

A World
Leading SFI
Research
Centre



INNOVATION THROUGH COLLABORATION 2023

www.sspc.ie

HOST INSTITUTION



PARTNER INSTITUTIONS



SSPC Activity Highlights 2023



1



2



3



4



5

January

The National SSPC-iCrag Crystal Growing Competition 2023 launch **1**

February

Long Acting Injectables Conference in Brussels

SFI Infrastructure Awards announced: €6.2M awarded to SSPC researchers

SSPC Flow Chemistry Knowledge Day, hosted in Pfizer **2**

March

SSPC Industry Forum, hosted by Alkermes **3**

SSPC EPE Bursaries launch

April

SSPC-PMTC Continuous Reactors and Processes for Pharmaceuticals training, University of Limerick

May

SSPC Recruitment Drive, welcomed industry members Eli Lilly, APC Ltd., Pfizer, MSD, CADFEM, Janssen, Innopharma and SK Biotek **4**

Simon Coveney visit to UL & SSPC Biolabs **5**

SFI Frontiers for the Future Programme announced: €4.4M awarded to SSPC researchers

June

- SSPC at 15 campaign launch **6**
- SSPC Industry Forum, hosted by SK Biotek
- SSPC Long Acting Injectables symposium for complex therapeutics in Ireland **7**
- European Study Groups with Industry, Working group with MACSI
- PROCESS MSCA Cofund, Engineering Solutions for the Process Industry video went live **8**

July

GA2023 71st International Congress and Annual Meeting of the Society for Medicinal Plant and Natural Product Research at Trinity College Dublin

August

SSPC Annual Symposim - 15 Years of Impact
 SSPC at 15 awards.

September

Multi-Product Resin Reuse Phase 2 project launch
 Principles of Drug Product Formulation training, University College Dublin **9**

October

Monolith training with Nanotemper, Dublin City University
 SSPC Discover our Impacts website launch
 SSPC UCC researchers researchers awarded €7.8M within international Optivivax consortium **10**

November

Chemometrics online training through MACSI, University of Limerick
 SSPC MU researchers create new molecule in the fight against bacteria showing Anti-Microbial Resistance **11**
 Assoc. Prof. Sarah Guerin, SFI Early Career Researcher of the Year 2023
 Prof. Anne Marie Healy, SFI Mentorship Award 2023

December

Transition Year Week at the University of Limerick
 SSPC Flow Chemistry Community of Practice Meeting



6



7



8



9



10



11

A message from SSPC Director

“Our goal is to ensure that Ireland remains **a leader in pharmaceutical and biopharmaceutical** research by delivering new science that addresses patient needs”.

SSPC, the Science Foundation Ireland Research Centre for Pharmaceuticals is a world-leading hub for pharmaceutical research and development. SSPC develops new molecular materials, technologies and processes that enable rapid development of more effective, safer drug formulations accelerating their commercialisation. All made possible by the deep expertise and passion, commitment and leadership of our researchers.

“The Centre’s agility and pioneering research in data-driven materials and process development are key to its success.”

SSPC’s Scientific Director Prof. Damien Thompson

The Centre has achieved remarkable success in helping to develop innovative medicines, deliver new treatments to patients, and developing PhD researchers for the Irish and global pharmaceutical industry. We have also made significant strides in understanding both the disease status and treatments opportunities, from cancer, neurodegenerative diseases, to microbial infections and antimicrobial resistance.



Prof. Damien Thompson
SSPC Director

IDA CEO Michael Lohan supporting SSPC

Michael Lohan describes how Ireland has a strong heritage in bio-pharmaceuticals, is home to 9 of the world’s top 10 companies in pharmaceuticals, employs over 45,000 people directly and has a vibrant ecosystem supporting life sciences and the biopharma industry.

Michael has been a member of the SSPC Governance Committee since 2019, working with the SSPC team providing oversight in shaping the Centre’s strategy and direction.



youtu.be/3izLCg0a1gM

SSPC at 15 – Who We Are

SSPC is widely regarded as world-leading in (bio)pharma research and talent development. SSPC has established **a globally unique academic-industry partnership** and are delighted to celebrate 15 years of impact.

Since its inception, SSPC has become an internationally recognised centre working closely with industry partners. SSPC has developed cutting-edge technologies and processes to enable rapid development of new drugs from discovery to commercialisation. As we continue to push forward, this year we reflect on the remarkable trajectory that has built 15 years of success and impact.

SSPC hosted at University of Limerick (UL), partners with nine higher-education institutes. Change Our industry-guided platform has to-date led to 69 project collaborations, with 51 global industry partners. These industry partnerships have generated €22.4 million of supplementary investment over the last ten years, delivering significant economic and human capital impacts.

SSPC’s success is defined through our unique collaboration, which builds R&D excellence in one of Ireland’s largest industry sectors. The biopharma sector now employs >80K highly skilled people directly and indirectly. The biopharmaceutical and chemical sector has an export value of over €106bn, accounting for 67% of total goods exported from Ireland. There are over 85 biopharma companies nationally, ranging from SMEs to MNCs.



*“Our research impacts society by improving and advancing the sustainable production and the availability of medicines globally. Talent is a particular focus point and with a dedicated team of highly skilled professionals, we are **nurturing and developing the brightest minds** in pharmaceutical research. We are proud that over 65% of our SSPC graduates have transitioned to industry.”*

Dr Sarah Hayes SSPC COO



Strategy and Research themes

SSPC has developed **Modelling** as a central theme, linking across each of the other themes **Molecules, Materials, Medicines and Manufacturing**.



SSPC is a world leader in (bio)pharma and talent development. Its reputation for excellence and close industry links help to place Ireland as a trailblazer in global development and manufacturing innovation.

Challenges addressed by SSPC research programme:

Challenge 1: Reducing time to market in drug development is critical to innovative pharmaceutical companies that generally rely upon time-limited patent exclusivity.

Challenge 2: Advanced Manufacturing will involve flexible and agile facilities, with the next generation manufacturing processes requiring scale out rather than scale up and focus on portability for distributed manufacture.

Challenge 3: Improved effectiveness of drug products can be accomplished by numerous methods, including combination drug products, which require design rules to reduce time and cost of development.

Challenge 4: Addressing special requirements of new, more complex active ingredients has arisen because drug molecules that are larger and more complex such as biologics, oligonucleotides/ oligopeptides and molecules with multiple chiral atoms are more challenging than small molecules to purify, process and formulate.



SSPC's strategy focuses on both Ireland and the global market, where we are driven by five pillars that underpin SSPC's vision and mission that make us stand out in the industry.

People: Advancing Talent

Science: Beyond the state-of-the-art

Industry Engagement: Impactful Partnerships

Global Impact: International Engagement

Societal Impact: Informing and Influencing



Dr Sinéad O'Doherty
Head of Strategic
Development

"Our commitment to collaboration with other research institutions and industry professionals has fostered a culture of knowledge-sharing and accelerated progress in (bio)pharma research. We continue to develop frontier science to future proof the (bio)pharma manufacturing sector, driving innovation that will undoubtedly benefit humanity for years to come."

SSPC by numbers (2019-2023)

Since its inception, **SSPC** has successfully collaborated with multiple **industry partners**, composed of indigenous and foreign operations, from start up through to multinationals

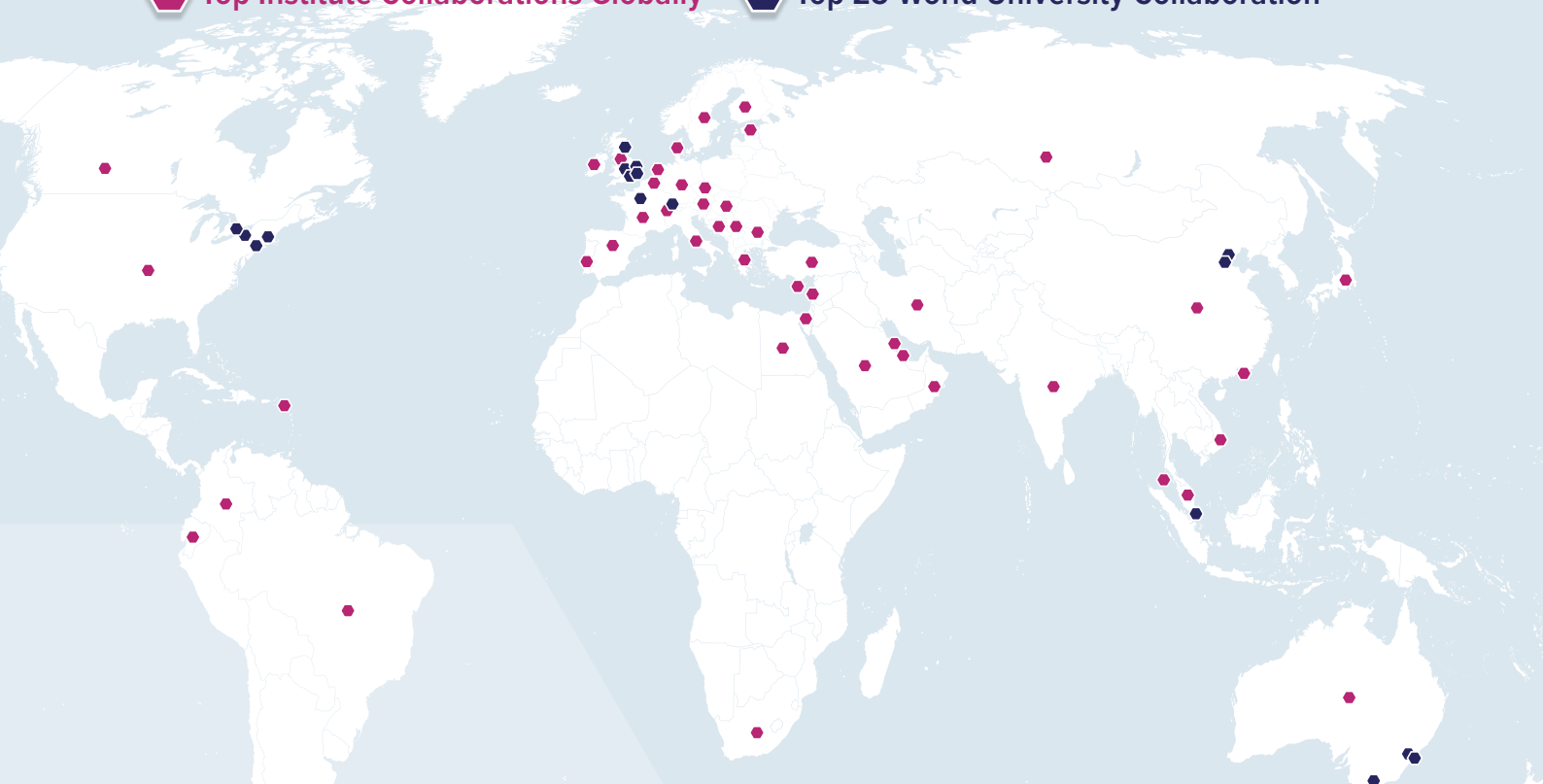


• Research Investigators	80	• Collaborative industry projects	69
• PhD researchers	124	• International Funding	€25.6M
• Postdoc researchers	18	• Number of nationalities working at SSPC	28
• Peer reviewed publications	615	• Co-authored publications with industry	76
• Industry members	28	• Higher Education Institute partners	9
• Industry partners	51		

Global Partners

Over 1,400 International Co-Authors in **48 countries** across **6 continents**

 **Top Institute Collaborations Globally**  **Top 25 World University Collaboration**



Oxford University	UK
Massachusetts Institute of Technology	US
University of Cambridge	UK
Imperial College London	UK
ETH Zurich	Switzerland
National University of Singapore	Singapore
University College London	UK
Cornell University	US
University of Melbourne	Australia
Peking University	China
The University of New South Wales	Australia
The University of Sydney	Australia
University of Toronto	Canada
The University of Edinburgh	UK
Columbia University	US
Université PSL	France
Tsinghua University	China

Research Excellence

Globally Ranked Scientists

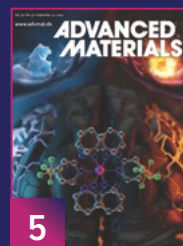
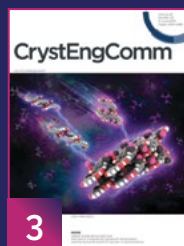
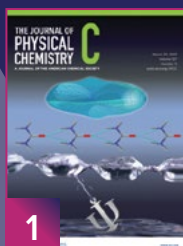
Prof. Michael Zaworotko is ranked number one chemist in Ireland, and within the top 1% globally. **Profs. Fergal O'Gara** and **Kavanagh** are ranked in the top 3% within the field of microbiology.

Prof. Åke Rasmuson (former SSPC PI, current SSPC collaborator), along with **Profs. Donal O'Shea, Thorri Gunnlaugsson** and **Pat Guiry** are ranked in the top 3% of chemists in Ireland and globally. **Prof. Martin Clynes** is ranked in the top 3% in Biology and Biochemistry globally. Our former Education and Publication Engagement (EPE) investigator **Prof. Merrilyn Goos**, is also globally ranked in the top 3% in Social sciences and humanities. **Prof. Anne Marie Healy** is ranked in the top 2% of researchers worldwide by Elsevier & Stanford.



A selection of Journal Covers

- 1 Decoding Supramolecular Packing Patterns from Computed Anisotropic Deformability Maps of Molecular Crystals.** Reabetswe R. Zwane, Joaquin Klug, Sarah Guerin, Damien Thompson, and Anthony M. Reilly in *Physical Chemistry*.
- 2 Carbene-controlled regioselectivity in photochemical cascades.** Mara Di Filippo and Marcus Baumann in *Organic & Biomolecular Chemistry*.
- 3 Nonclassical crystal growth and growth rate hysteresis observed during the growth of curcumin in impure solutions.** K. Vasanth Kumar, Srinivas Gadipelli, Kiran A. Ramisetty, Claire Heffernan, Andrew A. Stewart, Vivek Ranade, Chris Howard and Dan Brett in *CrystEngComm*.
- 4 A Click Chemistry-Based Artificial Metallo-Nuclease.** Alex Gibney, Raphael E. F. de Paiva, Vandana Singh, Robert Fox, Damien Thompson, Joseph Hennessy, Creina Slator, Christine J. McKenzie, Pegah Johansson, Vickie McKee, Fredrik Westerlund, Andrew Kellett in *Angewandte Chemie*.
- 5 Many-Body Molecular Interactions in a Memristor.** Santi P Rath, Damien Thompson, Sreebrata Goswami, Sreetosh Goswami in *Advanced Materials*.
- 6 A Review on the Adsorption Isotherms and Design Calculations for the Optimization of Adsorbent Mass and Contact Time.** Orla P. Murphy, Mayank Vashishtha, Parimaladevi Palanisamy, and K. Vasanth Kumar in *ACS OMEGA*.



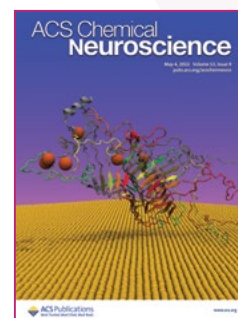
Research Excellence continued...

SSPC strives to conduct scientifically excellent research with impact. The following research highlights illustrate SSPC's fundamental state of the art scientific work with **notable breakthroughs**.

Modelling-predicted new molecular mechanisms behind the progression of the disorders for novel therapeutic strategies

Modelling team at UL led by **Prof. Damien Thompson**, used molecular dynamics to reveal the concentration effect of copper ions on the aggregation pathway of α -synuclein protein which plays a key role in the pathology of Parkinson's Disease. Further predictive molecular models were developed to understand the mechanisms by which accumulation of D-chiral form of amino acids may lead to other neurodegenerative or neurodevelopmental disorders, including schizophrenia and amyotrophic lateral sclerosis.

Image: Journal cover for ACS Chemical Neuroscience highlighting how the modelling research on predicting new molecular mechanisms behind the progression of the disorders is guiding wet lab experiments for novel therapeutic strategies.



Synthesis and Evaluation of Prodrugs of α -Carboxy Nucleoside Phosphonates



lipophilic prodrug derivatives:

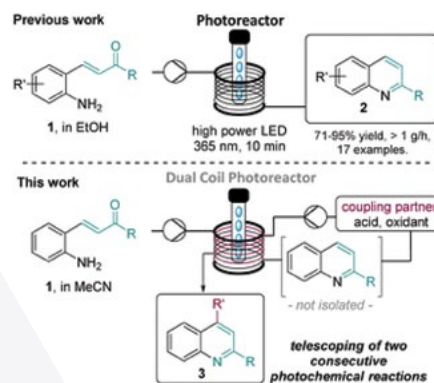
POM
POC
Amidate
ProTide
HDP
CycloSal
Acyloxybenzyl

Range of lipophilic prodrugs of α -carboxy nucleoside phosphonates, potent inhibitors of HIV-1 reverse transcriptase without requiring prior phosphorylation, which were synthesised to evaluate their *in vivo* potency against HIV in cell culture.

Maguire team in UCC led by **Prof. Anita Maguire** in collaboration with Rega Institute Belgium had a publication in the Journal of Organic Chemistry. Their research highlighted α -carboxy nucleoside phosphonate analogues (α -CNPs) which are a novel class of antiviral compounds. α -CNPs display a unique mechanism of action and show strong *in vitro* inhibition against both HIV and herpes viruses. They are the only class of phosphonucleosides which act directly to inhibit HIV RT without requiring prior activation through phosphorylation. As this activation step is often rate-limiting and can lead to significant side effects when employed in the clinic, obviating the need for prior activation is very significant. The long-term impact of this research is that the methodology developed to introduce a range of prodrug moieties protecting the phosphonate and carboxylic acid moieties may be applied to other compounds in the future.

Consecutive photochemical reactions enabled by a dual flow reactor coil strategy

Baumann Group in UCD led by **Dr Marcus Baumann** were researching a simple yet effective approach for using a single flow reactor with a single LED-based light source to perform the telescoping of two consecutive flow reactions. This concept can now be exploited to achieve a variety of telescoped photochemical flow processes without the need for multiple flow reactors and light sources which reduces both footprint and cost of such set-ups and serves as a further stepping stone towards establishing photochemical reactions as methods of choice in academic and industrial laboratories. This research was published in Chemical Communications.



Quinoline synthesis under photo-flow conditions and new telescoped approach.

Top Publications

SSPC has consistently delivered high quality publications, setting a strong foundation for translational science, leading to impact. See a sample of our outputs below:

Reversible transformations between the non-porous phases of a flexible coordination network enabled by transient porosity Varvara I Nikolayenko, Dominic C Castell, Debobroto Sensharma, Mohana Shivanna, Leigh Loots, Katherine A Forrest, Carlos J Solanilla-Salinas, Ken-Ichi Otake, Susumu Kitagawa, Leonard J Barbour, Brian Space, Michael J. Zaworotko. *Nature Chemistry*, 2023, 5(4): 542–549.

Double click macrocyclization with Sonheimer diyne of aza-dipyrrins for B-Free bioorthogonal imaging, Dan Wu, Gonzalo Durán-Sampedro, Sheila Fitzgerald, Massimiliano Garre and Donal F. O'Shea. *Chemical Communications*, 2023, 59, 1951-1954.

Radical-mediated thiol-ene 'click' reactions in deep eutectic solvents for bioconjugation Nolan, M.D., Mezzetta, A., Guazzelli, L. & Scanlan, E.M. *Green Chem*, 2022, 24, 4, 1456-1462. DOI: 10.1039/D1GC03714E. <https://doi.org/10.1002/anie.202305759>. This article is part of the themed collection: *Bioorthogonal and Click Chemistry: Celebrating the 2022 Nobel Prize in Chemistry*.

NUIG4: A biocompatible pcu metal-organic framework with an exceptional doxorubicin encapsulation capacity 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. *J. Mat. Chem. B* 2022, 10, 1378.

A Click Chemistry-Based Artificial Metallo-Nuclease Gibney, A. de Paiva, R.E.F., Singh, V., Fox, R., Thompson, D., Hennessy, J., Slator, C., McKenzie, C.J., Johansson, P., McKee, V., Westerlund, F., Kellett, A. *Angewandte Chemie - International Edition*, 2023, 62, 18.

CHOglycoNET: Comprehensive glycosylation reaction network for CHO cells Metabolic Engineering Pavlos Kotidis, Roberto Donini, Johnny Arnsdorf, Anders Holmgaard Hansen, Bjørn Gunnar Rude Voldborg, Austin W.T. Chiang, Stuart M. Haslam, Michael Betenbaugh, Ioscani Jimenez del Val, Nathan E. Lewis, Frederick Krambeck, Cleo Kontoravdi. *Metabolic Engineering*, 2023, 87-96.

Detection of bile acids in bronchoalveolar lavage fluid defines the inflammatory and microbial landscape of the lower airways in infants with cystic fibrosis Jose A. Caparrós-Martín, Montserrat Saladie, S. Patricia Agudelo-Romero, F. Jerry Reen, Robert S. Ware, Peter D. Sly, Stephen M. Stick & Fergal O'Gara on behalf of the COMBAT study group, *Microbiome*, 2023, 11,132.

Guest Molecule-Mediated Energy Harvesting in a Conformationally Sensitive Peptide-Metal Organic Framework Chen, Y., Guerin, S., Yuan, H., O'Donnell, J., Xue, B., Cazade, P.-A., Haq, E.U., Shimon, L.J.W., Rencus-Lazar, S., Tofail, S.A.M., Cao, Y., Thompson, D., Yang, R. & Gazit, E. *Guest. Am. Chem. Soc.* 2022, 144, 8, 3468–3476 Publication Date: January 24, 2022.

Hierarchical supramolecular co-assembly formation employing multi-component light-harvesting charge transfer interactions giving rise to long-wavelength emitting luminescent microspheres. Gorai, T., Lovitt, J.I., Umadevi, D., McManus, G., Gunnaugsson, T. *Chem. Sci.*, 2022,13, 7805-7813.

In-Vial Detection of Protein Denaturation Using Intrinsic Fluorescence Anisotropy. Krishnakumar Chullipalliyalil, Khaled Elkassas, Michael A. P. McAuliffe, Sonja Vucen, and Abina Crean, *Analytical Chemistry*, 2023, 95, 5, 2774-2782.

SSPC Celebrating 15 Years of Impact

Since being founded SSPC has become the best-known, and most highly regarded (bio)pharmaceutical research centres in the world. SSPC is a key conduit aiding Irish sites accessing global pharmaceutical R&D. SSPC leads the way for next-generation medicines manufacture. Its research programme spans from the small molecule API space, large molecule-biologics space and currently expanding into the medical device space.

Engagement levels within SSPC has grown from 10 founding members to 51 global industry partners, with 7 of the 10 founding partners continue to work with the Centre currently across Ireland and globally



sspc.ie/sspc-celebrating-20-years-of-research



Prof. Kieran Hodnett,
SSPC Director
(2008-2017)



**Prof. Mike Zaworotko and
Prof. Gavin Walker,** SSPC
Co-Directors (2017-2022)



Prof. Damien Thompson,
SSPC Director
(2022-present)

*"The Centre, established as a first large-scale, multi-partner research collaboration, now boasts a critical mass of world-class people and established global presence. **SSPC supports the pharmaceutical industry in Ireland** which is the jewel in the crown of the Irish economy."*

Prof. Mike Zaworotko

The talent developed through the Centre is now having a **far-reaching impact** on the pharmaceutical sector internationally with over 65% of SSPC graduates now working in leading pharmaceutical companies, including Vertex, US; Bayer, US; Pfizer, US, Australia, Ireland; Eli Lilly, Ireland, US; MSD/Merck, Ireland, UK; J&J, Ireland, Belgium; Biogen US, Switzerland.



US-Ireland Centre-to-Centre Partnership

Continuous Manufacturing for Nano-based Drug Products 2016

The tripartite US-Ireland R&D partnership with SSPC at University of Limerick, Ireland; the Center for Structured Organic Particulate Systems (C-SOPS) at Purdue University and Rutgers University, USA; and the Centre for Pharmaceutical Sciences (CPS) at Queens University Belfast.

This partnership focused on the development of novel continuous manufacturing technologies and processes. The project supported nine publications, leveraged over €2M additional funding and has formed the basis of acquisition of the SFI funded Nanopharma Process Development (NaPRO) facility at UL.



sspc.ie/us-ireland-centre-to-centre-partnership



MSD and the SSPC partnership through the years

MSD have been partnering with SSPC since 2009 and through this partnership have advanced knowledge and 'know how' on site particularly in the area of crystallisation. Membership with SSPC has helped to strengthen the Irish manufacturing operations as it positions itself to continue to move up the value chain and compete globally for R&D projects.

Collaborations between MSD and SSPC enables a multidisciplinary approach to problem-solving. By combining their respective areas of expertise, researchers can gain fresh perspectives on complex issues. Through a mutual commitment to innovation, these two entities can make significant contributions to their respective fields while pushing the boundaries of scientific discovery.

Tom O'Ceallaigh, R&D Associate Director at MSD pharmaceutical company, (pictured right) with Michael Napier, ex-Janssen, receiving the SSPC at 15 Industry Champion Award. Since 2009, Tom has been instrumental in forging a strong partnership with SSPC the SFI Research Centre for Pharmaceuticals formerly known as the Synthesis and Solid State Pharmaceutical Cluster.



sspc.ie/tom-oceallaigh-sspc-industry-champion-award

- 15 years of collaboration
- Founding industry partner
- 16 student placements
- 14 SSPC alumni to MSD
- Joint Publications
- Engaging with 8 MSD sites across Ireland, US and Switzerland
- Small Molecule and Large Molecule research
- Representation on our Scientific Advisory Board

Highlighting our Global Alumni

SSPC has developed an excellent international profile due to the quality of its research outputs and people. Some examples from our alumni campaign:

- **Rodrigo Soto**, Lecturer Chemical Engineering, University of Barcelona
- **Raquel Arribas Bueno**, Project Manager MS&T, Teva, Netherlands
- **Udaya Khandavilli**, Snr. Process Chemist, AbbVie, Ireland
- **Claire Heffernan**, Snr. Solid-State Scientist, AstraZeneca, UK
- **Dinesh Kumar**, Indian Institute of Technology, Varanasi

Advanced Biopharmaceutical Technologies Spokes Project

Partners: Pfizer, Allergan, Eli Lilly, Janssen, Merck, Biomarín, Genzyme, SSPC and NIBRT



This partnership showcased the industrial collaboration in the precompetitive biopharma manufacturing sector. This partnership resulted in the development of advanced technologies to maximize biotherapeutic production, reducing adverse effects of extractables and leachables and increasing bioengineering capability during cell bioprocess in polymeric disposable systems. 7 PDRA's supported and eleven publications.

sspc.ie/advanced-biopharmaceutical-technologies-spokes-project

Impact: Global Partnerships

SSPC, a Truly Global Centre

SSPC engages in over 45 distinct international programmes, involving 90 HEIs, 30 research performing organisations, 65 industry partners (50: SMEs and MNCs) and 25 societal partners (regulatory, representative groups, health and policy groups, schools and community groups). These partnerships span 25 countries within the EU and beyond. Our industrial collaborative research projects have significant global reach, with 41% (up from 35% reported in 2021) of active projects through global sites, and 40% of SSPC industry members engage through their global sites and Irish sites. This is truly impactful for Ireland, aiding the Irish sites to meaningfully engage in R&D work within the global organisation, and increase the value of Ireland as a location of choice.

Long Acting Medicines for Complex Therapeutics Needed Now

Assoc. Prof. Sarah Hudson, Assoc. Prof. Luis Padrela, UL, Prof. Lidia Tajber, TCD Prof. Gabriele Sadowski, TUD and Dr Bruno De Witte, Janssen Pharmaceutica.



LongActNow is a Marie Skłodowska-Curie Action (MSCA) led by a consortium of international academic and industrial centres. This project supported five PhD students on the development of long acting drug formulations.

sspc.ie/long-acting-medicines-for-complex-therapeutics-needed-now/

ClickGene: Development of next-generation gene silencing therapeutics and epigenetic DNA probes

Assoc. Prof. Andrew Kellett, DCU, partnering with the Institute for Organic Synthesis and Photoreactivity, Institute of Organic Chemistry and Biochemistry Academy of Sciences of the Czech Republic, Ludwig-Maximilians-Universität München, University of Oxford, ATDbio, LipiNutragen and National Centre for Scientific Research "Demokritos".



The Horizon 2020 Innovative Training Network (ITN) ClickGene is a research project in the field of click chemistry and gene therapy. The project, supporting 14 PhD students, studies drug-DNA interactions using cutting edge bioanalytical techniques for the next generation of health applications.

sspc.ie/clickgene-development-of-next-generation-gene-silencing-therapeutics-and-epigenetic-dna-probes/

OptiViVax: To Optimise a Vaccines for Plasmodium Vivax Malaria

Dr Anne Moore and Dr Sonja Vucen, UCC, partnering with Stichting Radboud Universitair Medisch Centrum, The Netherlands, Institut National de la Santé et de la Recherche Médicale, France, Novavax AB, Sweden, Armauer Hansen Research Institute, Ethiopia, Vaccine Formulation Institute, Switzerland, London School of Hygiene and Tropical Medicine, UK, University of Cambridge, UK, The University of Oxford, UK.



Plasmodium vivax is the most widespread human malaria-causing pathogen with 2.5 billion people living at risk in Africa, South America, Oceania, and Asia. Over the next 5 years, OptiViVax, a newly created consortium across academia and industry, will build on exciting breakthroughs in malaria research to integrate state-of-the-art advances in parasite immunology, vaccine design, and innovative pre-clinical and clinical studies, to develop next-generation vaccines with increased efficacy against the *P. vivax* parasite.

sspc.ie/optivivax-optimising-a-high-efficacy-vaccine-for-plasmodium-vivax-malaria/

Impact: Case Studies

SSPC has made a significant impact through its ground-breaking advancements and scientific outputs. With a relentless commitment to innovation, **this Centre has revolutionized the (bio)pharma industry.**

Continuous Flow Photochemistry

Continuous flow is advantageous for photochemical reactions due to high photon transfer rates and uniform irradiation with good scalability for many important transformations. The Baumann group (**Prof. Marcus Baumann**) at University College Dublin has exploited these features using commercially available reactors to affect the scaled synthesis of C-C bonds via TBADT-catalysed HAT processes, the preparation of various cyclobutene products, the generation of oxazole and quinoline-based scaffolds via reagent-free means as well as various innovative skeletal rearrangements to generate complex carbocyclic scaffolds as well as ketenimine building blocks that allow for the expedited generation of medicinally relevant chemical entities. Recent work with the Maguire group at UCC showcased the application of diazo compounds in continuous photochemical C-H insertion processes.

SSPC flow expertise: sspc.ie/sspc-flow-chemistry-spotlight

Antimicrobial Resistance (AMR)

Antibiotic/Antimicrobial resistance is an ongoing societal threat, and there is an urgent need to combat this significant challenge.

The approach takes two strategies, repurpose existing compounds and design novel antimicrobial agents with distinct modes of action. *Candida parapsilosis* is an emerging fungal opportunistic pathogen and poses a high risk to immunocompromised (neonates, AIDS, transplant, cancer) patients. It is capable of colonising mucosal surfaces in the body, and it is resistant to conventional antifungal agents. The SSPC team, led by Prof. Kavanagh have evaluated SBC3 - 1,3-dibenzyl-4,5-diphenyl-imidazol-2-ylidene silver(I) acetate (HBC). The team used label-free quantitative proteomics to analyse changes in protein abundance in the pathogenic yeast *Candida parapsilosis* in response to SBC3 treatment.

Pseudomonas aeruginosa (Gram-negative) and *Staphylococcus aureus* (Gram-positive) are associated with cystic fibrosis lung colonisation and chronic wound infections, respectively. There are a number of critical immediate impacts from this work ranging from societal (awareness, discussion and debate) and economic (patent), to more medium to long-term impacts focusing on health and wellbeing for society. Led by a team at Maynooth University, via Prof. Kevin Kavanagh, this is a critical area of focus for SSPC, and future work in the Centre over coming years will continue to focus on AMR.

ArrayPatch: A new horizon for Intradermal Drug Delivery

Microneedle ArrayPatch (MAP) led by **Dr Waleed Faisal**, University College Cork, 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. This state funded research has shown the potential to result in the commercialisation of new innovations by way of new company creation to help Ireland grow and scale and compete in international markets or by way of license where the license of that technology to companies in Ireland would improve the competitiveness of Irish Industry. **Pharma Industry Award 'Innovation of the Year' winner 2022**



ArrayPatch: sspc.ie/arraypatch-a-new-horizon-for-intradermal-drug-delivery

Funding

Total funding secured >€54.75M

Total funding secured 2023 €17.43M

Highlights from 2023 funded programmes



Prof. Lidia Tajber, TCD, **eRaDicate**: To test receptor-targeting compounds for stemness and metastatic potential in cancers, €2.5 million

The “eRaDicate” Marie Skłodowska Curie Doctoral-Network (DN) is an international, multi- & interdisciplinary and inter-sectoral training, research and development programme in the field of cancer drug research.

sspc.ie/eradicate-eu-project-to-research-innovative-ligands-for-nuclear-receptors-to-eradicate-cancer-relapse/

SFI Frontiers Awards, €4.4M

Large-Scale Project:

Prof. Elizabeth Topp (1), NIBRT, **Prof. Steven Ferguson (2)**, UCD and NIBRT: Stable chemically modified mRNA vaccines



1



2

High-Risk High-Reward:



3



4



5



6



7



8

- 3 **Dr Andrea Erxleben**, University of Galway: Novel Platinum-Based Mitocans for the Treatment of Resistant Cancers: Synthesis, Targeted Delivery and Biological Studies
- 4 **Prof. Declan Gilheany**, University College Dublin: Small Nitrogen Bicycles: Constrained Molecular Geometry for Aza Bioisosteres, Encouraged Lewis Pairs and Pentavalent, Pentaco-ordinate Nitrogen
- 5 **Dr Darren Griffith**, RCSI: Development of Pt-based PROteolysis TARgeting Chimeras (Pt-PROTACs) as Molecular Probes for Pt-binding proteins and Next Generation Anticancer Agents
- 6 **Assoc. Prof. Jakki Cooney**, University of Limerick: Dynamic communication networks controlling immunomodulatory enzyme specificity and activity (DyNetIME)
- 7 **Assoc. Prof. Doireann O'Kiely**, University of Limerick: Mathematical models for wrinkle technology
- 8 **Assoc. Prof. Susan Quinn**, University College Dublin: PhotoGene: Photoactive Nucleic Acid Probes Towards New Diagnostics and Therapeutics

Highlights from the SFI Infrastructure Awards, €6.2M

Prof. Andrew Kellett, DCU, AUTOPILOT, Automated High-Throughput Analysis of Cellular Phenotyping, **€2.41M**

This system is a unique, custom build, robotically controlled platform enabling high-throughput cell characterisation including phenotyping by flow cytometry, high content analysis, proteomics, and cell culture analysis. It enables numerous automated workflows to be performed simultaneously, essentially facilitating analysis of any perturbation to cellular function by a large pool of compounds or in a number of model systems.



Late diagnosis and a lack of curative treatments for aggressive cancers is likely to remain one of the most complex and expensive health issues of the 21st century in Ireland and beyond. Despite advances in our understanding of disease states and tandem targeted drug discoveries, clinical drug failure rates remain stubbornly high. This failure is partly associated with the analysis of complex disease states under narrow conditions with limited read-out and target pool screening capabilities.

sspc.ie/autopilot-automated-high-throughput-analysis-of-cellular-phenotyping/

Prof. Anita Maguire, UCC, Fast reaction kinetics in NMR Spectroscopy, **€908,579**

This infrastructure will enable for the first time in Ireland, direct monitoring of fast reactions in real time by NMR spectroscopy, providing unparalleled insight into the details of reaction processes which are complete in 5-10 mins or less, which to date have been beyond the reach of investigation by NMR spectroscopy. The technology which has led to the InsightXpressMR system was developed over recent years through a collaboration between Bruker and Prof. Guy Lloyd-Jones (University of Edinburgh), and is only recently commercially available. This new system compliments the existing ProSpect infrastructure in UCC.

"Our team warmly welcomes this award which will enable us to monitor fast reactions using NMR spectroscopy for the first time. This infrastructure will enhance our research capacity within the context of UCC Future Pharmaceuticals and the SSPC."



Prof. Anita Maguire, UCC

Enterprise Ireland Commercial Fund and IRC Laureate Consolidator **€4.4M** including

Dr Waleed Faisal, UCC, **€740,000** Enterprise Ireland Commercial Fund, ArrayPatch: A new horizon for Intradermal Drug Delivery and **Dr Michael Stocker**, UCD, **€432,000** Enterprise Ireland Commercial Fund, in collaboration with Anne Marie Healy, TCD and Steven Ferguson, UCD.

Assoc. Prof. Andrew Kellett, DCU, IRC Laureate Consolidator, ENACT: Gene Editing with Nucleic Acid Click Chemistry **€600,000**

The ENACT project seeks to develop a new type of gene technology that contains two components: an artificial chemical nuclease containing a reactive metal ion capable of damaging DNA, and targeting vectors called triplex forming oligonucleotides (TFOs) and peptide nucleic acids (PNAs) that can recognise specific cancer-causing genes. Therefore, under the guidance of the TFO or PNA probe, the artificial nuclease will sequence-specifically damage targeted genes of interest in human cancer cells.

sspc.ie/prof-andrew-kellett-irc-laureate-consolidator-award-enact/

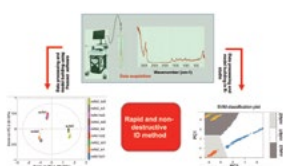
Industry Engagement

Industry Collaboration Publication Highlights

"A key aspect for APC in advancing our technology development and research capability is working with the brightest and best minds. We are extremely proud that APC is the largest employer of graduates from SSPC. For us as an industry partner, our support into the Centre research focus, education development programs and talent development is simply essential to APC's future and sustained growth."

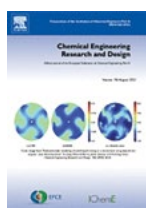
Mark Barrett, CEO & Co-Founder APC Ltd.

- ◆ Industry collaborators **51**
- ◆ Industry placements **44**
- ◆ Contracted Industry Projects **69**
- ◆ Co-authored papers with industry **76**



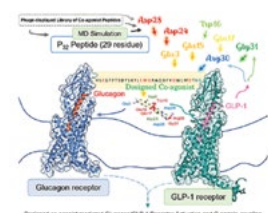
Identification of monoclonal antibody drug substances using non-destructive Raman spectroscopy, Mahendra K. Shukla, Philippa Wilkes, Norma Bargary, Katherine Meagher, Dikshitkumar Khamar, Donal Bailey, Sarah P. Hudson. *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*.

sanofi



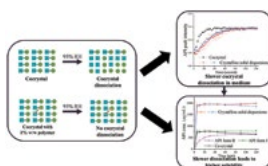
Two-fluid simulations of an aerated lab-scale bioreactor, Roya Jamshidian, James Scully, Harry E.A. Van den Akker. *Chemical Engineering Research and Design*.

REGENERON



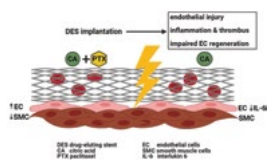
Computational Peptide Design Cotargeting Glucagon and Glucagon-like Peptide-1 Receptors. Shubham Vishnoi, Shayon Bhattacharya, Erica M. Walsh, Grace Ilevbare Okoh, and Damien Thompson. *Journal of chemical Information and Modelling*.

MERCK



In Situ Cocrystallization via Spray Drying with Polymer as a Strategy to Prevent Cocrystal Dissociation. ShiZhe Shao, Michael W. Stocker, Salvatore Zarrella, Timothy M. Korter, Abhishek Singh, and Anne Marie Healy. *Molecular Pharmaceutics*.

Janssen



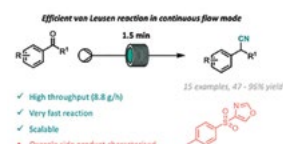
Candidates for smart cardiovascular medical device coatings: A comparative study with endothelial and smooth muscle cells. Miriama Ceresnakova, David Murray, Tewfik Soulimane, Sarah P. Hudson. *European Journal of Pharmacology*.

COOK MEDICAL



Heat Transfer Analysis of Laminar Pulsating Flow in a Rectangular Channel Using Infrared Thermography. R. Blythman, S. Alimohammadi, N. Jeffers, D. B. Murray, T. Persoons. *Heat and Mass Transfer*.

el ENOVUS LABS



A cyanide-free synthesis of nitriles exploiting flow chemistry. Niamh Disney, Megan Smyth, Scott Wharry, Thomas S. Moody and Marcus Baumann. *Reaction chemistry & Engineering*.

ALMAC

2023 Highlights

SSPC Recruitment Day

SSPC is committed to providing a platform for collaboration among all stakeholders involved in this sector so that they can work together towards achieving common goals.

In May 2023, SSPC welcomed industry members Eli Lilly, APC Ltd., Pfizer, MSD, CADFEM, Janssen, Innopharma and SK biotek to a (bio)pharma recruitment day which provided an opportunity to those looking to take their career to the next level. Through our collaborative approach, we were able to facilitate knowledge exchange between different stakeholders and foster new ideas that can help shape the future of the sector.

sspc.ie/sspc-recruitment-day/



Funding: Disruptive Technologies Innovation Fund (DTIF)

The **Selio System** is a pre-biopsy intervention device which prevents haemorrhage occurring before kidney or liver biopsy takes place, thereby facilitating same day release of patients – **€4,152,688**. SSPC Investigators include: **Assoc. Prof. Sarah Hudson**, **Assoc. Prof. Emmet O'Reilly** and **Assoc. Prof. Kieran McGourty**, University of Limerick.



The **BioBridge** project will make (bio)pharma manufacturing vastly more efficient by building new laboratory methods and computer models to design better manufacturing processes – **€3,182,042**. SSPC Investigator: **Prof. Vivek Ranade**, University of Limerick.

sspc.ie/funding-of-e58-8-million-announced-for-diverse-and-potentially-life-changing-disruptive-technology-projects/

Second phase of Resin project launched at BPCI Conference

At the 2023 annual BPCI Conference, SSPC, SFI and partners launched phase two of a project led by Prof. Sarah Hudson, addressing the growth of protein A resin market. The collaboration sees five leading biopharma companies Pfizer, Eli Lilly, Janssen, BMS and MSD working together to address challenges that are shared across the biopharmaceutical manufacturing sector.

sspc.ie/sspc-launch-phase-two-project-addressing-the-growth-of-protein-a-resin-market/

Pictured at the launch of the second phase of an SSPC resin project at the BPCI Conference, standing, Aisling Arthur, SSPC Industry Engagement Manager, Prof. Sarah Hudson, project lead (seated), Matt Moran, previous Director, BioPharmaChem Ireland, Dr Sarah Hayes, SSPC COO, Prof. Damien Thompson, SSPC Director and Prof. Philip Nolan, Director General, Science Foundation Ireland (seated). Picture: Conor McCabe.



Commercialisation: SEnclL

Dr Michael Stocker, UCD, was awarded an Enterprise Ireland Commercialisation Fund in Spring 2023, building on a patented technology, SEnclL. SEnclL uses commonplace manufacturing processes, it holds the distinction of having both disruptive and familiar, de-risked, aspects. A Commercialisation Feasibility Study funded by Enterprise Ireland ultimately informed the decision to apply for Enterprise Ireland's Commercialisation Fund programme, which was awarded as a Proof of Concept Study in Spring 2023. Michael is mentored by Prof. Anne Marie Healy, Trinity College Dublin and Assoc. Prof. Steven Ferguson, University College Dublin.

sspc.ie/sspc-commercial-activity-of-the-year/

Education and Public Engagement (EPE) spotlights



Number of
Events
280



Direct
Engagement
5,857



Indirect
Engagement
235,383



SSPC
Community
443



Funding
242K



Publications
12

DiSSI - Diversity in Science towards Social Inclusion

Partner Countries: UK – University of Strathclyde, Tbilisi; Slovenia – University of Ljubljana; North Macedonia – Ss. Cyril and Methodius University of Skopje. Project website: <https://dissi.org/>.



DiSSI



Co-funded by the
Erasmus+ Programme
of the European Union

Funded by the European Erasmus+ programme, Diversity in Science Towards Social Inclusion (DiSSI) aims to address a gap in research and practice pertaining to inclusive science teaching. Current methods tend to focus on only one dimension of diversity at a time. This neglects the fact that diversity is multidimensional in nature and the consideration of only one dimension of diversity can yield inclusive practices of only limited scope. Collaborating with third level institutions across Europe, the SSPC team focussed on low socio-economic status in the Limerick area in Ireland. Having worked primarily in local schools, we are currently analysing data and publishing papers.

The project collaborates with **Assoc. Prof. Sarah Guerin's** "Crystal Clear" project. This work aims to build a standardised kit in order to develop environmentally friendly bio-crystal molecules that are piezoelectric using a citizen science activity. DiSSI develops several interventions including informal workshops, escape room activities, debates and group discussions, as well as outdoor activities with local community members.



Hand Hygiene in Schools – National Citizen Science Project



This citizen science project targets hand washing given that it represents a key method to prevent local transmission of pathogens.

The project involves multiple interventions across Transition Year (TY) classrooms in Ireland. Students are asked to conduct a hand washing assessment using gloves and paint. Photos of the students' hands are then sent to the SSPC EPE team for quantitative analysis.

To date, over 300 students have taken part in the project with an aim to publish results this year (2024).

EPE Bursary Programme

The **SSPC Bursary Programme** enables researchers at all levels to develop their own EPE programme, event or activity, aligned with the SSPC EPE and research programmes.



Elevate VR led by Dr Jerry Reen

The project aims to aid students in their understanding of core science concepts, such as cell biology, by merging educational research and virtual reality (VR) technology. The simulations place the user in an interactive 3D world with a human and bacterial cell, with the aim of they can be applied in classrooms as a learning tool. Working with teachers, we are co-creating teaching methodologies and refining simulations simultaneously. In the current phase we have recruited a variety of teachers from the Munster area to test VR simulations and headsets.



Crystal Clear Project led by Assoc. Prof. Sarah Guerin

Working with a local school group to co-create a piezoelectric citizen science project that is simple and engaging. Following ethical approval, a 10-week intervention took place with a local girls' DEIS school, via DiSSI project workshops and the DiSSI team. Over the course of the 10 weeks, the students designed and tested multiple crystal growing kits until a pilot kit was developed. The kit is now being further tested with members of the public before a national launch later in 2024.



Chemistry School of Growth (CSG) led by PhD student Lena Kadri

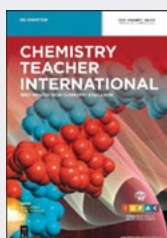
Utilising the power of social media, CSG makes content for Instagram, YouTube and TikTok around study tips, wellbeing, chemistry and the daily life of a scientist. Current work is looking to gather study tips from the entire SSPC community. This project is led by SSPC PhD student Lena Kadri at TCD and focusses on building a community via social media, utilising methods of engagement that are the primary methods of engagement for young people today.

Highlights from EPE collaborative publications



What is it good for? Basic versus applied research

McHugh, M., Baumann, M., Hayes, S., Reen, J., Ryan, L., Tiana, D., & Whelan, J. (2021). *Acta Tropica*, 194, 93–99.



Some people and personalities of organic chemistry: a teaching hook for mid-level university students

Mackey, K., McHugh, M., & McGlacken, G. P. (2022). *Chemistry Teacher International*, 4(4), 327-338.



Medicine maker: an outreach activity for pharmaceutical manufacturing and health literacy.

McHugh, M., Hayes, S., Tajber, L., & Ryan, L. (2022). *Journal of chemical education*, 99(3), 1231-1237.

Talent and Skills Development

Demonstrating relevance of training through talent pipeline high transition to industry roles and prestigious academic positions.

Since its inception, SSPC is the largest producer of PhD graduates for the (bio)pharma sector in Ireland, developing the next generation of innovators and leaders. SSPC's talent pipeline is futureproofing Ireland's exceptional international reputation in the field supporting many PhDs throughout its lifespan, with 63% transitioning to industry.

Numbers from 2019-2023

- Postdoctoral researchers **67**
- Academic International Placements **6**
- Industry International Placements **3**
- PhDs in study **182**
- **44** industry placements across **10** industry sites

SSPC Placement Programme highlight

Simin Arshi, UL, won the SSPC Industrial PhD Placement Award for an exceptional and impactful SSPC PhD placement experience at MSD, Ballydine

sspc.ie/simin-arshi-wins-sspc-industry-phd-placement-award/



International Placements

Lena Kadri, TCD, completed a placement with Zentiva, Czech Republic for three months sspc.ie/12080-2/

Kate Tolan, TCD and **Alice Parkes**, UL, completed their placements at Janssen, Beerse, Belgium for three/six months sspc.ie/alice-parkes-placement-at-janssen-belgium/

SSPC at ISIC-BACG

This year the British Association for Crystal Growth joined the International Symposium on Industrial Crystallization for their Annual Conference 2023 in Glasgow. With a strong presence from SSPC this year, three SSPC researchers from the University of Limerick won first prize for their exceptional contributions.

Mariana Diniz, won first prize in Crystals in Art competition with her image called Jack Frost

Vidit Tiwari was awarded first prize in the BACG poster competition for his poster on Particle Breakage using Wet Mill, Ultrasonic and Hydrodynamic Cavitation.

Vaishnavi Honavar was awarded first prize in the CG&D poster competition for her poster on Antisolvent Crystallization of Carbamazepine Dihydrate using a Fluidic Oscillator.

sspc.ie/sspc-award-winners-at-bacg-isic-2023/



Awards and Achievements

The Festschrift Issue in honour of Prof. Vivek Ranade, University of Limerick



The Festschrift Issue in honour of **Prof. Vivek Ranade**, UL, published in Industrial and Engineering Chemistry Research by ACS Publications called refaced for Festschrift Issue. This special issue celebrates Vivek's 60th birthday, is a befitting tribute his commitment, dedication and leadership within the chemical engineering profession and chemical industries.

<https://pubs.acs.org/doi/10.1021/acs.iecr.3c03616>

New molecule created in the fight against bacteria showing Anti-Microbial Resistance

Published in the journal *Chem*, November, 2023, the study demonstrated for the first time the use of table salt to cause cell death in bacteria. Researchers at Maynooth University were part of an international study that created a new molecule to kill bacteria that have developed antimicrobial resistance (AMR). The image, below, conveys the ability of the synthetic molecules (squindoles) reported in this issue to efficiently transport chloride ions through lipid membranes and thereby disrupt ion homeostasis and result in potent anti-microbial activity.

<https://pubs.rsc.org/en/content/articlelanding/2023/SC/D3SC03303A>



Assoc. Prof. Rob Elmes and Luke Brennan, Maynooth University

Publication and cover: Potent antimicrobial effect induced by disruption of chloride homeostasis



The November issue coincides with World Antimicrobial Resistance (AMR) Awareness Week (November 18–24, 2023). Copyright Ella Maru.

Luke E. Brennan, Lokesh K. Kumawat, Magdalena E. Piatek, Airlie J. Kinross, Daniel A. McNaughton, Luke Marchetti, Conor Geraghty, Conor Wynne, Hua Tong, Oisín N. Kavanagh, Finbarr O'Sullivan, Chris S. Hawes, Philip A. Gale, Kevin Kavanagh, Robert B.P. Elmes

DCU team creates compound that can damage cancer DNA

A team of scientists based in Dublin City University led by **Prof. Andrew Kellett** have created a new compound that can potentially destroy the DNA of cancer cells using a method known as "click" chemistry. The compound, called Tri-Click Thiophene, or TC-Thio, is a promising class of anti-cancer agents that binds and cuts cancer DNA. Through their research, the team was able to identify how TC-Thio – in the presence of copper ions – could bind and cleave DNA and damage it.



Prof. Andrew Kellett

Publication and cover: A Click Chemistry-Based Artificial Metallo-Nuclease



Alex Gibney, Dr Raphael E. F. de Paiva, Dr. Vandana Singh, Robert Fox, Prof. Damien Thompson, Dr Joseph Hennessy, Dr Creina Slator, Prof. Christine J. McKenzie, Dr Pegah Johansson, Prof. Vickie McKee, Prof. Fredrik Westerlund, Prof. Andrew Kellett

SFI/IRC Summit 2023

Assoc. Prof. Sarah Guerin, UL, received the SFI Early Career Researcher of the Year and Prof. Anne Marie Healy, TCD, received the SFI Mentorship award 2023.



2019-2023

2023 AT A GLANCE

New investigators 1

New PhDs 9

New Post Doc researchers 3

New industry partners 4

Publications 138

Industry Placements 12

Active industry projects 28

Training Events 5

EPE Activities 280

International Funding €14.6M

Centre Awards: 2

Investigators 80

PhDs 182

Post Doc researchers 67

Industry partners 51

Publications 615

Industry Placements 44

Collaborative industry project to date 69

Training Events 29

EPE Activities 803

International Funding €25.6M

Centre Awards 13

SSPC OPERATIONS MANAGEMENT TEAM

Dr Sarah Hayes	Chief Operations Officer	Sarah.Hayes@ul.ie
Dr Sinéad O'Doherty	Head of Strategic Development	Sinead.ODoherty@ul.ie
Cathal Connolly	Centre Co-ordinator	Cathal.Connolly@ul.ie
Aisling Arthur	Industry Engagement Manager	Aisling.Arthur@ul.ie
Jamie Guidera	Business Development and Commercialisation Manager	Jamie.Guidera@ul.ie
Dr Kristy Sirr	Research Programme Manager, Targeted Projects	Kristy.Sirr@ul.ie
Hilda Fogarty	Research Platform Programme Manager	Hilda.Fogarty@ul.ie
Louise Laffan	Reporting, Compliance & Accounts Officer	Louise.Laffan@ul.ie
Colm O'Hehir	Education Training & Public Engagement Manager	Colm.OHehir@ul.ie
Dr Martin McHugh	Project and Public Engagement Officer	Martin.McHugh@ul.ie
Louise O'Neill	Marketing & Communication Manager	Louise.ONeill@ul.ie
Jamie Stock	Funding Manager	Jamie.Stock@ul.ie


www.sspc.ie
