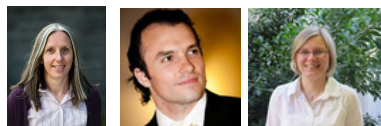


# Drug Delivery and Formulation at a glance

SSPC shines a spotlight on its' research initiatives in material, dosage form and process designs which work together to convert drug substances into stable, effective, and manufacturable drug products. Innovations in this space enables the clinical, regulatory, and commercial phases of drug development. Advancements in understanding disease pathologies and identifying targets to restore health have led to the design of complex therapeutics, with challenging properties, increasing the importance of formulation, drug delivery vehicles and drug product design. Here we highlight just a few examples of research projects and the talented SSPC researchers leading the work from across Ireland to showcase these initiatives. The selected projects focus on designing novel routes of administration for therapeutic molecules, ranging from biologics to hybrid and small molecules, developing medicines with increased therapeutic effectiveness and more patient friendly dosing regimens, ensuring better health outcomes and improved quality of life for patients.

## Long Acting Injectables (LAI)



**Prof. Sarah Hudson,**  
**Assoc. Prof. Luis Padrela**  
University of Limerick  
**Prof. Lidia Tajber**  
Trinity College Dublin



Responding to a current future and global need for the development of long acting drug formulations that achieve extended release dosage forms that are stable, predictable and which can be applied across multiple and complex Active Pharmaceutical Ingredients(API), LongActNow, a Marie Skłodowska Curie funded consortium was established under the co-ordination of SSPC investigator Prof. Sarah Hudson. This collaboration consisted of investigators from University of Limerick, SSPC, Trinity College Dublin, Technische Universität Dortmund and Janssen Pharmaceutica. It achieved its aim of contributing to the research field for LAI and graduating industrially-informed, interdisciplinary Early Stage Researchers (ESRs) in relevant areas of expertise including crystallisation, solution behaviour modelling and solvent switching, pharmacokinetics and formulation. [www.longactnow.eu](http://www.longactnow.eu).

## Multifunctional Agents for Targeted DNA Imaging and Therapies

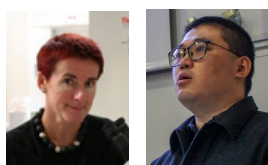


**Prof. Susan Quinn**  
**Maria Byrne**  
University College  
Dublin

The pharmaceutical industry has seen an increasing interest in the generation of novel hybrid drugs which can increase the efficacy and therapeutic efficiency of medicines. This research develops a versatile nanomaterial that can be modified with various surface chemistries and internal components to give widespread application potential in biomedical fields. It creates a nanomaterial hybrid species with dual emission and DNA sensing capabilities by attaining an emissive nanomaterial species which is encapsulated with a range of emissive dyes and complexes.

Work has also been performed to investigate the use of multicomponent reactions to introduce varied functionalities including the addition of fluorophores, stabilizing ligands and biologically active groups in a single reaction.

## Targeted RNAi Therapeutics For Prostate Cancer

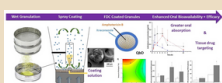


**Prof. Caitriona O'Driscoll**  
**Dr Yao Sun**  
University College Cork

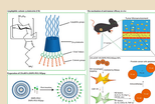
Prostate cancer is the most prevalent cause of cancer deaths in men, and conventional strategies, such as surgery, radiation, or chemotherapy, face challenges including poor prognosis and resistance. As the current treatments are often ineffective, particularly in case of metastasis, which severely affects the quality of life of patients. Consequently, more advanced targeted therapies are urgently needed. The use of small interfering RNA (siRNA) to silence genes associated with initiation and spread of cancer is particularly promising as it targets the diseased site while avoiding healthy tissue. However, effective delivery of the siRNA remains the main challenge to translating this concept into the clinic. This work describes a novel non-viral nano-delivery system for siRNA designed to re-model the immune microenvironment of the prostate cancer tumour resulting in the reduction of tumour growth.

The team realised a smart drug delivery system to deliver colony stimulating factor-1 receptor CSF-1R siRNA, and the system was based on an amphiphilic cationic  $\beta$ -Cyclodextrin CD and an M2 macrophage-targeting ligand DSPE-PEG-M2pep, incorporated into the delivery system via a "post-insertion" method. The specific targeting efficacy for M2 macrophages was verified in vitro and in vivo. This is the first time such a delivery system has been described for prostate cancer and the positive results obtained in the pre-clinical in vivo model indicate the future potential of this approach.

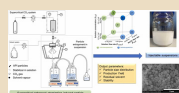
## Publication highlights



**Can amphotericin B and itraconazole be co-delivered orally? Tailoring oral fixed-dose combination coated granules for systemic mycoses**, Fernandez-Garcia, R., Walsh, D., O'Connell, P., Slowing, K., Raposo, R., Ballesteros, P. Jimenez-Cebrian, A., Chamorro-Sancho, M. J., Bolas-Fernandez, F., **Healy, A.M.**, Serrano, D.R., 2023, 183, Pg 74-91, *European Journal of Pharmaceutics and Biopharmaceutics*



**M2pep-Modified Cyclodextrin-siRNA Nanoparticles Modulate the Immunosuppressive Tumor Microenvironment for Prostate Cancer Therapy**, Sun, Y., Cronin, M. F., Medonca, M. C. P., Guo, J., **O' Driscoll, C. M.** 2023, 20, 11, 5921-5936, *Mol. Pharmaceutics*



**Supercritical enhanced atomization induced particle entrapment for continuous production of injectable micro and nano-suspensions**, Snehashis Nandi, Alain Collas, Lidia Tajber, Luis Padrela., 2024, 81, *Journal of CO2 Utilization*

## Investigating Novel Manufacturing Methods for Vaccine-Containing Dissolvable Microneedle Patches for Skin Immunisation



**Prof. Anne Moore**  
**Lyndsey Moore**  
University College  
Cork

Vaccine-loaded microneedle patch production is currently limited by poorly scalable fabrication techniques, limiting their use in phase III clinical trials and subsequent licensing. Identification of technologies that can be used in scaling up or scaling out microneedle production is key for mass manufacture and commercial use of dissolvable microneedle patches. Common techniques for microneedle fabrication result in high amounts of API wastage. Additionally, only 40-60% of the microneedle enters the skin and delivers the incorporated API. This research project looks to identify industrially relevant, scalable methods to produce vaccine-containing dissolvable microneedle patches. It investigates how new patch designs modulate the success of vaccine delivery into skin in ex vivo pig skin and increase the dose delivered. Enhancing the microneedle design will reduce waste in both the fabrication and application processes, keeping the cost low.

## Synthesis of Metal-Organic Frameworks for Drug Delivery



**Dr Constantina Papatriantafyllopoulou**  
**Dr Ahmed Ahmed**  
University of Galway

This research programme examines the synthesis of highly porous biocompatible Metal Organic Frameworks (MOFs) such as zinc, copper, cobalt and magnesium. It studies the loading and delivery capability of anti-cancer drugs such as rifampicin and doxorubicin in the novel MOFs which are based on elongated biocompatible linkers. It also looks at developing antibacterial MOFs. The MOFs developed are excellent candidates for biomedical applications that involve drug delivery, enzyme immobilisation, gene targeting and can lead to the development of a new drug carrier, with controlled drug release, overcoming the burst effect of conventional carriers. The team also studies the synthesis and characterization of a new MOF based on the tetrahedral secondary building unit  $[Zn_4O(CBAB)_3]_n$  (NUIG4). Read the below publication and find out more.



**NUIG4: A biocompatible pcu metal-organic framework with an exceptional doxorubicin encapsulation capacity.** B Ahmed, A., Efthymio, C.G., Sanii, R., Patyk-Kazierczak, E., Alsharabasy, A.M., Winterlich, M., Kumar, N., Sensharma, D., Tong, W., Guerin, S., Farras, P., **Hudson, S., Thompson, D., Zaworotko, M.J.**, Tasiopoulos, A.J., **Papatriantafyllopoulou, C.**, 2022, 10, 1378, *J. Mat. Chem. B*

## Potential Spin-outs



### **Prof. Sarah Hudson, NanoComp**

Developing a patented oral drug formulation platform that utilises simple and efficient manufacturing processes to change insoluble APIs into powder that is ready for tableting while adding superior dissolution and stability to the final form.



### **Dr Michael Stocker, SEnclL**

Commercialising a novel platform technology that enables the spray encapsulation of ionic liquids to enable formulation of poorly soluble active ingredients.



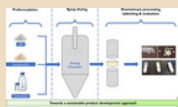
### **Dr Waleed Faisal, ArrayPatch**

Microneedle ArrayPatch (MAP) is a propriety wearable microneedle patch technology designed to treat local diseases. ArrayPatch consists of an array of sharp but painless dissolvable MN that penetrate the skin on application and then dissolve to deliver a local effective dose of medication.

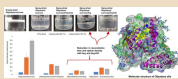
## Publication highlights



**Design of liposomal nanocarriers with a potential for combined dexamethasone and bevacizumab delivery to the eye.** Farooq, U., **O'Reilly, N. J., Ahmed, Z.**, Gasco, P., Singh, T. R., Behl, G., Fitzhenry, L., **McLoughlin, P.**, 2024, *Int. J. Pharm*



**The challenge of downstream processing of spray dried amorphous solid dispersions into minitables designed for the paediatric population - A sustainable product development approach,** Virtanan, A. A., **Mysińska, M., Healy, A. M.**, Power, E., Madi, A. & Siven, M., 2024, 196, 106752, *European Journal of Pharmaceutical Sciences*



**On the role of excipients in biopharmaceuticals manufacture: Modelling-guided formulation identifies the protective effect of arginine hydrochloride excipient on spray-dried Olipudase alfa recombinant protein.** Ashutosh Sharma a, Pierre Cazade, Dikshitkumar Khamar, Ambrose Hayden, **Damien Thompson**, Helen Hughes., 662, 5, *International Journal of Pharmaceutics*

Meet the

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**Dr Sonja Vucen, UCC**  
**Prof. Anne Moore, UCC**  
**Prof. Caitriona O'Driscoll, UCC**  
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