A Decade of Research in the Centre of Applied Science for Health

Shaping the Course of (Bio) Pharmaceutical Development & Sensor Technologies

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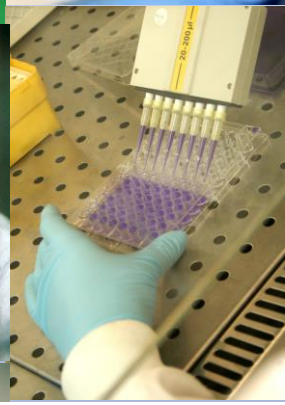
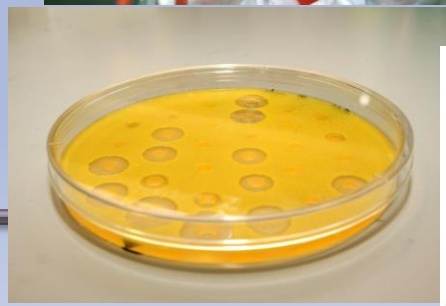




Centre of Applied Science for Health

Funded Under the Programme for Research in Third Level Institutions Cycle 4

Ireland's EU Structural Funds Programmes 2007 - 2013
Co-funded by the Irish Government and the European Union
EUROPEAN REGIONAL DEVELOPMENT FUND
AN ROINN OIDEACHAIS AGUS EOLAÍOCHTA | DEPARTMENT OF EDUCATION AND SCIENCE
HEA
Higher Education Authority
An tÚdarás um Ard-Oideachas
INVESTING IN YOUR FUTURE

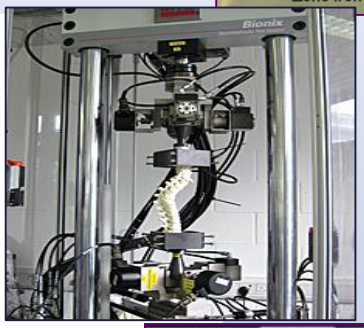
Centre of Applied Science for Health

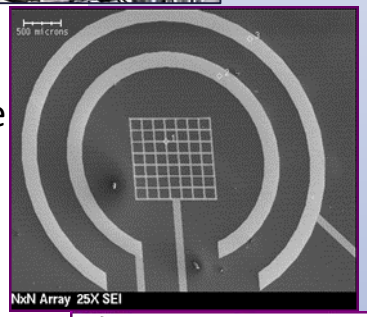
- **Established in 2007 at IT Tallaght**
  - *with funding under the Irish Government Programme for Research in Third Level Institutions (PRTLI) Cycle 4 administered by the Higher Education Authority*
  - *€10.65 million funding*
- **A partnership programme between:**
  - IT Tallaght [Lead Institute]
  - National Institute for Cellular Biotechnology (NICB) at Dublin City University
  - National University of Ireland Maynooth (NUIM)
  - Tallaght Hospital (Teaching Hospital of the University of Dublin, Trinity College)

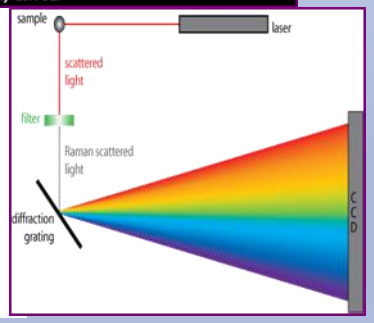
Adelaide, Meath & National Children's' Hospital

Early Thematic Areas

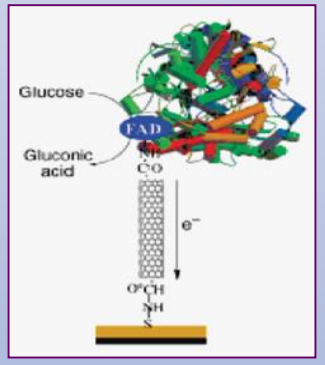
- **Microbial Host Interactions**
  - Commercialisation of IP relating to vaccine candidates
  - Development of novel anti-microbial agents
- **Bioengineering Technology**
  - Evaluation of bone cements for spinal repairs
- **Biomedical Sensors Devices**
  - Commercialisation of IP relating to electroanalytical detection of disease markers
  - Commercial development of microbe specific probes
  - Prototyping service for design and fabrication of sensor devices
- **Pharmaceutical & Materials Analysis**
  - Services and research supports to industry using NMR, LC-MS, GC-MS, SEM
  - Use of PAT technologies to analysis and resolve manufacturing challenges







Some of our Early Projects

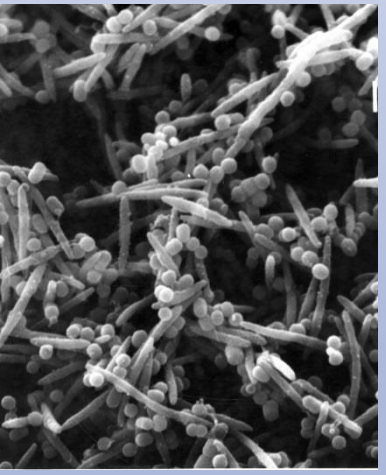


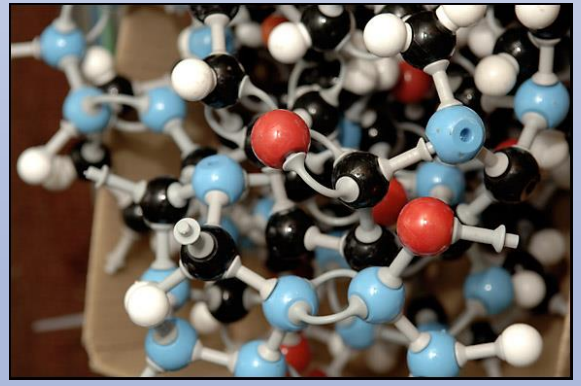
Project Title
Electrochemical Detection of Neurotransmitters with Integrated Microdialysis System
Neurological Oxidative Stress - Brain Energy Metabolism: Towards Implantable Peroxide and Glutamate Probes
Investigating the Control of Copper Redox Activity – a Potential Route to New Neuroprotective Agents
Development of a biosensor framework via inkjet printing
Functioning Lumen Imaging Probes (FLIPs) for the real-time analysis of the sphincters & other active lumens within the human body
Hepatocyte Growth Factor and its Role in Human Cancers
Translational Research in Cancer
Novel Intervention Drugs for Therapy and Prevention of Gastric Cancer

Expanded Thematic Areas

- Microbial Disease Control
- Design and Synthesis of Novel Therapeutics
- Drug Delivery Systems
- Biomedical Sensors and Devices
- Implant & Biomaterial Design
- Pharmaceutical & Materials Analysis
- Nutraceuticals
- Cardiac Rehabilitation
- Smart Sensors
- Microfluidic Systems
- Data Analytics
- Sports Performance & Health
- The Role of Exercise & Diet on Disease Control

Shaping the Course of (Bio) Pharmaceutical Development & Sensor Technologies





Introduction

- Understanding how pathogens invade the body
- Strategies to combat antimicrobial infection and prevent biofilm formation
- Novel antimicrobials and anticancer agents
- Peptide synthesis advancements
- Macromolecules and host-guest Interactions
- New drug delivery systems
- Wide range of sensor platforms
- Close-to-market research

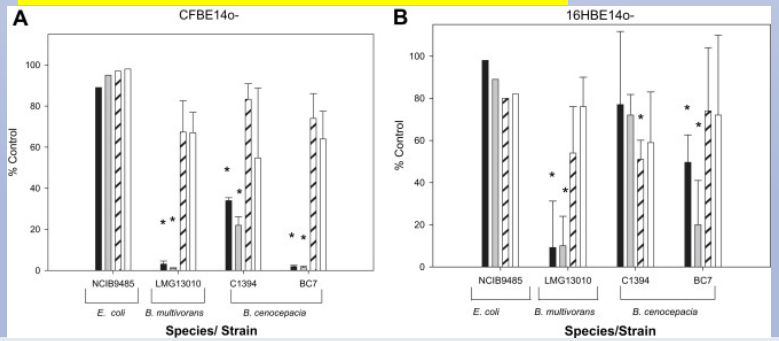
Understanding Cystic Fibrosis Pathogenosis

- *Burkholderia cepacia complex* (Bcc) is an opportunistic bacterial pathogen that causes chronic infections in people with cystic fibrosis (CF).
- A highly antibiotic resistant organism and Bcc infections are rarely cleared from patients, once they are colonized.
- The two most clinically relevant species within Bcc are *Burkholderia cenocepacia* and *Burkholderia multivorans. The mechanisms of colonisation and pathogenesis of Bcc are still poorly understood and many virulence factors remain unidentified.*[1]

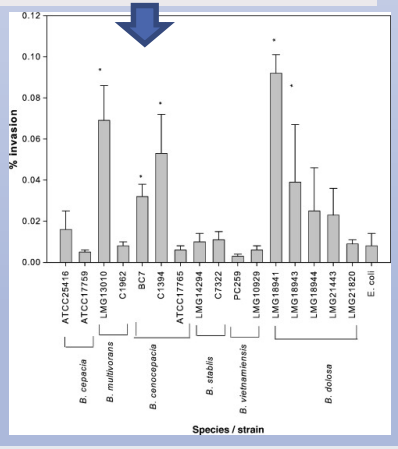
Strategies investigated at ITT [2]

- Bacterial invasion studies
- Variable O_2 concentrations
- Low iron content

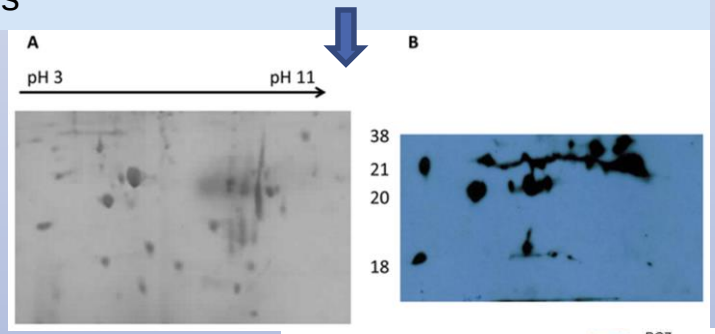
Have found glycoplipids play a role in pathogen invasion [2]

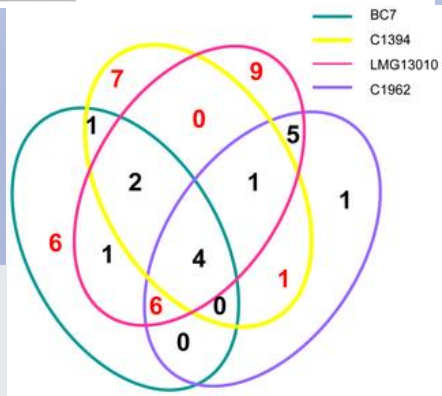


Examined biofilm formation of *Burkholderia Dolosa*[4]



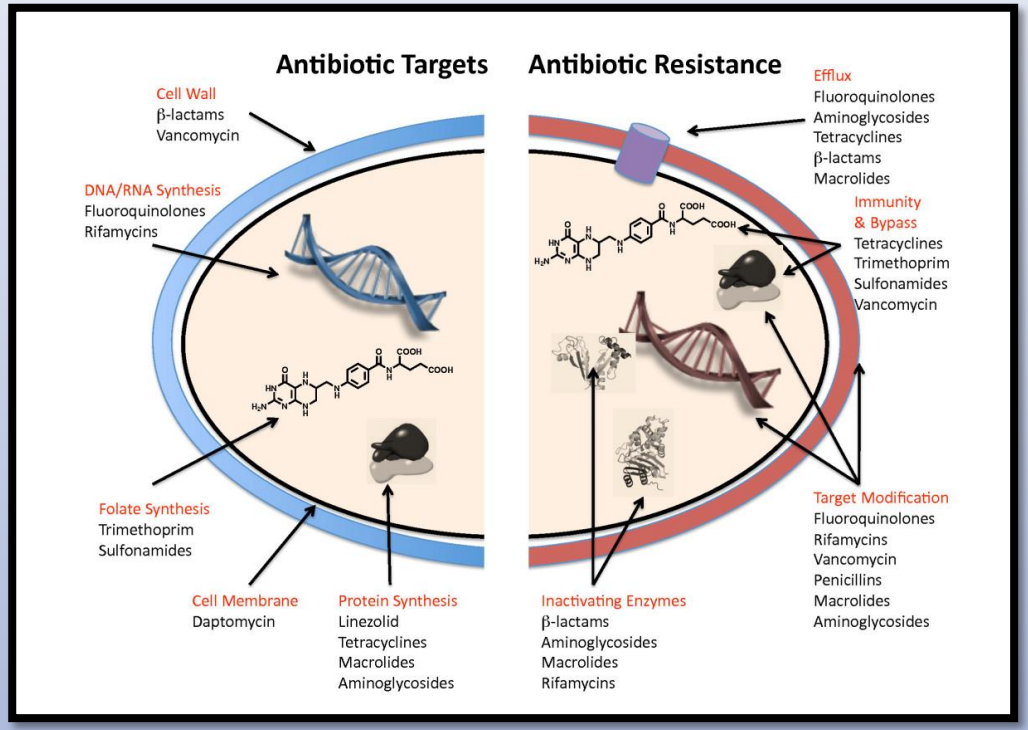
15 immunogenic proteins identified which are common to both species[3]





1. Maire Callaghan, Siobhan McClean, ***Current Opinion in Microbiology 2012, 15:71–77***; Maire Callaghan, Jean Tyrell, ***Microbiology, 162: 191-205***
2. Tracey Mullen, Maire Callaghan, Siobhan McClean, ***Microbial Pathogenesis 49 (2010) 381-387***
3. Minu Shinoy, Ruth Dennehy, Lorraine Coleman, Stephen Carberry, Kirsten Schaffer, Máire Callaghan, Sean Doyle, Siobhán McClean, ***PLOS ONE, November 15, 2013***
4.Emma Caraher, Caroline Duff, , Tracy Mullen, Suzanne Mc Keon, Philip Murphy, Máire Callaghan, Siobhán McClean**, *Journal of Cystic Fibrosis 6 (2007) 49–56***

Bacterial lung infections – Developing an understanding of resistance mechanisms



https://commons.wikimedia.org/wiki/File:Antibiotic_resistance_mechanisms.jpg

Highlights

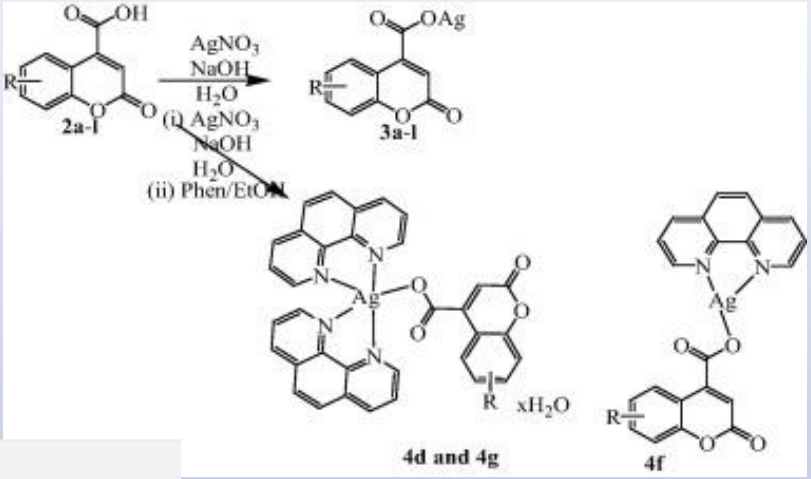
- Antibiotic resistance in bacteria is increasing at a rapid rate.
- Resistance in bacteria is increasing mortality in many patients with lung infections such as cystic fibrosis and pneumonia.
- We need to better understand the mechanisms behind the resistance in order to develop novel therapies, including adjunct therapies.
- We're working on novel antimicrobial peptides and novel small molecular weight inhibitors as weapons against bacterial lung infections.

References:

- **Tynan A, Mawhinney L, Armstrong ME, O'Reilly C, Kennedy S, Caraher E, Cooke G, et al.** *Macrophage migration inhibitory factor enhances Pseudomonas aeruginosa biofilm formation potentially contributing to cystic fibrosis pathogenesis*. FASEB journal : **official publication of the Federation of American Societies for Experimental Biology. 2017.**
- **Hisert, K.B., Cooke, G., et al.,** *Restoring Cystic Fibrosis Transmembrane Conductance Regulator Function Reduces Airway Bacteria and Inflammation in People with Cystic Fibrosis and Chronic Lung Infections.* ***Am J Respir Crit Care Med, 2017. 195(12): p. 1617-1628.***
- ***Adamali, H., et al.,*** *Macrophage migration inhibitory factor enzymatic activity, lung inflammation, and cystic fibrosis.* ***Am J Respir Crit Care Med, 2012. 186(2): p. 162-9.***

Strategies to Combat Antimicrobial Infection and Prevent Biofilm Formation – New Compounds …

- A novel series of coumarin-4-carboxylate ligands and their Ag(I) complexes and phenanthroline adducts (**4d**, **4f** and **4g**) have been synthesised and characterised.
- Six of the complexes (3a–f) were also tested against *P. aeruginosa* (PA01) either in planktonic form or as a biofilm
- Activity was greater than $AgNO_3$ against biofilms



Compound	*Pseudomonas aeruginosa* (PA01)	
	MIC_{90} (μM)	BIC_{90} (μM)
Ligands (**2a–f**)	>200	>200
[Ag(6-OCH_3CA)] **(3a)**	95.8 (±0.4)	25.0 (±1.3)
[Ag(7-OCH_3CA)] **(3b)**	96.6 (±1.4)	18.3 (±3.6)
[Ag(8-OCH_3CA)] **(3c)**	93.2 (±0.4)	19.6 (±3.8)
[Ag(6-ClCA)] **(3d)**	91.7 (±1.0)	16.9 (±2.4)
[Ag(6-BrCA)] **(3e)**	154.2 (±30.2)	21.2(±0.5)
[Ag(8-Cl-6-OCH_3CA)] **(3f)**	95.6 (±1.0)	15.2 (±3.2)
$AgNO_3$	95.2 (±0.9)	18.1 (±3.7)

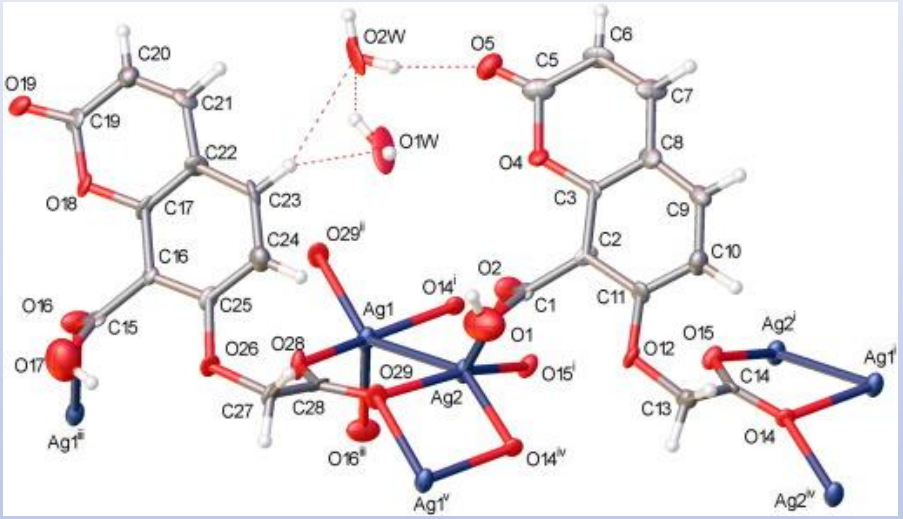
Antimicrobial activity of selected Ag(I) complexes (**3a–f**) against *Pseudomonas aeruginosa* (PA01) expressed as MIC_{90} and BIC_{90}.

MIC_{90} values (minimum concentration required to inhibit 90% of visible cell growth in 24 h).

BIC_{90} values (biofilm inhibitory concentration, defined as the minimal concentration of compound to reduce biofilm formation by 90% after 18 h treatment.).

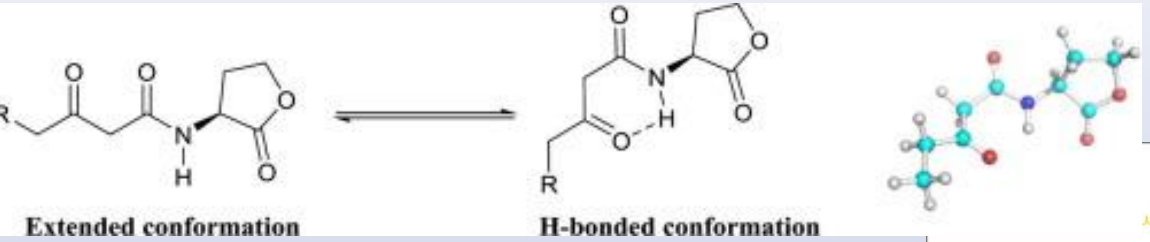
Maeve Sullivan, Agnieszka Folytn-Arfa Kia, Mark Long, Maureen Walsh, Kevin Kavanagh, Siobhán McClean, Bernadette S. Creaven
Polyhedron 67 (2014) 549–559

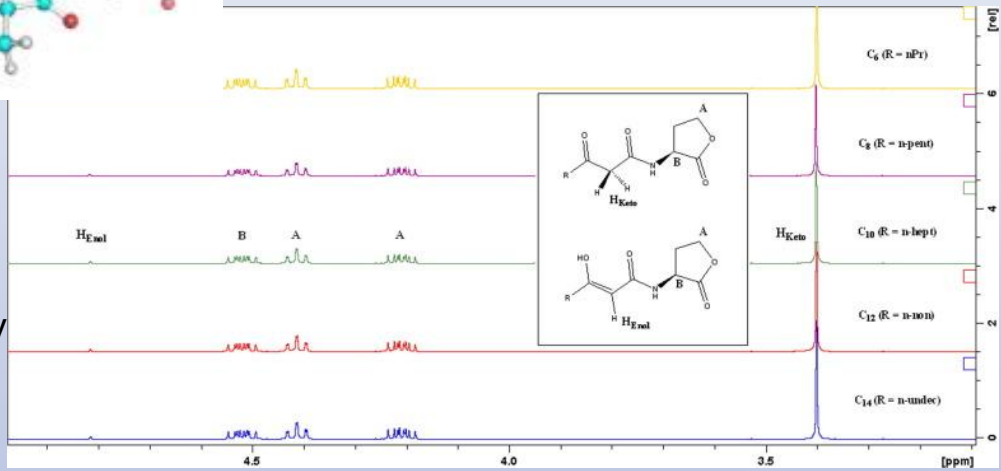
- Molecular modeling studies of silver(I) complexes established their binding modes.
- The complexes had antifungal and cytotoxic activity but moderate antibacterial activity.
- Selectivity towards Gram-negative bacteria relative to Gram-positive bacteria
- Significant anti-*Candida* activity
- Complexes don't appear to interact via DNA intercalation or have nuclease activity.
- Their ability to act as superoxide dismutase mimetics may be linked to their chemotherapeutic activity.



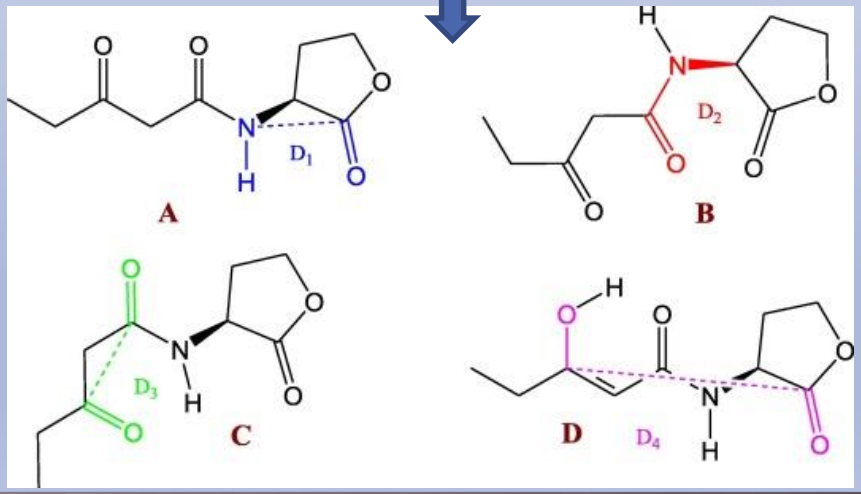
Muhammad Mujahid, Natasha Trendafilova, Agnieszka Foltyn Arfa-Kia, Georgina Rosair, Kevin Kavanagh, Michael Devereux, Maureen Walsh, Siobhán McClean, Bernadette S. Creaven, Ivelina Georgieva ***Journal of Inorganic Biochemistry 163 (2016) 53–67***

Biofilm Studies Aided by Computational Chemistry and NMR





A compact H-bonded structure (**C**) is the lowest energy keto conformation for OHLs in the gas phase, as well as in solvent models.



The computational and NMR studies show that care must be taken in reaching conclusions on exact ligand (or protein) bioactive conformations based solely on calculations *in vacuo* or one solvent model, X-ray crystal structures including ligand-bound receptor structures, or indeed solution NMR data, **as in reality the actual picture is likely to be far more complicated**

Darren Crowe, Alan Nicholson, Adrienne Fleming, Ed Carey, Goar Sánchez-Sanz, Fintan Kelleher ***Bioorganic & Medicinal Chemistry 25 (2017) 4285–4296***

Antimicrobial Resistance Network Ireland

http://amr.ie/

A site for those in Ireland with a Professional or Personal interest in addressing Antimicrobial Resistance AMR Ireland has been set up to provide a one-stop shop for information related to Antimicrobial Resistance in Ireland and beyond.

Dr. Fintan Kelleher, (Founder) Molecular Design and Synthesis Group and Centre of Applied Science for Health, IT Tallaght

Part of the One Health Initiative (*One World-One Medicine-One Health*)

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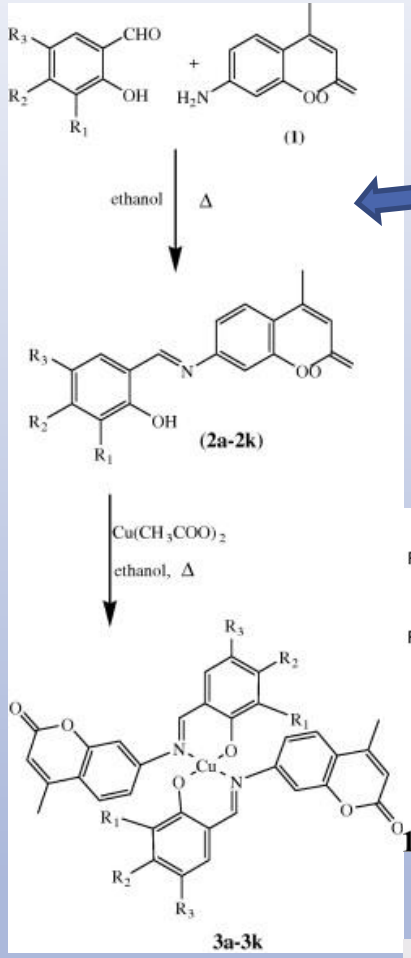
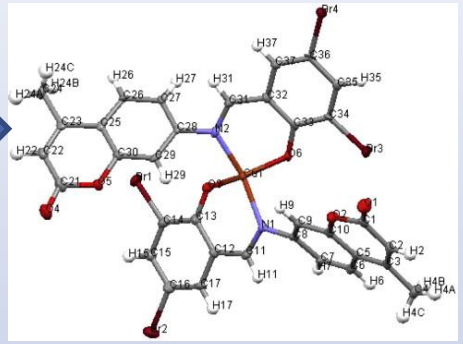
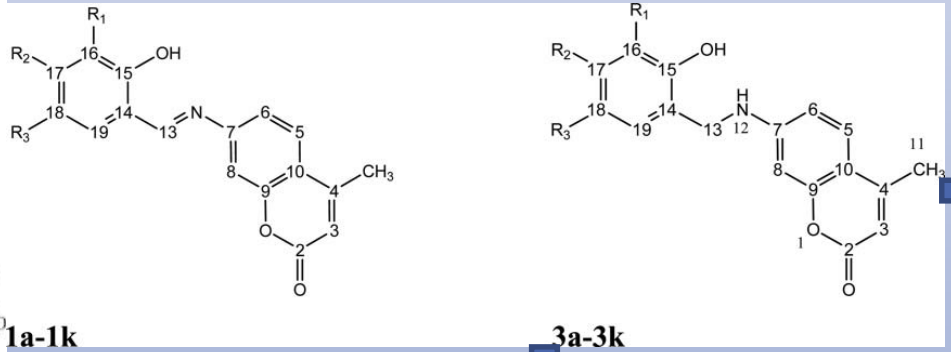
A Selection of Novel Antimicrobials



Schiff base ligands with electron-withdrawing substituents such as –Cl, –Br, or –I, at the R_1 and R_3 positions of the salicylaldehyde moiety had greater anti-*Candida* activity than ligands with electron-donating substituents.



Bernadette S. Creaven, Michael Devereux, Dariusz Karcz, Andrew Kellett, Malachy McCann, Andy Noble, Maureen Walsh Journal of Inorganic Biochemistry 103 (2009) 1196–1203



Also have anticancer activity against hepatic carcinoma cell lines

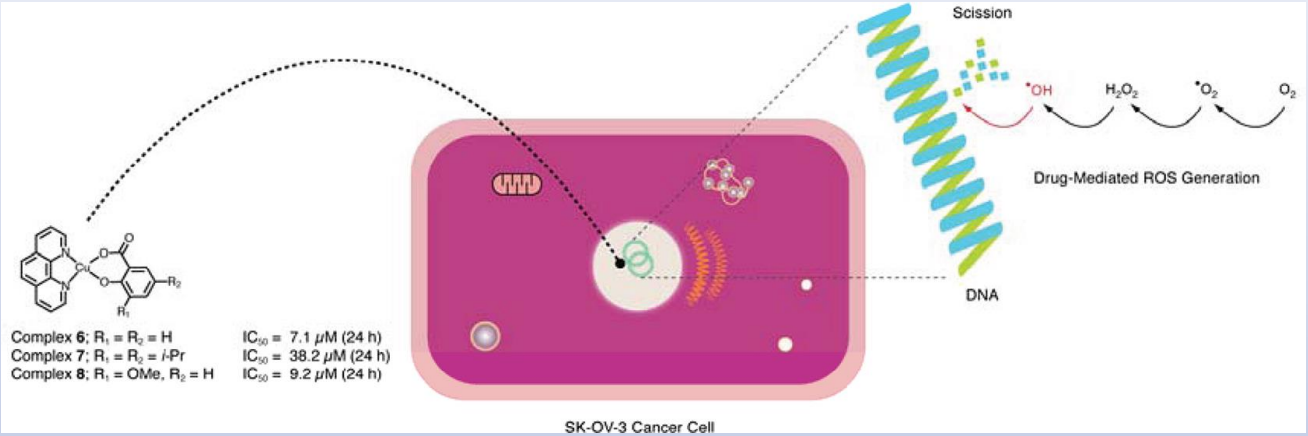
Bernadette S. Creaven, Brian Duff, Denise A. Egan, Kevin Kavanagh, Georgina Rosair, Venkat Reddy Thangella, Maureen Walsh ***Inorganica Chimica Acta 363 (2010) 4048–4058***

Coordination data show the predominant formation of *mono-ligand* complexes [CuLH]+, [CuL] and [CuLH-1]- for **1c**, while the predominant species for the other ligands were [CuL]+, [CuLH-1] and [CuLH-2]-. Active against *Candida Ablicans*

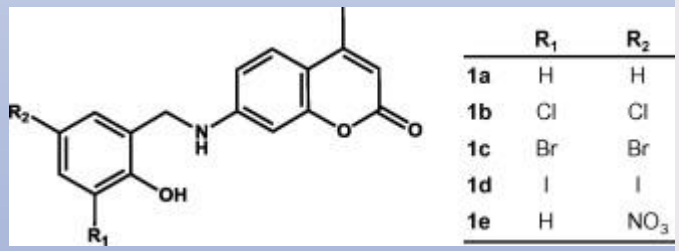
Bernadette Sarah Creaven, Eszter Czegle´di,Michael Devereux, E´ va Anna Enyedy, Agnieszka Foltyn-Arfa Kia, Dariusz Karcz, Andrew Kellett, Siobhán McClean, N´ora Veronika Nagy, Andy Noble, Antal Rockenbauer,Ter´ezia Szab´o-Pl´anka and Maureen Walsh ***Dalton Trans., 2010, 39, 10854–10865***

Some New Anti-Cancer Agents

Complexes 6−8 display rapid micromolar cytotoxicity against cisplatin sensitive (breast (MCF-7), prostate (DU145), and colon (HT29)) and cisplatin resistant (ovarian (SK-OV-3)) cell lines



Mark O'Connor, Andrew Kellett, Malachy McCann, Georgina Rosair, Mary McNamara, Orla Howe, Bernadette S. Creaven, Siobhán McClean, Agnieszka Foltyn-Arfa Kia, Denis O'Shea, and Michael Devereux ***J. Med. Chem. 2012, 55, 1957−1968***

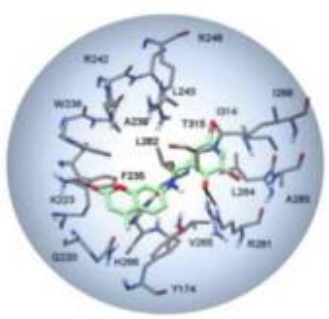


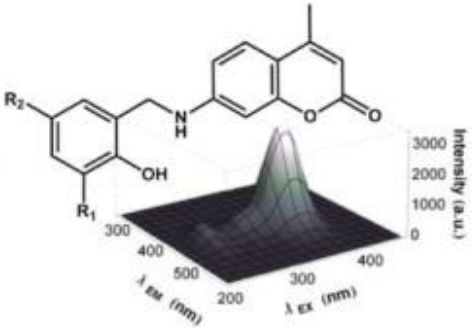
	R_1	R_2
1a	H	H
1b	Cl	Cl
1c	Br	Br
1d	I	I
1e	H	NO_3

Cl, Br, I derivatives show remarkable anticancer activity against HT29 (human colon cancer) cell line (IC_{50} values: 60–82 μM), which was found to be comparable to that of mitoxantrone, an antineoplastic chemotherapy drug

Fluorescent at physiological pH

Bind to HSA

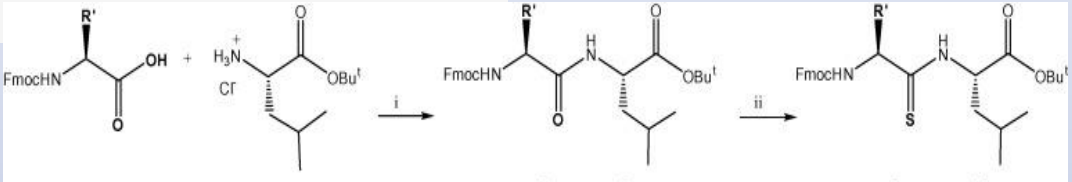




Orsolya Dömötör, Tiziano Tuccinardi, Darius Karcz, Maureen Walsh, Bernadette S. Creaven, Éva A. Enyedy ***Bioorganic Chemistry 52 (2014) 16–23***

Peptide Synthesis Advancements

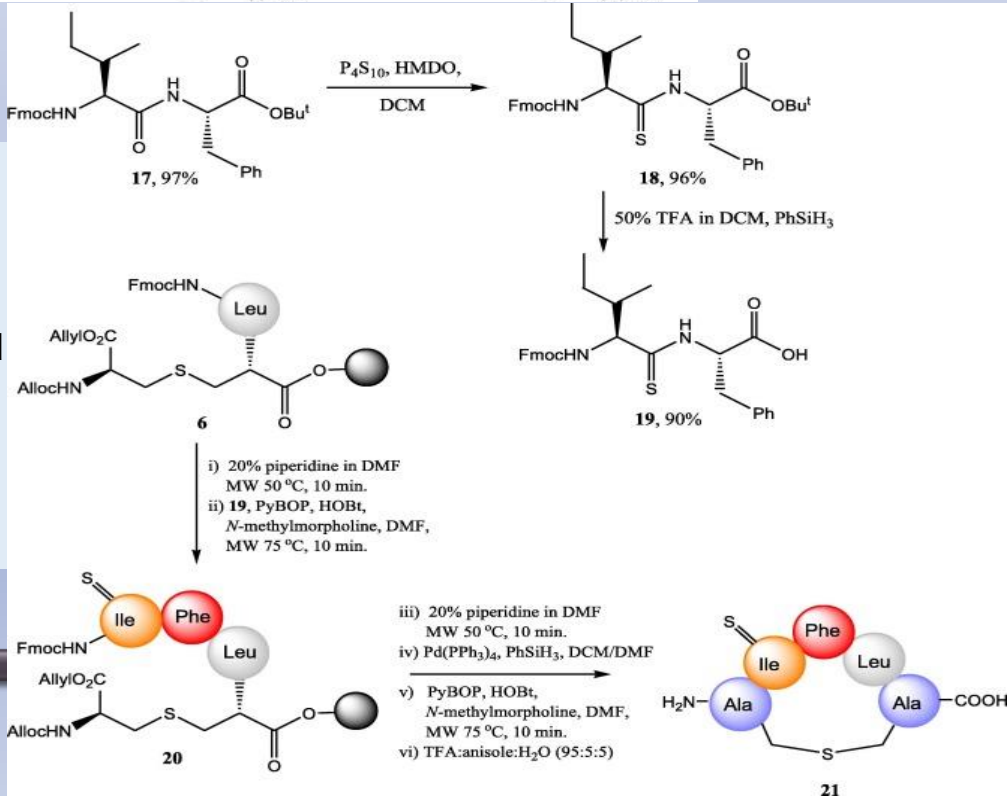
- Efficient synthesis of orthogonally protected dipeptides.
- Fully optimised method.
- Clean removal of the C-terminal ester protecting group.



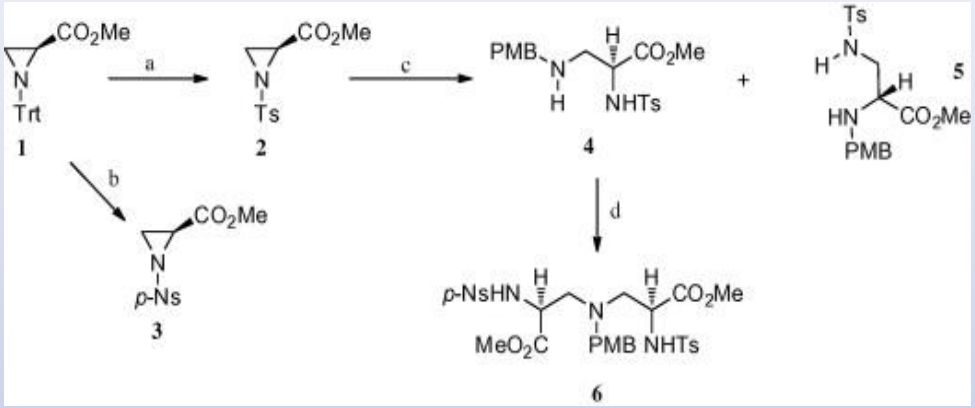
Kim Manzor, Fintan Kelleher
Tetrahedron Letters 57 (2016) 5237–5239

- Solid-phase peptide synthesis of five A-ring analogues of the lantibiotic nisin.
- Solid-phase synthesis of a nisin A-ring analogue containing a thioamide link.
- First report of a thioamide being incorporated within a lantibiotic ring structure.

Kim Manzor, Keith ó Proinsias, Fintan Kelleher
Tetrahedron Letters 58 (2017) 2959–2963

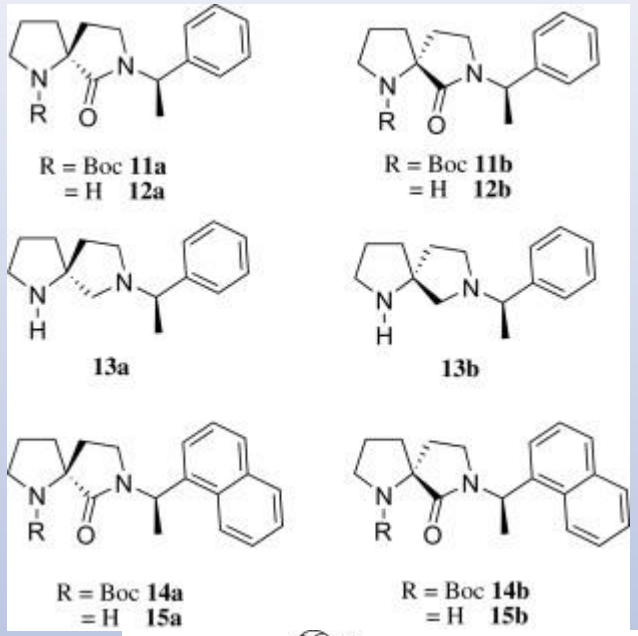


New Peptide Synthetic Reactions

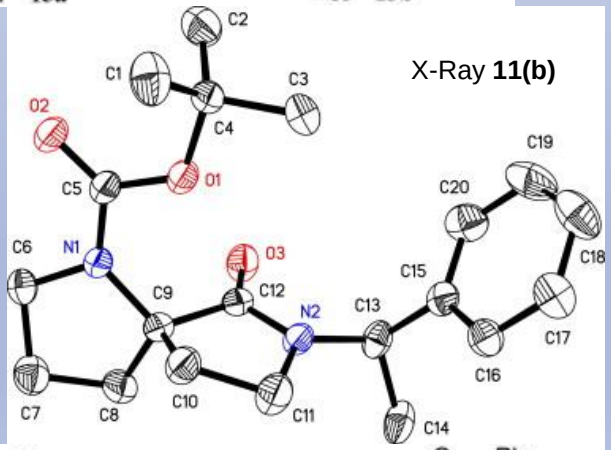


Reagents and conditions: (a) (i) 50% TFA in CH_2Cl_2/MeOH (1:1), rt, 30 min, (ii) $NaHCO_3$, H_2O, rt, (iii) *p*-toluenesulfonyl chloride, EtOAc, rt, 24 h, 92% from **1**; (b) (i) 50% TFA in CH_2Cl_2/MeOH (1:1), rt, 30 min, (ii) $NaHCO_3$, H_2O, rt, (iii) *p*-nitrobenzenesulfonyl chloride, EtOAc, rt, 24 h, 85% from **1**; (c) *p*-methoxybenzylamine, MeCN, rt, 24 h (70% **4** and 23% **5**); (d) **3**, MeCN, 80 °C, 24 h, 51%.

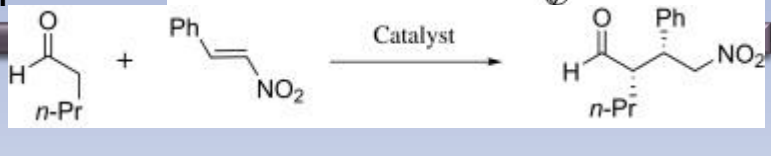
Keith O'Brien, Keith ó Proinsias, Fintan Kelleher **Tetrahedron Letters 54 (2013) 2395–2397**



Keith O'Brien, Keith ó Proinsias, Fintan Kelleher ***Tetrahedron, Volume 70, Issue 34, 2014, pp. 5082-5092*** – Work on allyl derivatives, more sterically hindered aziridine and EWG …

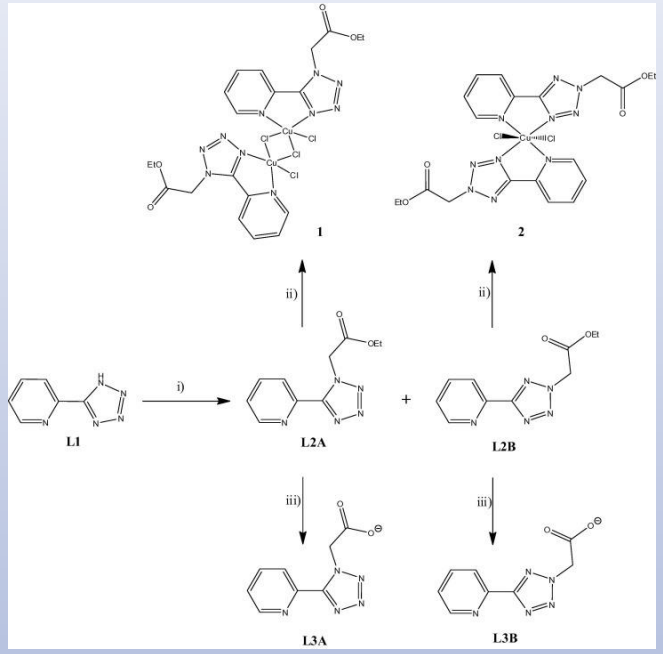


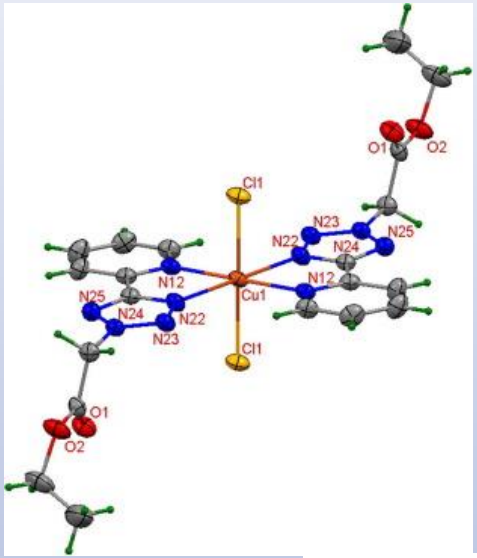
Spirolactam and α-methyl prolinamide organocatalyst in Michael Addition

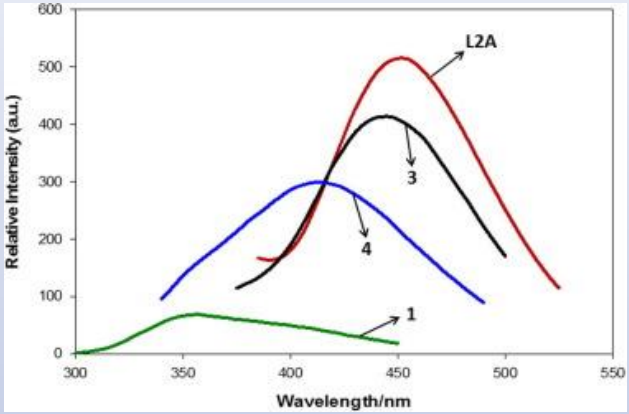


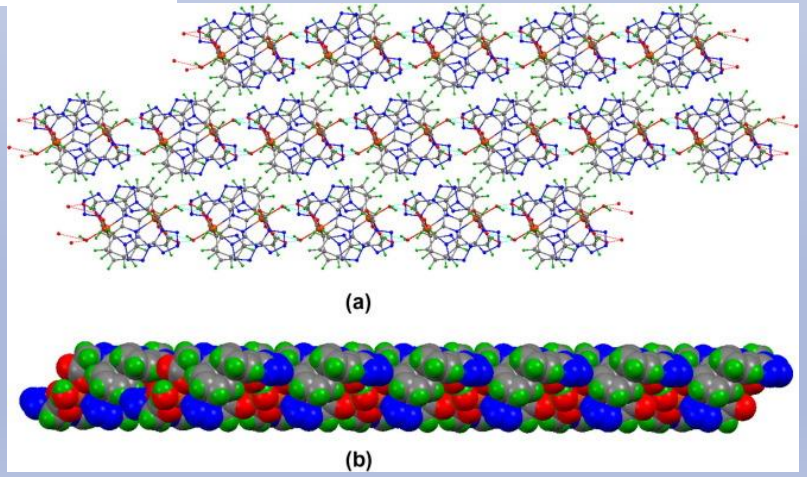
Fintan Kelleher, Sinead Kelly, John Watts, Vickie McKee ***Tetrahedron 66 (2010) 3525–3536***

Metal-organic Frameworks Tetrazole Based



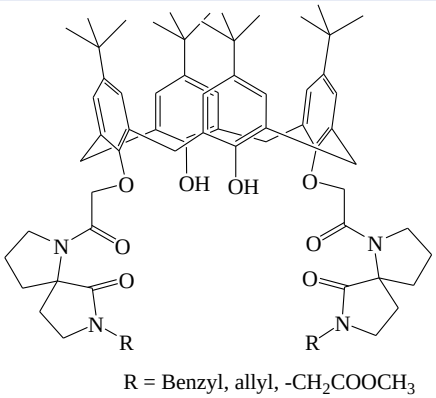




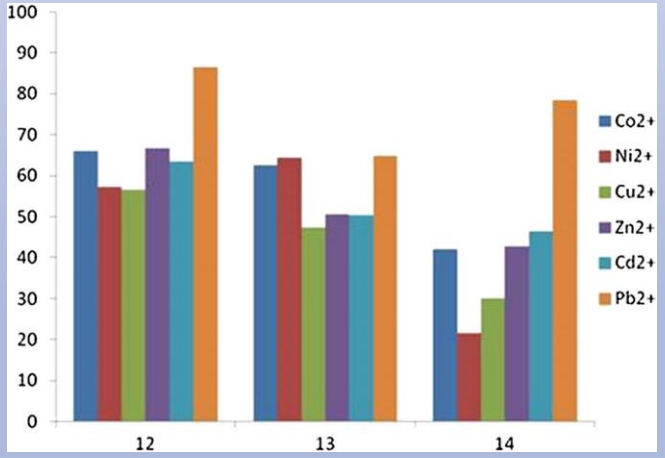


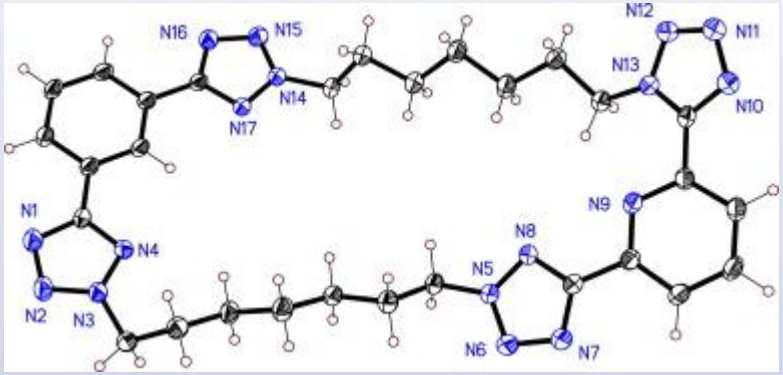
Ursula Sheridan, John F. Gallagher, Morten J. Bjerrum, Adrienne Fleming, Fintan Kelleher, John McGinley ***Inorganica Chimica Acta 421 (2014) 200–209***

Macromolecules and Host-Guest Interactions

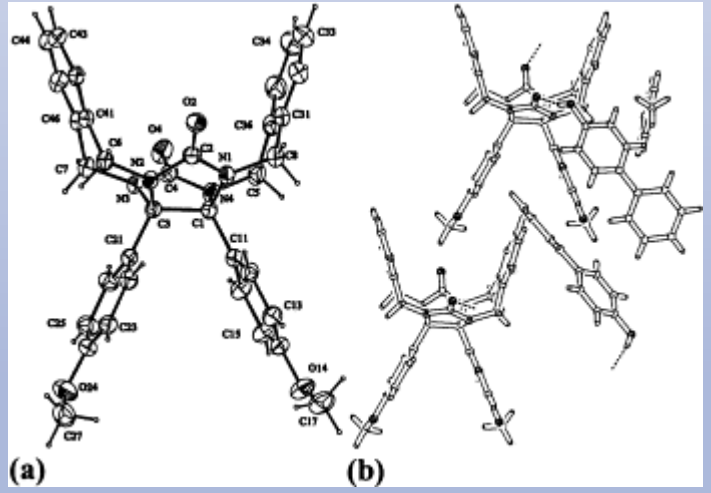


James Ward, Li Li, Fiona Regan, Mary Deasy, Fintan Kelleher ***J. Incl. Phenom. Macrocycl. Chemistry 2015, 83, 377-386***

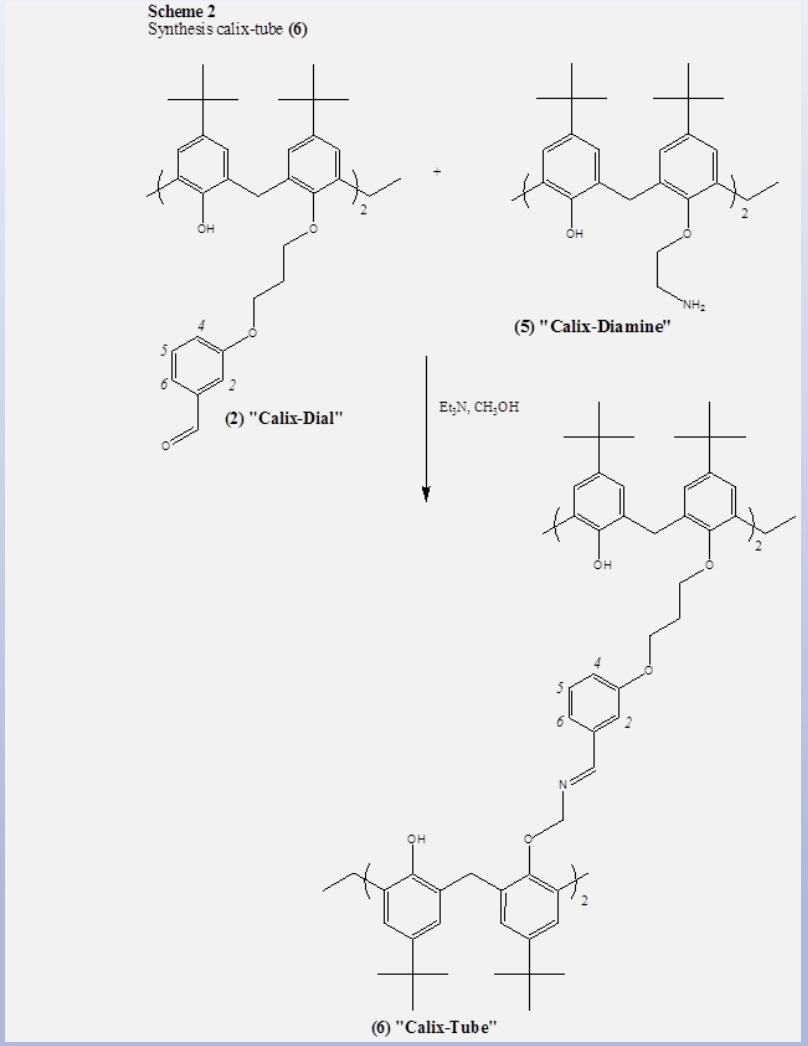


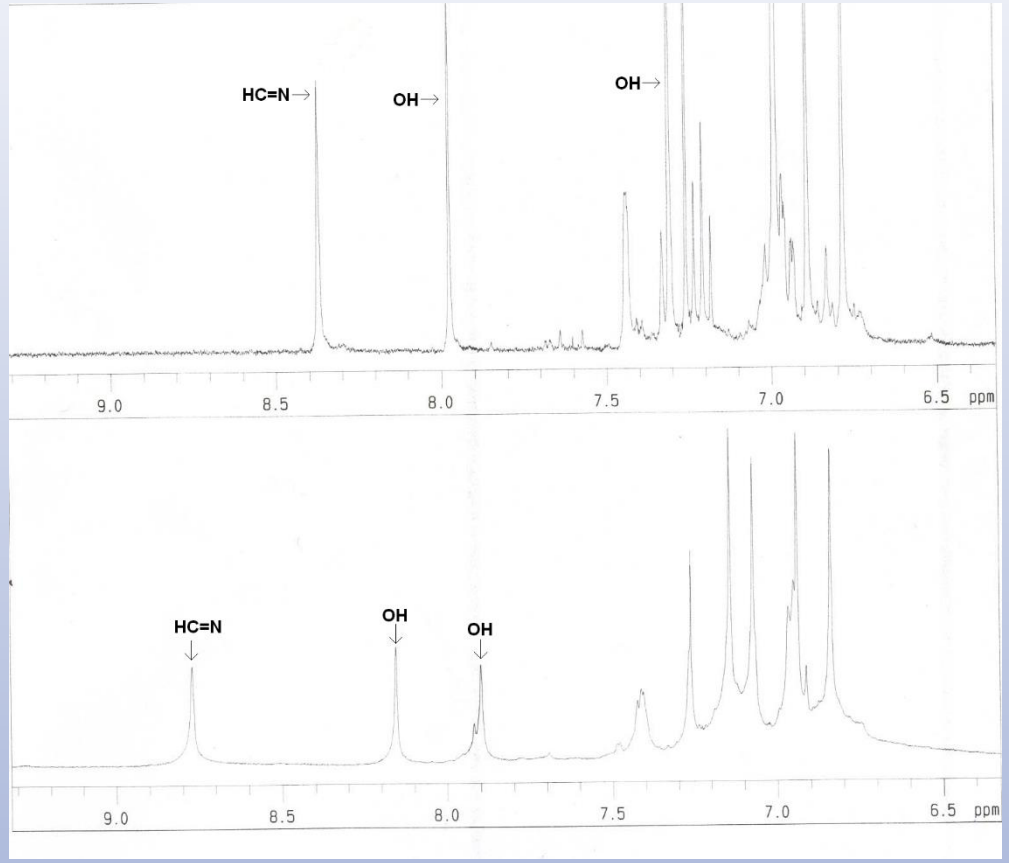


Adrienne Fleming, Jackie Gaire, Fintan Kelleher, John McGinley, Vickie McKee ***Tetrahedron 67 (2011) 3260-3266***



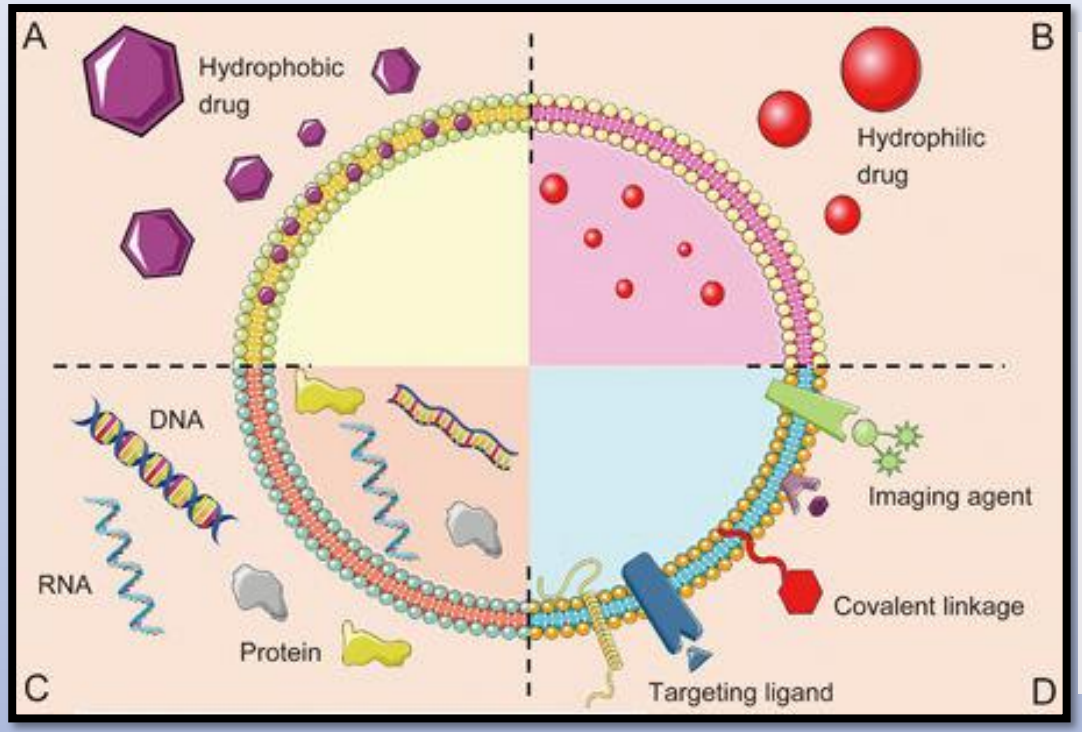
Bernadette S. Creaven, John F. Gallagher, John P. McDonagh, John McGinley, Brian A. Murray and Giuseppe S. Whelan ***Tetrahedron 60 (2004) 137–143***





B. S. Creaven, M. Deasy, P. M. Flood, J. McGinley, and B. A. Murray , ***Inorganic Chemistry Communications, Volume 11, Issue 10, October 2008, Pages 1215-1220***

Exosomes/microvesicles as targeted drug delivery systems

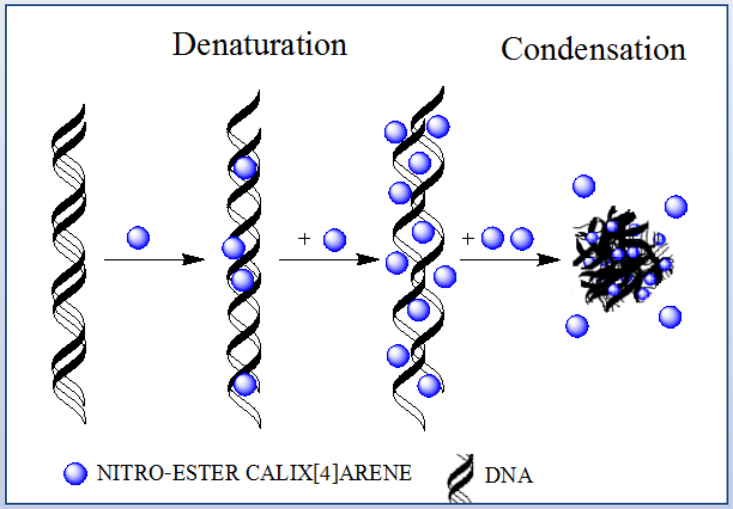


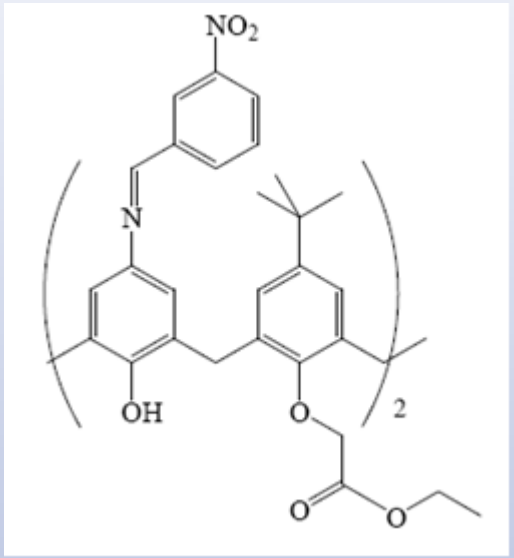
Highlights

- Exosomes are a class of secreted nanoparticles defined by size, surface protein and lipid composition, and the ability to carry RNA and proteins.
- They are important mediators of intercellular communication and regulators of the cellular.
- They have been linked to disease development/progression.
- Receptors on their surface allow them to hone in on specific cells.
- They have potential as a targeted drug delivery system.

https://rdcu.be/KGO4

- Serum exosomes from IPF patients contain miR-125b, which is correlated to severity of disease progression. October 2016, QJM: monthly journal of the Association of Physicians 109(suppl_1) DOI: 10.1093/qjmed/hcw118.001
- The Role of Fibrocyte Derived Exosomes in the Development of Idiopathic Pulmonary Fibrosis, November 2016, DOI: 10.1007/s11845-016-1497-4



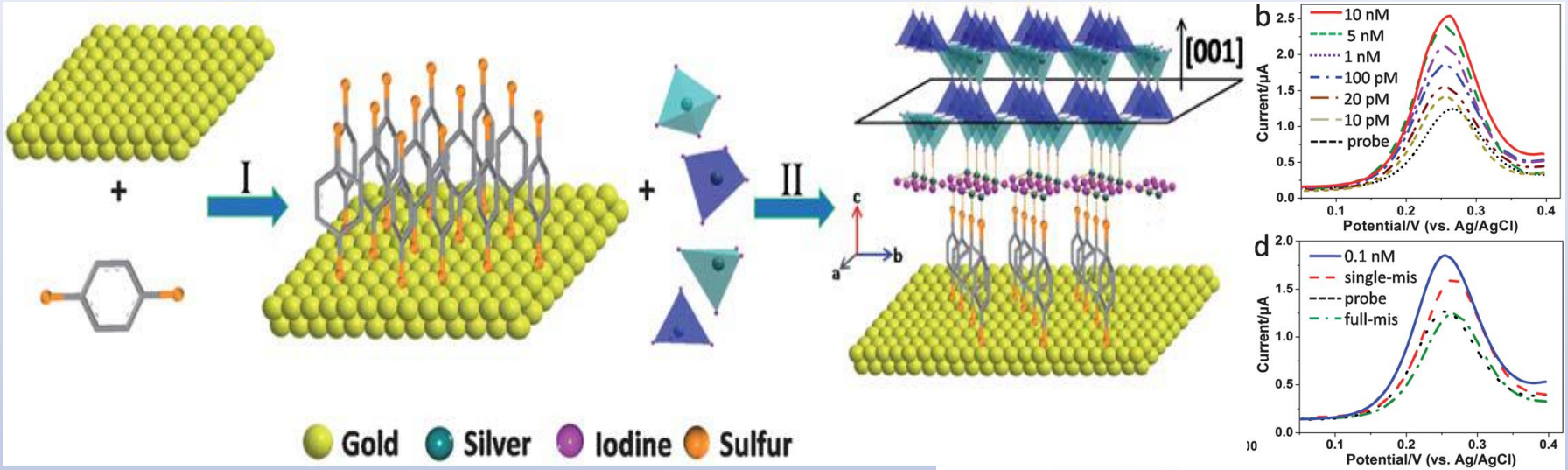


The dinitro-diester calix[4]arene used interacts with calf-thymus DNA generating different conformational changes

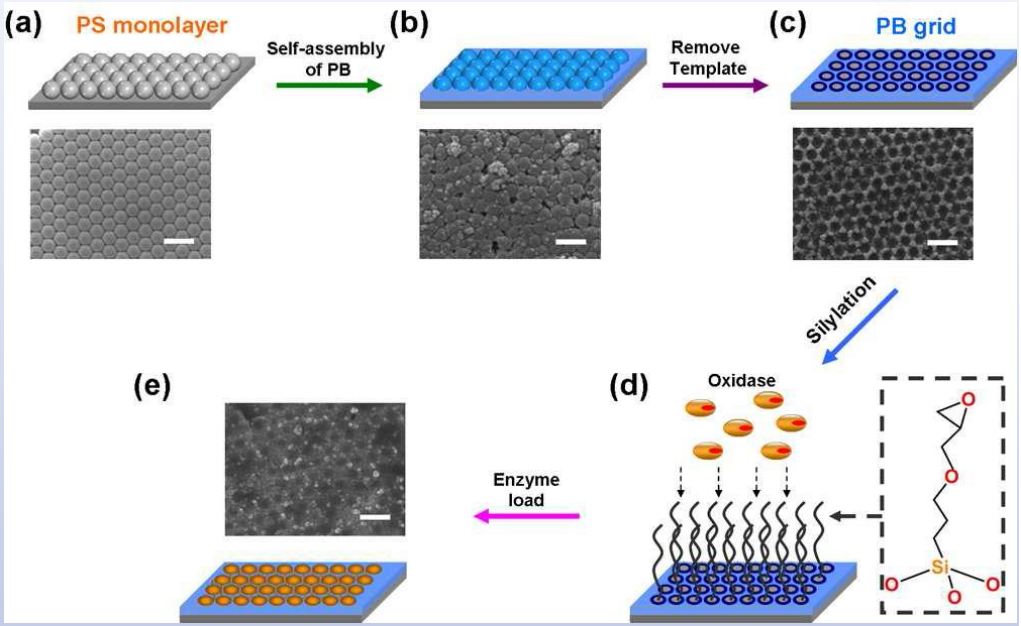
Potential to use in drug delivery systems able to transport nucleic acids to target cells …

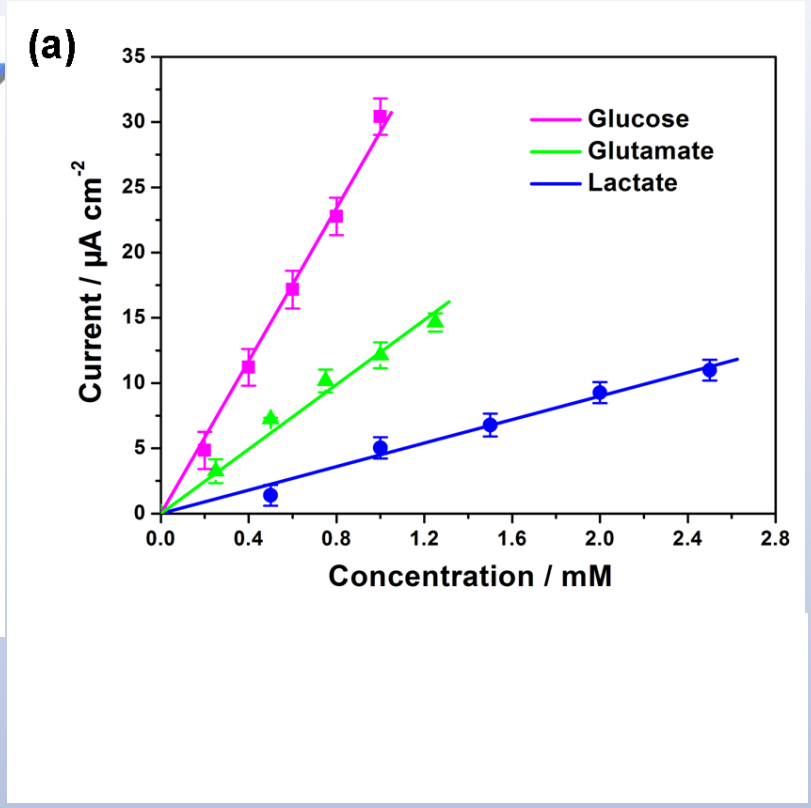
Lopez-Cornejo; F.J. Ostos; J. A. Lebron; M. L. Moya; M. Deasy, ***Colloids and Surfaces B: Biointerfaces 2015,*** *127,* 65-72

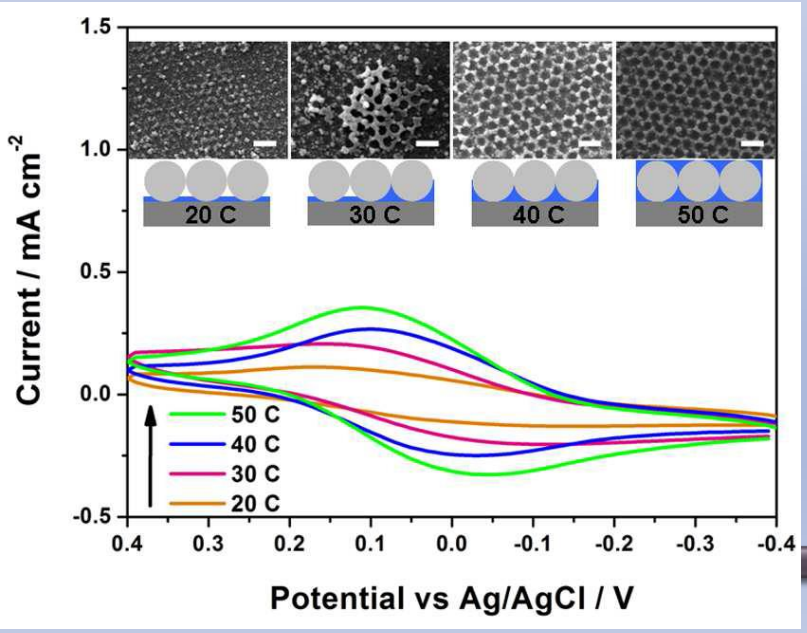
Wide Range of Sensor Platforms



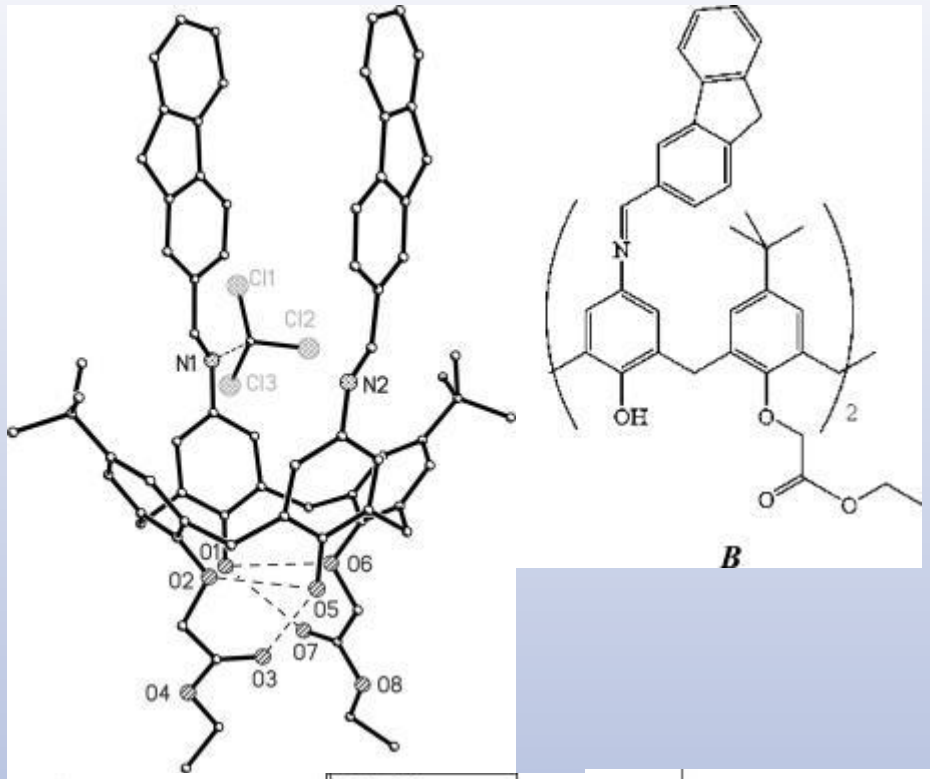
Lei Shi, Zhenyu Chu, Xueliang Dong, Wanqin Jin, and Eithne Dempsey
Nanoscale, 2013, 5, 10219

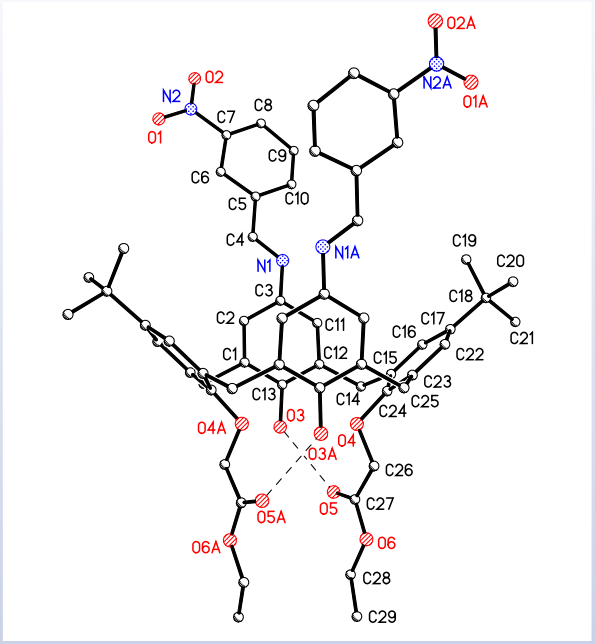




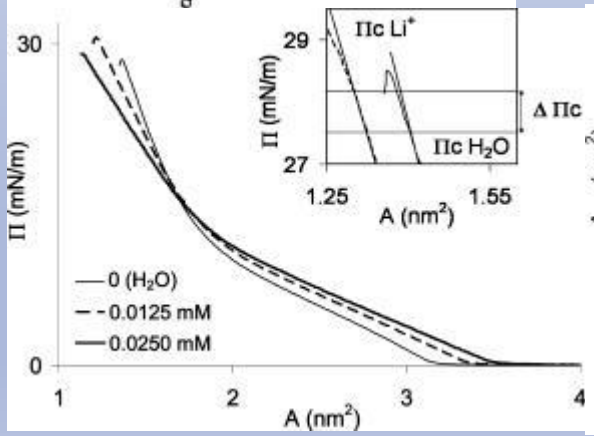


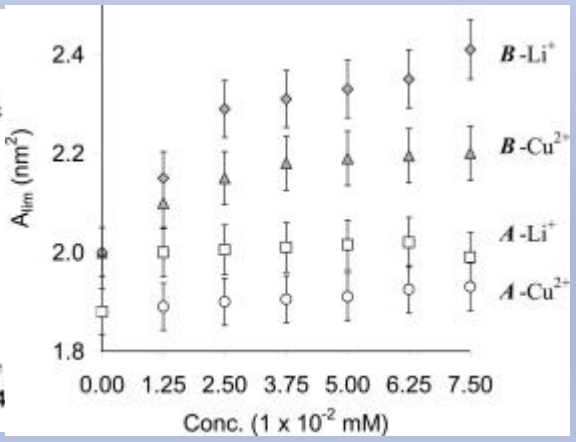
Z. Chu, L. Shi, Y. Zhang, W. Jin, S. Warren, D. Ward, E. Dempsey ***J. Mater. Chem. 22 (2012) 14874–14879.***

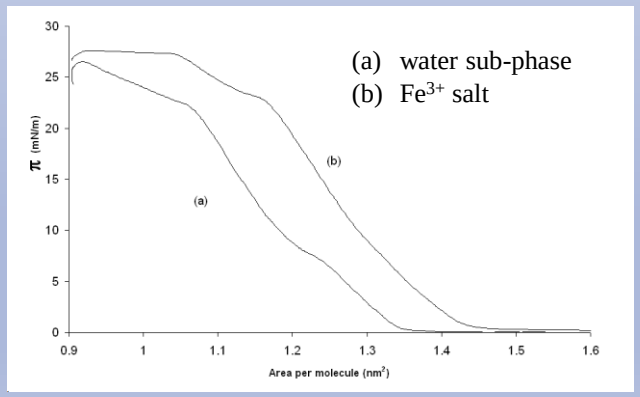




Embedded in Langmuir-Schäfer-printed surface layers that enables the development of new organic transistor sensors



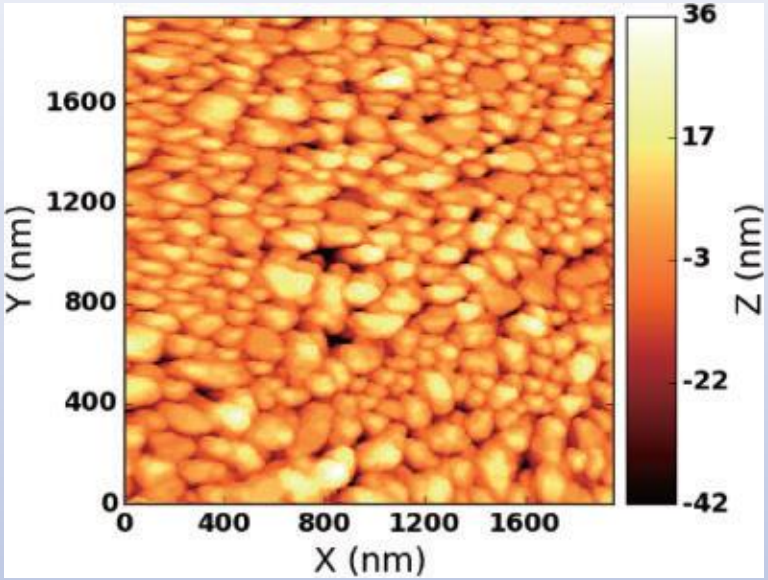


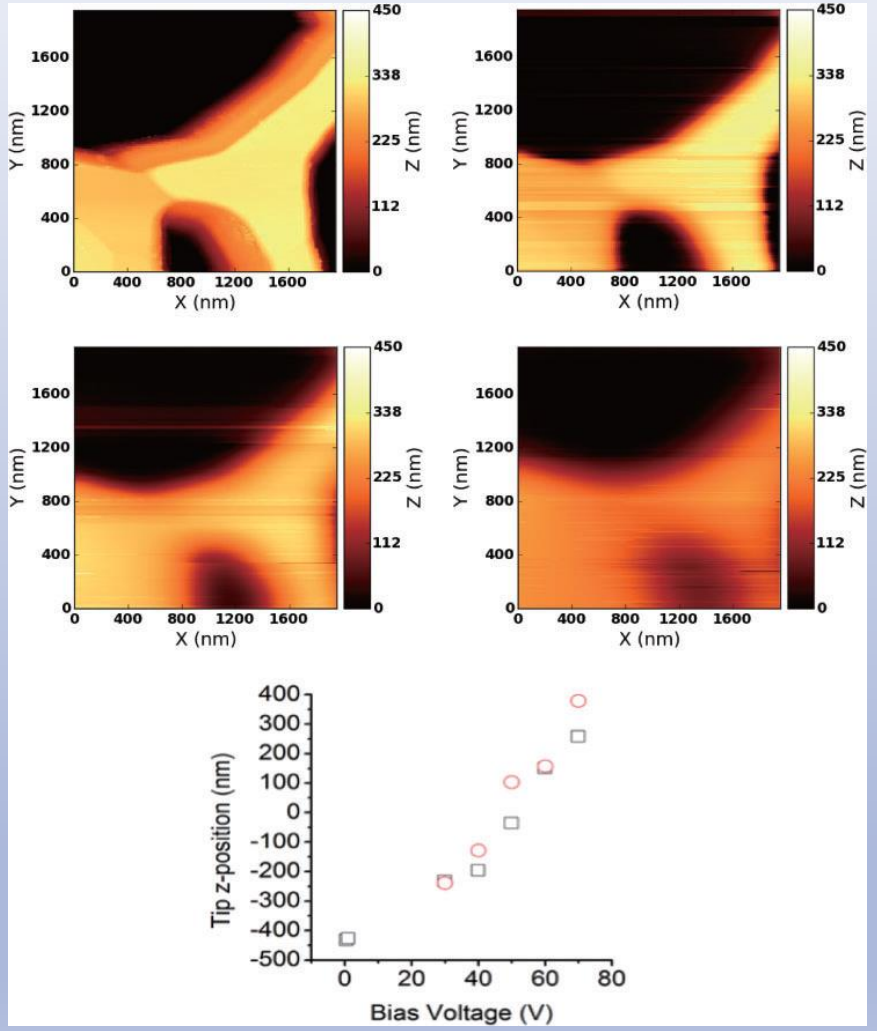


Faridah L. Supian, Tim H. Richardson, Mary Deasy, Fintan Kelleher, James P. Ward, and Vickie McKee ***Langmuir, 2010, 26 (13), pp 10906–10912.***

D. Puzzovio, A.Al Naim, L. Hague, M. Deasy, J. Ward, T. Richardson, M. Grell ***Journal of Surfaces and Interfaces of Materials, 2012, Vol. 1, No. 1, pp 1-6.***

Surface Characterisation Research





Mapping the plasmon response of Ag nanoislands on graphite at 100 nm resolution with scanning probe energy loss spectroscopy

Shane Murphy, Karl Bauer, Peter A. Sloan, James J. Lawton, Lin Tang, and Richard E. Palmer ***Applied Physics Express 8, 126601 (2015)***

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- **Dairy and Agri-food sensor technologies**
- **Rapid sensors for environmental testing**
- **Materials Science: Nanomaterials/Nanoscacled**
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- **MOBILE DEVICES:** Portable electrochemical devices for on-site and continuous monitoring and rapid testing.

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- **RAPID SENSORS:** Bio-molecules detection, food allergens and contaminants in dairy milk and food products. Rapid microbiology, PHEROMONES and chemical residues analysis (bacterial cells/spores) of water/CIP wash-water and dairy products (milk, cheese, SMP and powder products).

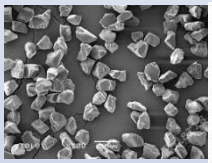
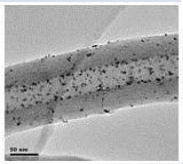
- **WATER QUALITY/TOXICITY SENSORS**: Microbial and chemical contamination. Heavy metal and pesticide detection. Water toxicity analysis. Waste water analysis. Biofilm monitoring.

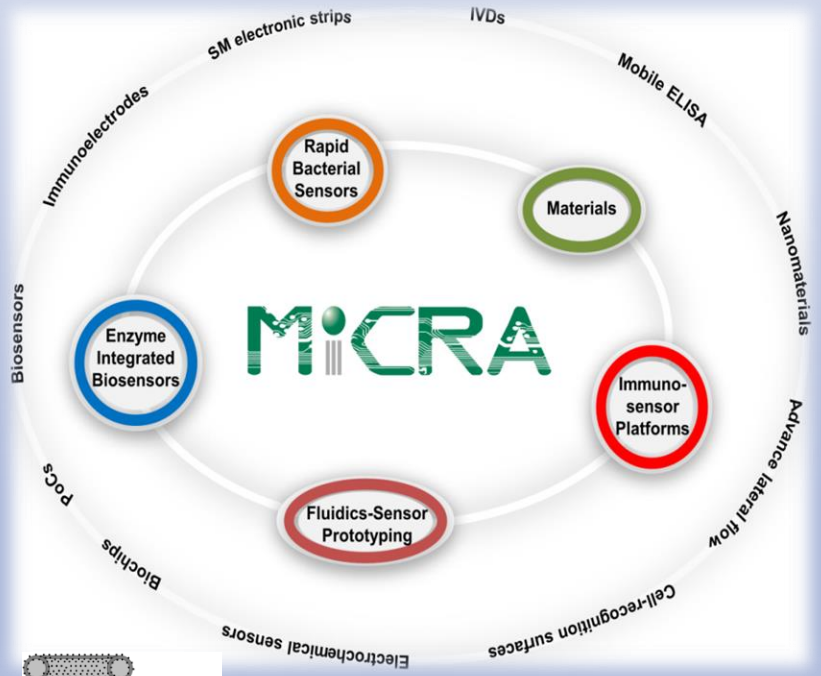
- **PROTOTYPE FABRICATION:** Design-engineering of electrode detection systems and prototyping of fluidic-reagent systems (lateral-flow membrane and capillary-fill microchannel techniques, and flow-actuated hydraulic devices) and their integration and utility to diagnostic assays and chemical & bio-sensors development. Cell capture devices. Translation of standard methodologies to portable devices. Sensor production and microfluidics know-how, plastic thin-film devices, laser machining and screen/stencil printing of electrodes.

- **CHEMICAL FORMULATION** and product development.

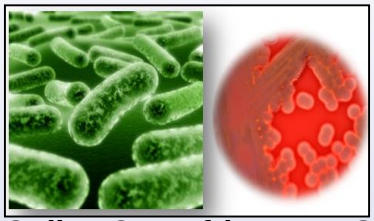
MiCRA TECHNOLOGY THEMES

- Human and animal diagnostics
- Agri-food sensor technology
- Rapid sensors for environmental testing
- Materials Science
- Bio and Pharma Technology
- Analytical test services

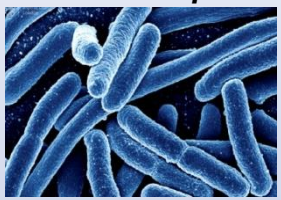


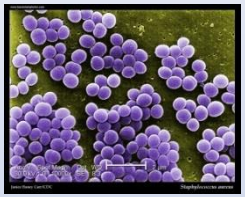
B. cereus



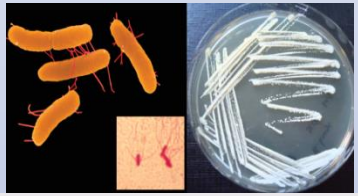
Cronobacter sakazakii

E. Coli *C. perfringens* *Staphylococcus* Aureus





Salmonella *Campylobacter*

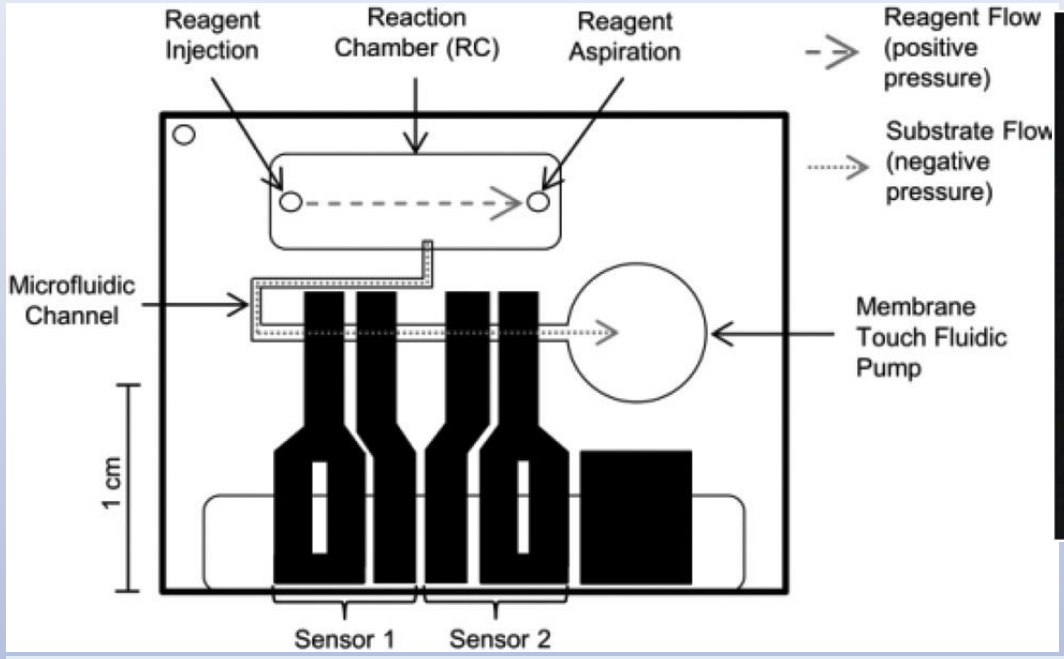


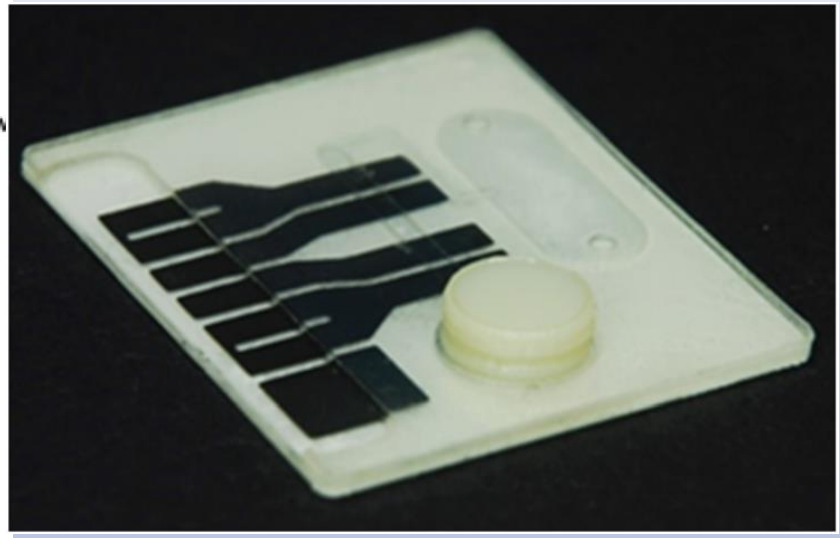

- ***TVC & B. cereus and Bacillus Species***
- ***Total coliforms - Citrobacter freundii, Enterobacter aerogenes, Klebsiella pseunmoniae & E. coli.***
- ***Clostridium difficile (toxin B)***
- ***SRCs: C. perfringens & C. botulinum***
- ***Legionella pneumophila***
- ***Staphylococcus aureus***
- ***Micrococcus leutus***
- ***Campylobacter jejuni***
- ***Salmonella Enteritidis & S.Typhimurium***
- ***Enterococcus faecium, E. faecalis***
- ***Pseudomonas aeruginosa***
- ***Cronobacter sakazakii***
- ***Yeasts and moulds***
- ***Liver fluke , Ostertagia Ostertagi***
- ***Chemical contamination/milk residues and adulteration: chlorates, 3-MCPD mycotoxins, antibiotics, pesticides, melamine.***



nanocor
ImmunoTouch
bio-card
CATOXE electrochemistry
pullus online detection
MICROPRINT Rapid Bacterial Detection
goldLINE gold sensor technology
BioScan
Signalman

Membrane Touch Biosensor Research





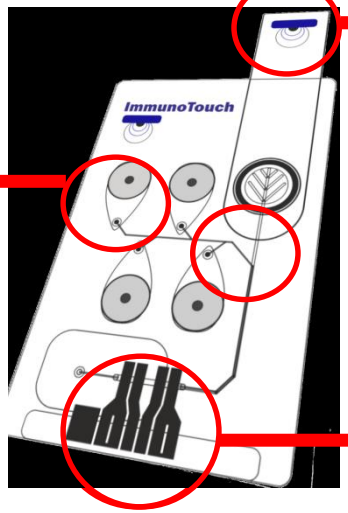
- The application of a membrane-touch biochip to the qualitative HSV-2 immunoassay for human samples was demonstrated.
- Assay performance of a novel microfluidic coulometric sensor responsive to HSV-2 antibodies was validated against diagnostics industry standard methods.
- The results from a human panel confirm the potential of the biochip to fulfil an unmet need for rapid, accurate and cost effective clinical diagnosis and management of HSV-2 infection.

Tony Loughman, Baljit Singh, Brian Seddon, Philip Noone and Padmanabhan Santhosh ***Analyst, 2017,142, 2725-2734***

Self-contained, portable ELISA system consisting of replaceable assay cards with sampling strips and a handheld meter

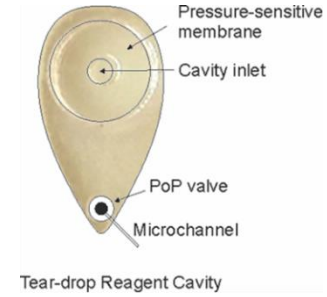
Fluidics
MEMBRANETOUCH
Patented microfluidics

Sampling



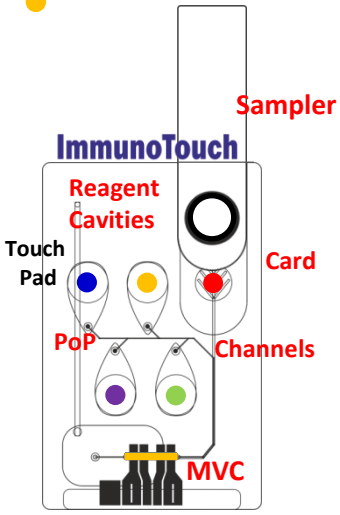
Removable strip technology with capillary flow fluidics for milk or blood collection. The strip has a filtration function to remove cells and fat from a sample.

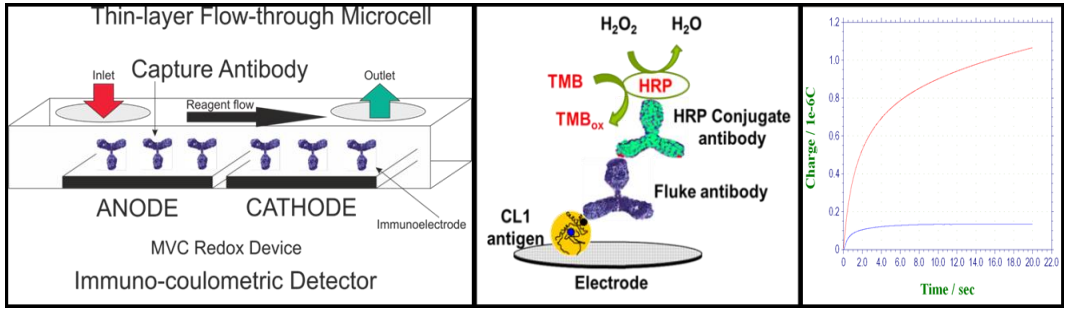
Reagent System



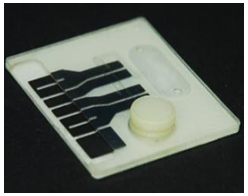
MVC detector

- Sample sent to the detector
- Wash step removes unbound antibodies
- Conjugate sent to the detector
- Wash step removes unbound conjugate
- Substrate sent to the detector





The ImmunoTouch detector is a series of electrodes coated with antigens specific for the target antibody. The detector measures peroxidase levels in a thin-layer flow cell.



APPLICATIONS

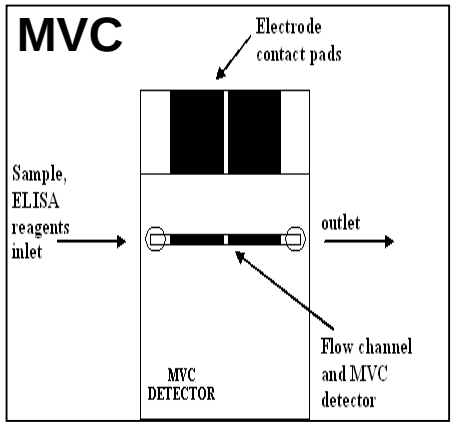
- Human IVD & Livestock infectious diseases
- Food allergen and security testing
- Dairy and water quality

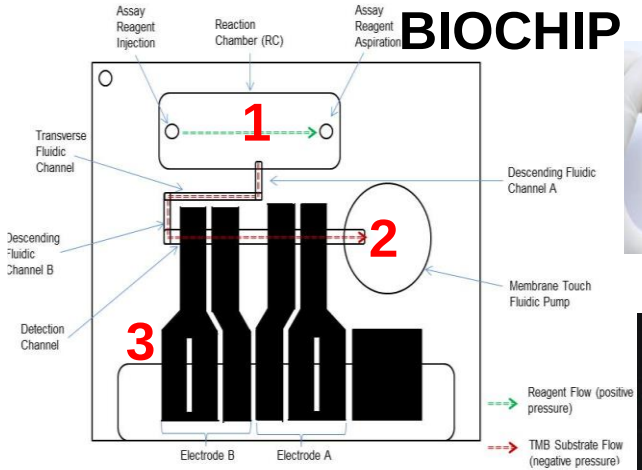
ITT DUBLIN Institute of Technology Tallaght Institiúid Teicneolaíochta Tamhlacht
MiCRA Microsensors for Clinical Research and Analysis
TECHNOLOGY GATEWAYS delivering solutions for industry
MiCRA - Biodiagnostics an Enterprise Ireland network
ENTERPRISE IRELAND where innovation means business

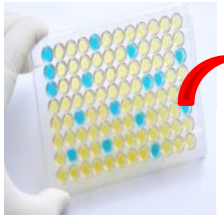
MVC & BIOCHIP

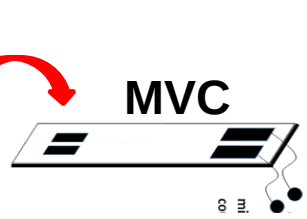
Electrochemical sensors for the detection of small molecules, proteins and bacteria (cells/spores)

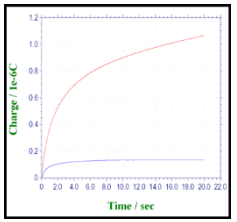
MVC operates on millivolt potential difference excitation pulses (≤50mV) applied across a pair of electrodes. The electrodes measure charge flow (nC/µC) associated with redox molecule concentrations and peroxidase activity. **BIOCHIP** feature electrode-base sensors integrated with immuno-functionalised reactors & fluidics device and supported by patented MembraneTouch technology (PCT number: PCT/EP2013/073876).

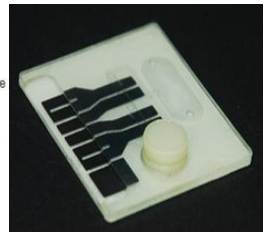








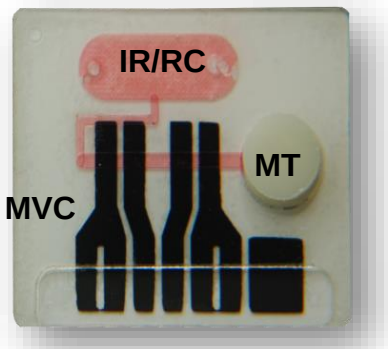




1 **BASIC MVC**

2 **IMMUNO-MVC**

3 **BIOCHIP**



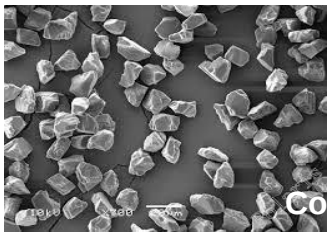
BIOCHIP TECHNOLOGY

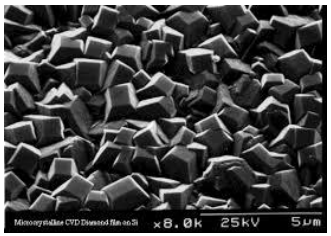
- **Technical R&D**. Development phase of BIOCHIP completed phase 1 - verification the technology works reliably. Design & testing of the MT microfluidics and MVC sensors.
- **Fields of use**. Biodiagnostics applications: milk liver-fluke and stomach worm-*ostertagia* antibody, blood HSV antibody and food allergens (gluten and peanut protein), urine hCG etc.
- **Validated technology**. Human panel study. Validation of BIOCHIP against an industry accredited laboratory diagnostic.
- **Patented technology**. BIOCHIP is protected by its Membrane Touch fluidics device.
- **Licence agreement**. Signed for use in human diagnostics and food related application.

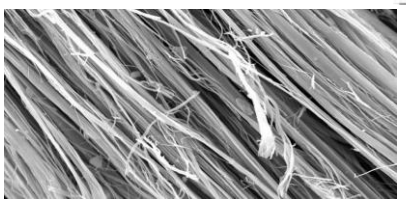
ELISA & ENZYME PROFILING: BIOFILMS LEGIONELLA HSV SPORES LIVER FLUKE OSTERTAGIA OSTERTAGI

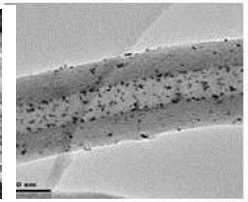
MiCRA MATERIALS & CONTRACT SERVICS

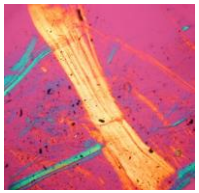
MiCRA's nanotechnology explores the design & engineering of advanced electrodes and materials for use in energy devices and sensor applications.

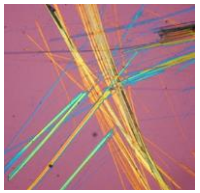


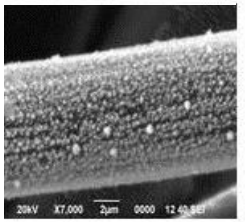


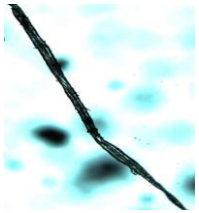


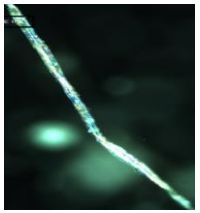


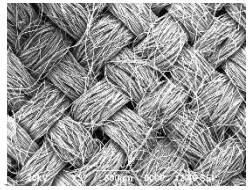




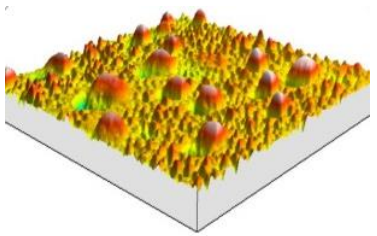








Material	Property	Characterisation	Application
PtAu nanoparticles	Nanosize/surface area	XRD/XPS/TEM	Enzyme electrodes & Biosensors
Gold reagents	Biocompatibility	SEM/AFM/UV	Immunoassay – Au bioconjugates
Nano-Gold	Conductivity	AFM/CV	Immunosensors
Metal nanocomposites	Surface composition	TEM/XPS	Chemical sensors
Au Self assembly molecules	Electron transfer characteristics	SEM/Impedance	Chemical sensors
Gold nanocatalysts	Surface modification	TEM/SEM/EDX	Biomolecule detection
GaTe quantum dots	Size/surface-to-volume ratio	TEM/EDS	Nucleic acid/DNA biosensors
Carbon nanotubes graphene	Electronic & structural properties	SEM/EDX/FTIR/Raman	Heavy metal detection
Ultrafine diamonds	Surface impurities	SEM/EDX/TGA	Industrial abrasives & optical applications
Metal-polymer composites	Thermal conductivity	Thermal conductivity analyser	NANO-k membrane – insulation applications
Porous Pt-Ag nanocatalysts	Porous morphology/surface structure	TEM/EDS/XRD	Fuel cells



Quantum Dot Nanotoxicity Investigational Research

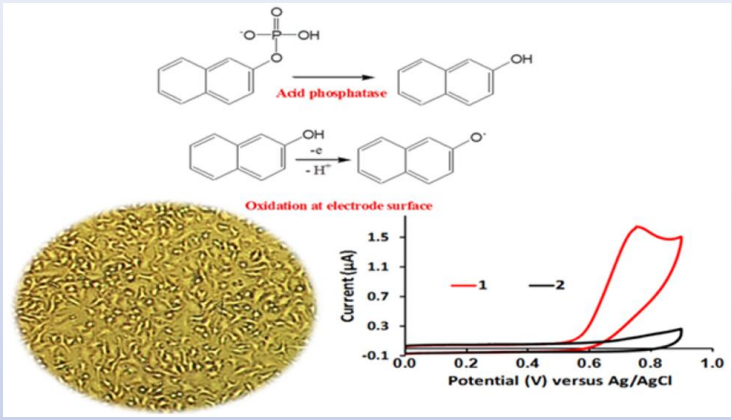
Tony O'Hara, Brian Seddon, Andrew O'Connor, Siobhán McClean, Baljit Singh, Emmanuel Iwuoha, Xolile Fuku, and Eithne Dempsey ACS Sens. 2017, 2, 165−171

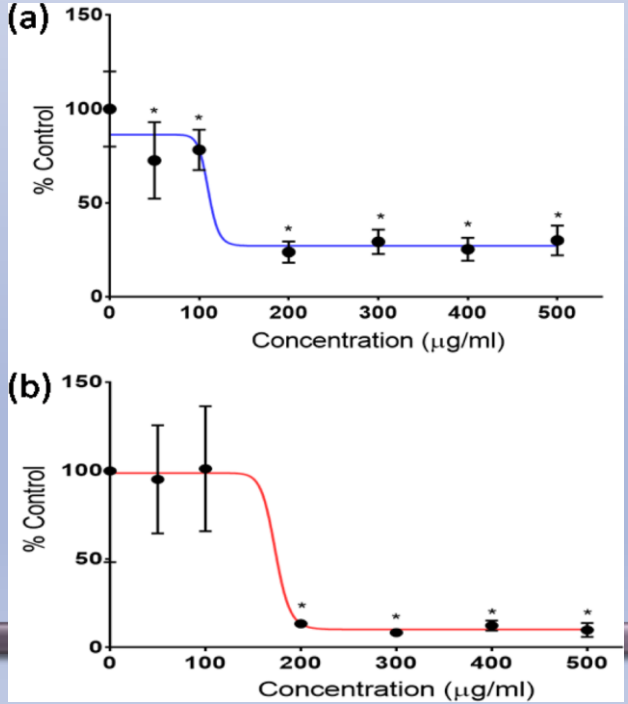
QDs - unique semiconductors emerging as alternative materials for displays, solar energy harvesting, and as complementary tools to organic fluorescent dyes for biological imaging

QDs are cytotoxic due to Cd(II) and colourimetric test results are not reliable as dyes used can interfere with nanomaterial wavelength and absorbance measurements

An electrochemical cytotoxicity assay developed in house within MiCRA (TOXOR) in the evaluation of toxic effects of mercaptosuccinic acid capped cadmium telluride quantum dots (MSA capped CdTe QDs), toward mammalian cells

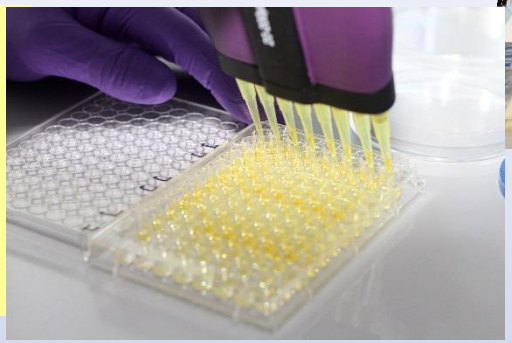
Potential uses of this electrochemical assay include the screening of nanomaterials, environmental toxins, in addition to applications in the pharmaceutical, food, and health sectors





Currently in 2017

People
- 20 Academic Principal Investigators
- 3 Senior Scientists
- 34+ Postgraduate Researchers
- 2 Scientists – Biodiagnostics Area



Project Types
- Postgraduate Masters by Research & PhD – Basic Research
- Postgraduate Masters by Research – Industry specific
- Industry troubleshooting & method development
- Product and prototype design
- Analytical Services to Industry

Resident Companies
- Connexicon – Surgical Glue area
- Vornia – polymers for medical devices
- BBB Technologies – industrial grade polymers
- Chinnery Spirits – Food & Beverage area

Acknowledgements

(Bio) Pharmaceutical & Sensor Technologies Work

ITT Principal Investigators

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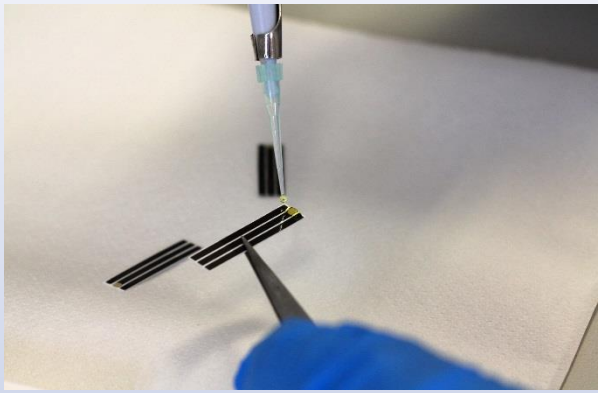
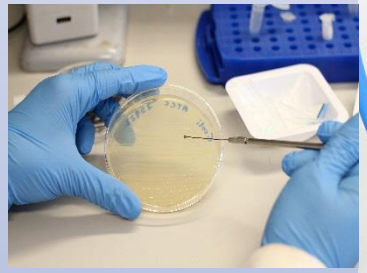
Goar Sánchez-Sanz

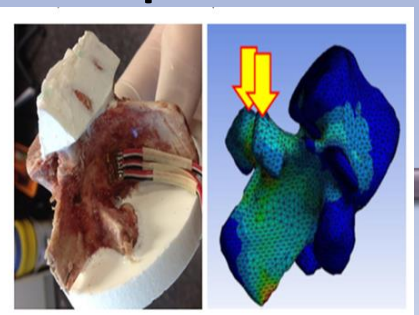
Industry
Philip Noone

Planning Ahead

- **Applied research, development and close to market projects**
  - To address a deficit in the national research ecosystem in the field of bioanalytical research and innovation as applied to the (bio)pharmaceutical and agriculture/food/dairy sectors
  - Growing industry requirements for bioconversion/bioprocess monitoring, characterization strategies for biologics and rapid screening/diagnostic information at point of use
- **3D Printing space and new materials – continue to grow**
- **Expansion into Data Analytics through the PAT Facility**
- **Expansion of our Masters by Research with Industry**







Thank You for Listening