactive Nanostructures and their Hierarchical Systems	Chair: Prof. J. Samitier
18:25	**Awards and Closing Ceremony**		

Institute for bioengineering of Catalonia

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Keynote lectures

From Miniature to Nano Robots for Diagnostic and Therapeutic Applications

Paolo Dario [1,2]

(1) Scuola Superiore Sant'Anna
Piazza Martiri della Libertà 33, 56127, Pisa, Italy

(2) Italian Institute of Technology – Center for MicroBioRobotics IIT@SSSA
Viale R. Piaggio 34, 56025, Pontedera, Italy

(e-mail: p.dario@sssup.it)

This talk presents the evolution of diagnostic and therapeutic procedures as a process of convergence of technologies coming from different fields and involving different disciplines. In particular, it illustrates how modern surgery evolved thanks to fundamental biology knowledge; thus, with the introduction of imaging techniques intra-operatively and with the introduction of robotics, surgical procedures became much more predictable, precise and effective. In addition, the recent developments of optics (with the introduction of fiber optic technologies and with CMOS and CCD) allowed to "see" inside the human body, thus reducing the invasiveness of surgical procedures and making diagnostic procedures adequate for an effective early discovery of pathologies.

Nowadays, we are assisting to a concrete merging between microrobotics technologies and bioengineering, with the potential to bring therapeutic tools where requested and when requested, with high precision and with very limited side effects.

This presentation will show briefly four examples of *miniaturized machines* for diagnostic and therapeutic applications by highlighting a common design methodology: a miniaturized active capsule for early diagnosis in the gastrointestinal tract (Fig. 1), a reconfigurable robot for internal surgery with advanced kinematics (Fig. 2), an integrated system for procedures in the vascular system which exploits a synergistic merging between external devices/platforms and internal micro-instrumentation operating in the vessels (Fig. 3) and nanotools (e.g. nanoplasters and active nanotubes) with remote activation for localized delivery of drugs and therapy (Fig. 4).

The speaker will propose an integrated approach to minimally invasive diagnosis and therapy by combining the well-established results accomplished in the field of miniaturized robotic and computer assisted surgery, with novel discoveries of bioengineering and nanotechnology. This contribution represents a step forward in the attempt to fill the gap between nanomedicine and traditional endoscopic procedures.

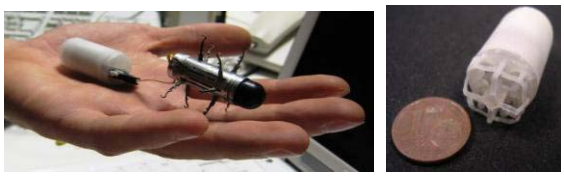


Fig. 1. (Left) Legged capsule for crawling through the colon; batteries are included in the tender module. (Right) Swimming wireless capsule for stomach exploration.

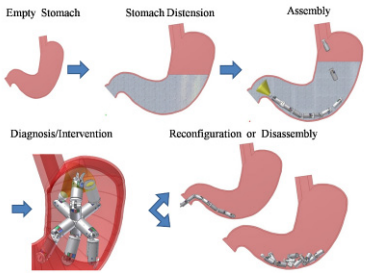


Fig. 2. Concept of the internal reconfigurable robot.

Fig. 3. Novel, integrated system for accurate diagnosis and tailored therapy of vulnerable plaque in arteries.

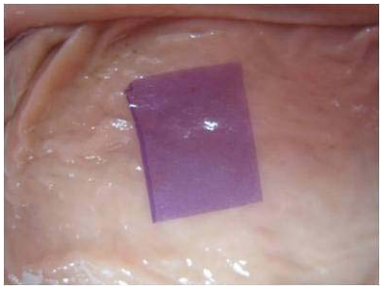


Fig. 4.Free-standing nanosheet to be delivered as nanoplaster, possibly loaded with post-therapy medical treatment, e.g. on endothelium after plaque removal by the system shown in Fig. 3.

Detection of biomolecular recognition using bio-transistors

Yuji Miyahara, Akira Matsumoto, Chiho Hamai-Kataoka, Tatsuro Goda ,Yasuhiro Maeda
(Biomaterials Center & MANA, National Institute for Materials Science)
1-1, Namiki, Tsukuba, Ibaraki, 305-0044, Japan
Email address: MIYAHARA.Yuji@nims.go.jp

We have been investigating a new method to detect molecular recognition events by means of electrostatic interaction between charged biomolecules and electrons in silicon. We have reported several types of biologically coupled field effect transistors (FET) which are based on direct transduction of surface density change of charged biomolecules into electrical signal by the field effect[1-4].

The conceptual structure of a genetic FET is shown in Fig. 1. Oligonucleotide probes are immobilized on the surface of the gate insulator. The genetic FET is immersed in a measurement solution together with an Ag/AgCl reference electrode with saturated KCl solution. The photograph of the fabricated FET chip is shown in Fig. 2.

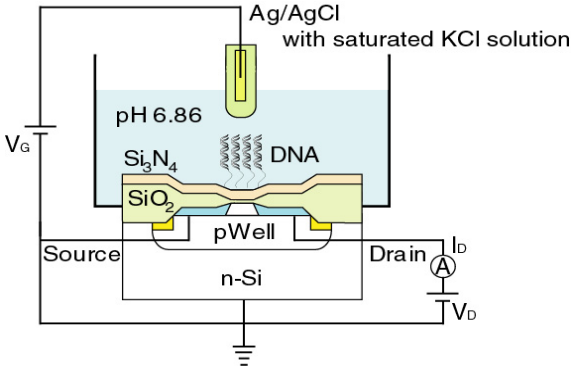


Figure 1 Schematic diagram for measurements of electrical characteristics of genetic FET.

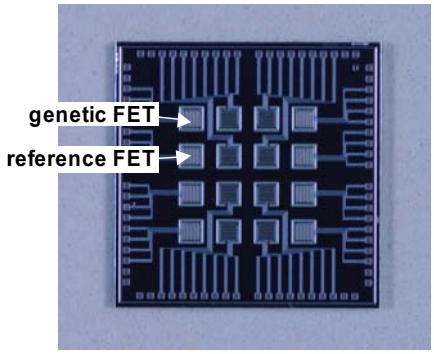


Figure 2 Photograph of the fabricated genetic FET chip. Sixteen FETs and a temperature sensor are integrated in a 5 mm x 5 mm chip.

When complementary DNA molecules are contained in a sample solution, hybridization occurs at the surface of the gate area. Since DNA molecules are negatively charged in an aqueous solution, electrons are expelled from the surface of silicon by electrostatic interaction through the thin gate insulator. Thus, a specific binding of charged biomolecules at the gate surface can be detected as a shift of the threshold voltage V_T.

The hybridization events are followed by the introduction of DNA polymerase and all four deoxynucleotides. The sequence-specific extension can be controlled by a match or mismatch at the 3'-end of each oligonucleotide probe. As a result of extension reaction, negative charges increase at the gate surface of the genetic FET, because of intrinsic negative charges of polynucleotide. This charge density change can be detected as a shift of the threshold voltage V_T of the genetic FET. The allele specific primer extension on the gate surface could be directly transduced into electrical signal using the genetic FETs.

We prepared four kinds of buffer solution containing both DNA polymerase and one of dCTP, dATP, dGTP or dTTP, respectively. The FETs hybridized with target DNA were immersed into the above-mentioned buffer solutions for single-base extension reaction and the shift of the threshold voltage was measured in a 0.025 M phosphate buffer solution after washing the FETs. The cycle of single-base extension and measurement of the V_T was repeated iteratively to determine the base sequence of the target DNA. As a result, the positive V_T shifts could be detected in accordance with the base sequence of the target DNA. Thus, the results of iterative extension reaction and detection of the threshold voltage indicated the ability of a direct, simple and potentially precise DNA sequencing analysis using the FETs.

References

1. T. Sakata and Y. Miyahara, *Angew. Chem. Int. Ed.*, 45, 2225-2228 (2006)
2. T. Sakata and Y. Miyahara, *Anal. Chem.* 80, 1493-1496 (2008)
3. A. Matsumoto, N. Sato, T. Sakata, R. Yoshida, K. Kataoka, and Y. Miyahara, *Adv. Mater.* 21, 1-7 (2009)
4. A. Matsumoto, N. Sato, H. Cabral, K. Kataoka, and Y. Miyahara, *J. Am. Chem. Soc.*, 131, 12022–12023 (2009).

Detection and Characterization of Elementary Events Underlying Force Generation in Neuronal Lamellipodia

R. Shahapure, affiliation: International School for Advanced Studies (SISSA), via Beirut 2-4 34014 Trieste, Italy; E. Ercolini, affiliations: SISSA, Trieste, Italy; Cluster in Biomedicine (CBM), Area Science Park Basovizza, Trieste, Italy; L.Amin, affiliation: SISSA, Trieste, Italy; G.Bisson, affiliation: SISSA, Trieste, Italy; V. Torre (email: torre@sissa.it), affiliations: SISSA, Trieste, Italy; Cluster in Biomedicine (CBM), Area Science Park Basovizza, Trieste, Italy; Italian Institute of Technology, SISSA Unit, Italy.

Introduction Force generation is a fundamental process at the basis of cellular motility, allowing neurons to explore the environment. Neuronal growth cones are the major motile structures located at the neurite tips and composed of lamellipodia and filopodia. Force generation is thought to originate from the progressive addition of actin molecules to the existing network of actin filaments and is determined by the balance between actin polymerization and depolymerisation, modulated by controlling proteins and by chemical and mechanical receptors coupled to the cytoskeleton. However, very little is known on the elementary events underlying force generation.

Material and Methods Neurons from dorsal root ganglia (DRG) of P10-P12 rats were isolated and plated on poly-L-lysine-coated glass coverslips, positioned on the stage of an inverted microscope used for imaging and measuring forces. After 24 to 48 hours of incubation, lamellipodia emerged from the DRG soma. Silica beads of 1 μm in diameter were trapped with an infrared (IR) optical tweezer in front of lamellipodia of differentiating DRG neurons: when lamellipodia protruded and displaced the bead, the exerted force $\boldsymbol{F} = (F_x,F_y,F_z)$ was be measured with high sensitivity and temporal precision.

Results By using optical tweezers, we have identified and characterized the elementary events underlying force generation when lamellipodia push a test bead. When the lamellipodium grows pushing the bead, forward and backward jumps occurring within 1 msec with an amplitude varying from some to 20 nm are detected. When the lamellipodium retracts, pulling the bead with it, no jumps are observed. Frequency and amplitude of these events were reduced by Jasplakinolide, a blocker of actin filament depolymerization. Our results show that neuronal lamellipodia generate force in at least two modes: one in which the lamellipodium leading edge advances by forward and backward steps of 2-10 nm with a net protrusion velocity up to about 70 nm/s and a slower mode with smaller steps. The first mode is a discontinuous process characterized by large fluctuations, while the second mode is a smoother process in which actin monomers are presumably added one by one to the existing network of filaments.

Conclusions Lamellipodia generate force in at least two modes: one in which the lamellipodium leading edge advances by forward and backward steps of 2-20 nm with a net protrusion velocity up to about 70 nm/s and a slower mode with smaller steps. Our results identify the *elementary events* underlying force generation and show that *protrusion is not a smooth mechanism* in which actin molecules are added one by one continuously but is a discontinuous process in which bursts of actin polymerization and depolymerization alternate.

Cellular and Respiratory Biomechanics: from bench to bedside

D. Navajas

Institute for Bioengineering of Catalonia, Baldiri Reixac 10-12, 08028 Barcelona, Spain, dnavajas@ub.edu

Lung function is primarily determined by the mechanical properties of airways and parenchymal tissues. Mechanical dysfunction of the lung is associated with prevalent respiratory diseases. We study pulmonary mechanics with a multiscale approach extending from organ to molecule. Our research is aimed at furthering our understanding of the mechanical behavior of the respiratory system to improve the diagnosis and treatment of respiratory diseases.

At the organ level, our work is currently focused on sleep apnea-hypoapnea syndrome (SAOS) and acute lung injury (ALI). We have shown in an animal model of SAOS that recurrent airway obstructions enhance migration and endothelium adherence of bone marrow mesenchymal stem cells (1). Thus, mesenchymal stem cells could protect patients with SAOS from endothelial dysfunction and cardiovascular diseases. Using the same model, we studied changes in oxygen partial pressure of brain tissue showing that, in contrast to other tissues, cerebral cortex is partially protected from intermittently occurring interruptions of oxygen supply induced by obstructive apneas (2). This protective mechanism could reduce neuro-cognitive consequences of SAOS. We have also shown that oxygen desaturations and respiratory efforts associated with SAOS induce systemic inflammation (3). SAOS-induced inflammation could be reduced by infusion of mesenchimal stem cells. By measuring mechanically impedance in mechanical ventilated patients we have shown that the success of weaning from the ventilator can be better predicted from the breathing pattern of the patient than from respiratory mechanics (4).

Recent development of nanotechnologies specially suited for probing biological samples allows the study of respiratory mechanics at the single cell and molecule level. We developed a novel device to subject cultured cells to dynamic stretch (5). Combination of this device with nanomanipulation of microbeads attached to the cell surface allowed us to reveal a universal law of strain-induced transient cell fluidization (6). A novel technique to map traction forces exerted by cultured cells in a stretchable substrate allowed us to show that strain-induced fluidization is associated with a transient disruption of the actin-myosin machinery (7).

We have investigated the physical laws that govern cell dynamics by particle nanotracking, showing that cytoskeleton remodeling is a thermically activated process mediated by ATP (8). With atomic force microscopy (AFM) we have shown that the dependence of cell mechanics with temperature is dominated by the contractile activity of molecular motors (9).

AFM is a powerful tool for probing cell nanomechanics. However, contact area between the tip and the cell is not precisely defined in conventional AFM tips. Novel flat ended cylindrical tips (10) allowed us to reveal a differential mechanical response of lung epithelial cells to compressive and tensile local stresses.

Neutrophil mechanics was measured with AFM in patients with advanced hypoxemic chronic obstructive pulmonary disease (COPD) before and after bilateral lung transplantation, and compared with measurements taken in healthy nonsmokers. Young's modulus of neutrophils from patients with COPD was significantly greater than controls. Neutrophil stiffness decreased after lung transplantation showing no significant differences with healthy nonsmokers. Neutrophil stiffening in COPD patients may be related to the abnormal inflammatory response of the lung. Neutrophil improvement after lung transplantation suggests decreased inflammatory pulmonary and systemic responses.

References

1. Carreras *et al. Sleep* 32:117-119, 2009.
2. Almendros *et al. Resp Res*, 11:3, 2010.
3. Nacher *et al. Sleep Med* 10:892–897, 2009.
4. Sellares *et al. Brit J Anaesth* 103:828–832, 2009.
5. Trepat *et al Am J Physiol Lung Cell Mol Physiol* 287 L1025-L1034, 2004.
6. Trepat *et al Nature* 447:592-595, 2007
7. Gavara *et al Biophys J* 95:464–471, 2008
8. Sunyer *et al. Phys Rev E* 79:051920, 2009.
9. Sunyer *et al. Phys Biol* 6: 025009, 2009.
10. Rico *et al J Mol Recognit* 20 459-466, 2007.

Mechanotransduction:

Design Principles of Mechano-Chemical Signal Converters

Viola Vogel
Department of Materials, ETH Zurich, Switzerland

While cells and tissues are known to sense mechanical stimuli and convert them into biochemical signals, the underpinning mechanisms remain unclear. New nanotechnology and computational tools begin to reveal that a multitude of structural protein motifs have evolved, from catch bonds that strengthen the adhesion of bacteria and cells to surfaces under fluid flow, to proteins that enable mechano-chemical signal conversion. These structural motifs include designs by which force can destroy recognitions sites, or alternatively open up cryptic sites that can then recruit binding partners in a force-upregulated manner. Deciphering the underlying engineering principles by which proteins can serve as mechano-chemical signalling switches is essential to learn how cells sense and respond to mechanical forces and probe the physical properties of their environments. It has far reaching implications in tissue engineering, systems biology and medicine.

Chemical Information Processing: Biology or Statistics

S. Marco, Artificial Olfaction Lab
Institut for BioEngineering of Catalonia

Chemical Information is critical for human health and survival. There is increasing concerns about potential toxic effects in food, drinks or even in the air we breathe. Chemical analysis and sensing is present in diverse industrial sectors: from continuous emission monitoring in environmental control, to flavour and aroma quality control in the food or perfumery industries. On the other hand, we are biochemical machines. Sampling and analysing bio-fluids give us information about our health state. In the near future, continuous chemical sensing in clinical settings or even in point-of-care, home-care scenarios will be more and more prevalent. Examples of VOC sensing will be given.

Current analytical instrumentation and continuous sensing can provide huge amount of data. However, chemical sensing and information processing is far from trivial in many cases. I will review the main difficulties associated with chemical sensing, in particular for low cost continuous monitoring. In consequence, information is not directly available and may be hidden in continuous streams of spectra or sensor signals. Automatic signal processing and information evaluation is needed to overcome drowning in data. Today, statistical techniques are typically used to analyse and extract information from continuous signals. A short introduction to the typical procedure for chemical data processing will be given.

It is very interesting to note that biology (insects and vertebrates) has found alternative solutions for chemical sensing and information processing. In the presentation I will review the hypothesized computational functions of different anatomical parts in the olfactory system. I will end this part with a short introduction to the developments in the NEUROCHEM Fp7 project devoted to biomimetic olfactory systems.

High throughput microelectrode array platforms for quantitative pharmacology, toxicology, and drug development using spontaneously active neural tissue.

Guenter W. Gross
Professor of Neuroscience, Department of Biological Sciences
Director, Center for Network Neuroscience
University of North Texas
Denton, TX 76203

In light of the accelerated production of new chemical and pharmaceutical compounds, present testing systems are overwhelmed. As the extensive use of animals is ethically problematic, rapid screening with neuronal networks in vitro is a viable answer. Ten mouse embryos can provide enough tissue to seed up to 1,000 networks if most regions of the brain and spinal cord are used. Remaining cell pools can be frozen and saved for subsequent analyses. This approach provides a high efficiency of tissue utilization.

Primary cell cultures, derived from dissociated murine central nervous system tissue, form stable, spontaneously active networks on microelectrode arrays (MEAs) that provide long-term action potential readout from many discriminated units and simultaneous optical information on cell condition and general network morphology. The spontaneous activity is driven by competing ignition sites (burst leaders) that form a primary, monosynaptically connected circuit (1). Such cell group activity represents a window to the internal dynamics of self-organized networks, but also provides reproducibility and fault tolerance through the use of ensemble activity. In addition to supporting theoretical studies, it is now clear that these networks can be used in pharmacology, toxicology, and as tissue-based biosensors. Experimental evidence shows such models to be "histiotypic", as their responses are highly similar to those of the parent tissue *in vivo.* The networks, which consist of non-neuronal glia cells as well as brain region-specific different neuronal subtypes, reliably report a range of toxic responses: cytotoxicity (death of all cells), neurotoxicity (death of subtypes of neurons), and functional toxicity (loss of electrical function in the absence of cell death). Reproducible dose response curves for many compounds have been obtained (2) and dissociation constants for bicuculline, gabazine, and trimethylolpropanephosphate have been calculated from network activity changes (3). However, before such systems can be used effectively for rapid toxicity screening or for drug development, it is essential to develop high throughput platforms.

Approaches to high throughput have commenced at UNT with the development and testing of 8-network platforms served by a liquid handling robot (BioTek Precision 2000). Eight recording arrays, with 32 microelectrodes each, reside on a single glass plate, are seeded at the same time and grow under a common medium during 3-4 weeks of development. The networks are confined to separate, 1 ml medium pools upon assembly of the recording chamber. Automated dose response data have been obtained, and continual recording periods of up to 20 days have been achieved with robotic osmolarity maintenance and medium changes. The remaining challenges lie in life support engineering, the precision of robotic pipetting, in automated data acquisition, processing, and display, in the development of an effective user interface, and in effective coupling to inverted microscopes.

Supported by the Texas Advanced Technology Program, Plexon Inc., Dallas, and the Charles Bowen Endowment to the CNNS.

(1) Ham, M., Bettencourt, L. M., McDaniel, D, and Gross, G.W. (2008). Spontaneous coordinated activity in cultured networks: Analysis of multiple ignition sites, primary circuits, and burst phase delay distributions. J. Computational Neuroscience 24: 346-357.
(2) Gross, G.W and Gopal, K.V. (2006) Emerging histiotypic properties of cultured neuronal networks. In: M. Taketani and M. Baudry (eds) Advances in Network Electrophysiology using Multi-Electrode Arrays. Springer, pp 193-214.
(3) Rijal-Oli, S. and Gross, G.W. (2008) Determination of dissociation constants using spontaneous neuronal network activity recorded with microelectrode arrays *in vitro.* Journal of Ne
uroscience Methods 173: 183–192

Application of Chimera Protein Matrices for Stem Cell Engineering and Regenerative Medicine

T. Akaike, B. Hexig, H. Ise, M. A. Haque
Department of Biomolecular Engineering, Graduate School of Bioscience and Biotechnology, Tokyo Institute of Technology, Yokohama 226-8501, Japan. E-mail: takaike@bio.titech.ac.jp

Introduction: Biomaterials can play central role in biomedical engineering and regenerative medicine by facilitating cellular behavior and function, such as those where extracellular matrix (ECM) can facilitate embryonic stem (ES) cell growth, proliferation and differentiation. Both biologically derived and synthetic materials have been explored as an ECM in regenerative medicine and tissue engineering. However, complexities associated with natural materials, including complex structural composition, purification, immunogenicity and pathogen transmission have driven the development of synthetic biomaterials for use as 2D or 3D extracellular microenvironments. Moreover, the natural ECMs generate a complex environment and can place considerable stress on the differentiating cells during ES cell culture. The designing of artificial ECM should enable more efficient and scalable culture of ES cells, as well as greater control over material properties and tissue responses. It is expected that development of a new recombinant ECM using chimera proteins for tissue engineering and regenerative medicine will play a significant role in providing an alternative to organ or tissue transplantation.

Materials and Methods: Here, we summarizes some of the most recent developments on the construction of novel ECM using chimera proteins of adhesion molecules (e.g., E-cadherin and N-cadherin) or growth factors such as leukocyte inhibitory factor, LIF, epidermal growth factor, EGF and hepatocyte growth factor, HGF for ES cell proliferation and differentiation. To construct these chimera proteins, we fused functional domains of adhesion molecules and growth factors to IgG-Fc region (abbreviated as E-cad-Fc, N-cad-Fc, LIF-Fc, EGF-Fc, and HGF-Fc).

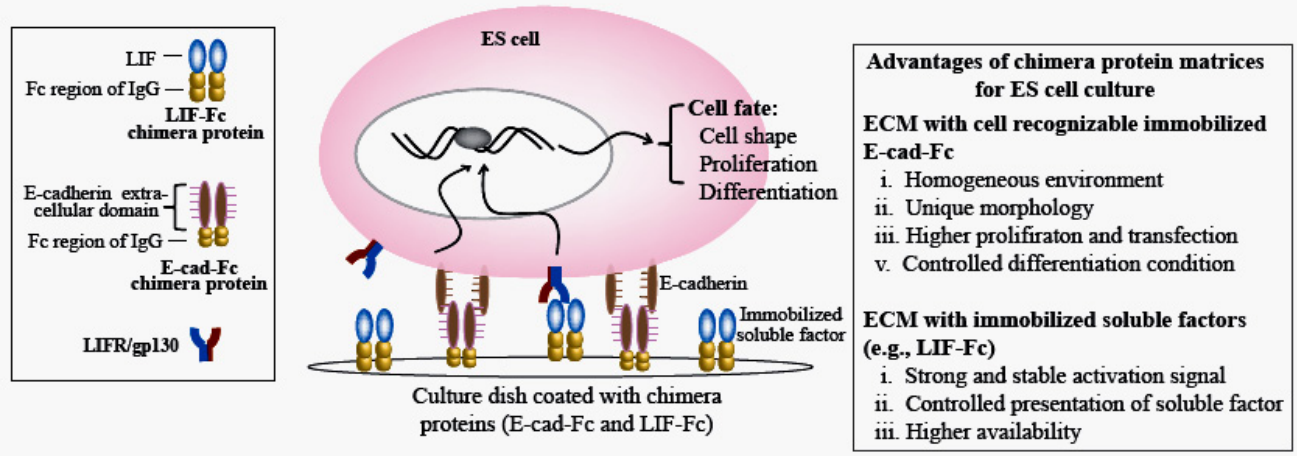
Results and Discussion: Until recently few successes have been reported on proliferation of ES cells in single cell cultures with homogeneous environment. Here, we showed that mouse ES cells cultured on E-cad-Fc coated surface had unique single cell morphology, higher proliferative ability and transfection efficiency than those grown under conventional conditions (Fig. 1). Furthermore, they require less LIF, probably due to the homogeneous exposure of cell to this cytokine.

The biological signals of growth factors and cytokines are mediated by two different forms, the secreted form and the cell membrane- or matrix-anchored form, which release different signal transduction cascades. Compared to soluble form, immobilized recombinant EGF-Fc and HGF-Fc showed more strong and stable activation signals downstream from cell membrane. Besides, as growth factors are required in only very tiny quantities to elicit biological response, designing artificial matrices for controlled growth factor presentation is necessary. We showed that immobilized LIF and E-cadherin can maintain ES cells efficiently with lower dependency of ES cells on LIF (Fig. 1). In addition to ES cell proliferation, E-cad-Fc and N-cad-Fc immobilized ECM can be used to induce controlled and efficient hepatic and neural differentiation at a single cell level.

Summary: The targeted application of chimera protein for designing of ECM will benefit from expansion of ES cells for regenerative medicine and nonobiomedicine, as well as the production of a specific differentiated cell type either by controlling the differentiation in a very specific pathway or by elimination of undesirable cell types.

Reference: Nagaoka, M. Akaike T. PLoS ONE, 1, e15, (2006)

Figure 1: Design and application of chimera protein matrix for stem cell culture and regenerative medicine (Haque & Akaike et al. 2010).



Expression and biomechanical features of fimbrial adhesin organelles by pathogenic *Escherichia coli*

BE Uhlin
The Laboratory for Molecular Infection Medicine Sweden (MIMS), Department of Molecular Biology, Umeå Centre for Microbial Research (UCMR), Umeå University, SE-90187 Umeå, Sweden,
bernt.eric.uhlin@molbiol.umu.se

Extraintestinal pathogenic *Escherichia coli*, as exemplified by the uropathogenic *E. coli* (UPEC) isolates typically carry a multitude of chromosomally located gene clusters known as pathogenicity islands (PAIs) that are absent in non-pathogenic *E. coli* strains. PAIs are considered to have been acquired by horizontal gene transfer and include virulence genes such as toxins and genes coding for specific adhesins. Fimbrial adhesins are involved in establishment of infection in the urinary tract by mediating adherence and allowing the bacteria to resist the shear forces from the urine flow. The UPEC strains generally carry multiple determinants for fimbrial adhesins and our studies revealed a regulatory network among different fimbrial adhesin gene systems and suggest that there may be a hierarchy in the expression involving several families of regulators and transcription factors (Lindberg et al, 2008; Sjöström et al, 2009; Müller et al, 2009; Müller et al, 2010; Hultdin et al, 2010).

By the use of force measuring Optical Tweezers it was shown that the UPEC fimbriae have the ability to unfold and refold in different modes of elongation (Fällman et al, 2005). Differences in biomechanical properties of selected fimbrial structures can be correlated to the host environment in which their role presumably evolved (Andersson et al. 2007; 2008; Castelain et al, 2009)

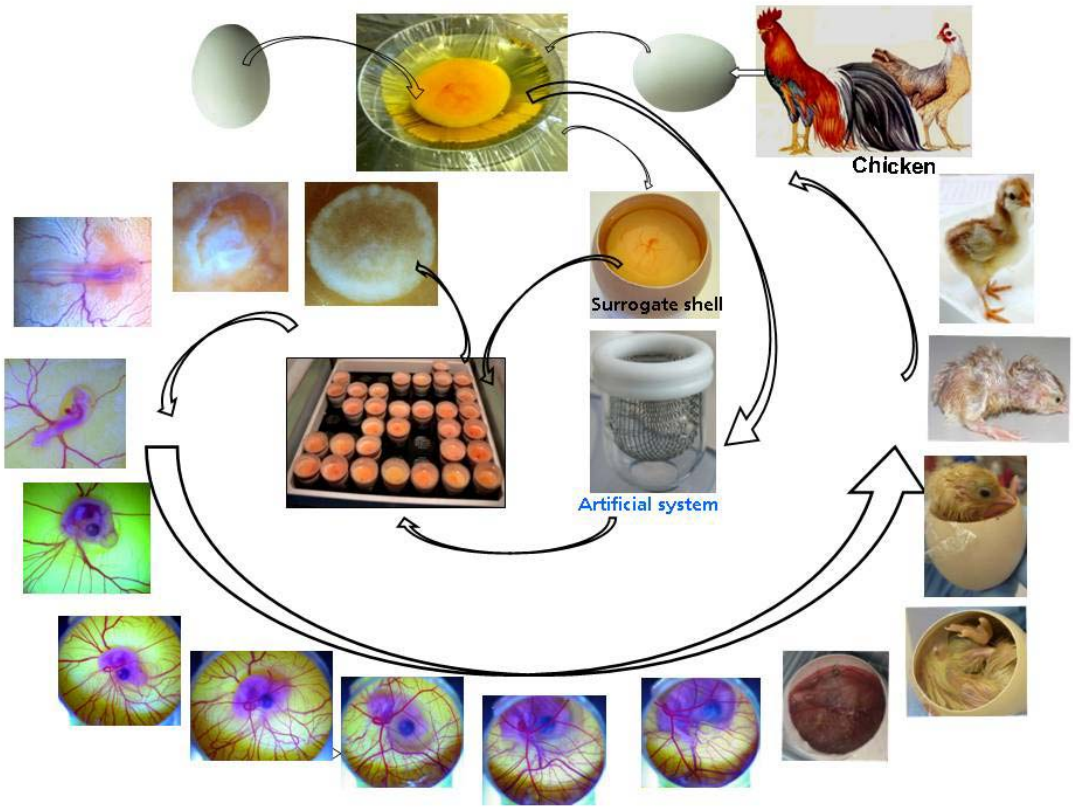
References

Andersson M, Uhlin BE, Fällman E (2007) Biophys. J. 93: 3008-3014.
Andersson, M., Axner, O., Almqvist, F., Uhlin, BE., and Fällman, E. (2008) Chemphyschem. 9:221-235.
Castelain M, Sjöström A, Fällman E, Uhlin BE, Andersson M (2009) Eur. Biophys. J. In press
Fällman E, Schedin S, Jass J, Uhlin BE, Axner O (2005) EMBO Reports 6:52-56.
Hultdin UW, Lindberg S, Grundström C, Huang S, Uhlin BE, Sauer-Eriksson EA (2010) Submitted for publication.
Lindberg S, Xia Y, Sondén B, Göransson M, Hacker J, Uhlin BE (2008) Infect. Immun. 76:771-780.
Müller CM, Åberg A, Straseviciene J, Emödy L, Uhlin BE, Balsalobre C (2009) PLoS Path. 5:e10000303.
Müller CM, Schneider G, Dobrindt U, Emödy L, Hacker J, Uhlin BE (2010) Mol. Microbiol.75:280-293.
Sjöström AE, Sondén B, Müller C, Rydström A, Dobrindt U, Wai SN, Uhlin BE (2009) Microb. Path. 46:150-158.

In vitro-Culture of animal cells – a biological and technical challenge

Günter R. Fuhr, Erwin Gorjup and Siddiqul Haque
Fraunhofer-Institute for Biomedical Engineering (IBMT)
Ensheimer Str. 48-50, 66386 St. Ingbert, Germany
guenter.fuhr@ibmt.fraunhofer.de

Termini like „*in vitro*-culture“, „tissue culture“, „tissue engineering“, „artificial organs“ are often used as summarizing termini in the life sciences from a variety of scientists of different origin. These termini imply well established and well defined research areas. This is, however, due to some fundamental problems, only partially the case. Therefore, at the beginning of the presentation the state of the art of *in vitro*-culture of vertebrate cells (not bacterial or plant cell culture) and limitations of cell handling are explained. As shown, the problems can be divided into two groups: First, related to biology and second, physical and technical problems. It is the aim of the presentation to analyze both fields of problems and to develop concepts for improvement. Demonstrating selected examples of projects currently in progress at Fraunhofer-IBMT should focus the attention on this interdisciplinary field of research with fundamental importance for future biotechnology. At the end, perspectives are given and research strategies are discussed.



Total *ex ovo* development of a bird in surrogate shell to develop new *in vitro* culture systems.

Supramolecular Engineering of Bioactive Nanostructures and their Hierarchical Systems

Samuel I. Stupp
Northwestern University
Departments of Chemistry, Materials Science and Engineering, and Medicine
2220 Campus Drive Evanston, IL 60208, USA
s-stupp @northwestern.edu

Bioactive nanostructures molecularly crafted to signal cells or deliver genes and proteins have great potential in the regeneration of organs and tissues. The supramolecular chemistry of such nanostructures should allow them to interact specifically with cell receptors or intracellular targets. Our laboratory has developed a broad class of amphiphilic molecules that are programmed to self-assemble into nanoscale filaments with the capacity to display signals to cells and bind specific proteins or DNA. Their remarkable bioactivity is thought to originate in the internal supramolecular structure of the filaments. The biological functions to be illustrated in this lecture include their use in spinal cord injury, Parkinson's disease, infarct and ischemic tissue management through rapid growth of blood vessels, bone regeneration, cartilage regeneration, and cell transplantation for diabetes. These filaments can also self organize into systems with hierarchical structure across scales. These systems include the formation of filament crystals, monodomain gels that serve as wires to guide cells, as well as spherical membranes that can be macroscopic or microscopic. These membrane systems involve the use of biopolymers and peptide amphiphiles, and depending on dimensions may serve as bioreactors or artificial cells in novel therapies.

Institute for bioengineering of Catalonia

3rd IBEC SYMPOSIUM ON BIOENGINEERING AND NANOMEDICINE

BARCELONA 1-2 JUNE 2010

Posters with flash presentation

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Posters with flash presentation			
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Poster 3	Artés	J. M.	Electron transfer properties of redox protein azurin measured by electrochemical tunneling spectroscopy
Poster 4	Barilani	Mario	Generation of transgenic cadiomyocyte-specific reporter lines of human pluripotent stem cells
Poster 5	Barreto	Sara	Modelling the mechanical response of a single cell in magnetic twisting cytometry: contribution of the cytoskeleton filaments
Poster 6	Carminati	Marco	Single-Chip Instrumentation with zeptoFarad Capacitive Resolution and femtoAmpere Current Sensitivity for Nano-Biotechnology
Poster 7	Casares García	Laura	A stretching system to combine high resolution imaging and traction microscopy
Poster 8	Cendra	Maria del Mar	The importance of ribonucleotide reductase genes in Escherichia coli biofilm formation
Poster 9	Coelho	Nuno	Type IV Collagen and Laminin assembly on Substrates with Controlled –OH density
Poster 10	Darwish	Nasser	Surface Plasmon Resonance Using Nanocrystalline Diamond Substrates
Poster 11	Díez-Ahedo	Ruth	Biofuntional micropatterned surfaces to study the role of tetraspanins on the spatio-temporal organisation of LFA
Poster 12	Dols-Perez	Aurora	Dielectric properties of supported biomembranes at the nanoscale
Poster 13	Esteban i Ferrer	Daniel	Electrical Studies of Single Bacteria
Poster 14	Fernández Romero	Luis	Gas sensor array system inspired on the sensory diversity and redundancy of the olfactory epithelium
Poster 15	Garcia	Simon	Immobilized chemoattractant gradients to study mechanics and migration of satellite cells
Poster 16	Garde	Ainara	Study of periodic breathing in chronic heart failure patients based on correntropy
Poster 17	Gil	Vanessa	Developmental expression of the Oligodendrocyte Myelin Glycoprotein in the mouse telencephalon
Poster 18	Gil de Mesquita	Joana Margarida	Analysis of regular and non regular snores and its relationship with SAHS
Poster 19	Giralt	Xavier	Intention Based Robot Interaction Modes and their Transitions
Poster 20	Gonzalez	Arlyng	Role of extracellular calcium in bone tissue regeneration through CASR
Poster 21	Gonzalez Claramonte	Laura	ROBIOCAT: Robotized Nanobiocharacterization Station
Poster 22	Guamán	Ana	Pilot Study: Breath Analysis with GC-MS to identify Sepsis in Rats
Poster 23	Hoyo	Javier	Characterization of biomimetic mixed films of DPPC and ubiquinone
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Poster 29	Olivares	Andy	Prediction of cell seeding on regular scaffold using spherical particles
Poster 30	Pedró Pujibet	Laura	Stress-induced Deletion of the Operon Encoding the Toxin α-Hemolysin in Escherichia coli
Poster 31	Pérez-Samper	Gemma	Extracellular Ca2+ Differentially Regulates LFA-1 Adhesiveness by Coupling Conformational Changes to Lateral Mobility.
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Local Organizer:

Institut de Bioenginyeria de Catalunya
Baldiri Reixac 10-12
08028 Barcelona – Spain
Tel. +34(93)403 97 06
Fax. +34(93)403 97 02
www.ibecbarcelona.eu

Partners: