

SCIENTIFIC SPOTLIGHT

An editorial series
by Atrandi Biosciences

In every lab there's a quieter narrative running alongside the results: the intriguing questions, the workarounds, the moments when a method finally clicks. Scientific Spotlight is a series of editorial profiles of researchers pushing single-cell science forward. We focus on the science, the journey, and the practical realities behind the headlines – what worked, what didn't, and what changed their trajectory.

THE ART OF BUILDING TOOLS OTHER SCIENTISTS CAN TRUST



SCIENTIFIC SPOTLIGHT

INSIDE THE JEROEN LAMMERTYN LAB: THE ART OF BUILDING TOOLS OTHER SCIENTISTS CAN TRUST

For years, droplets were a major part of how the team of Jeroen Lammertyn at KU Leuven approached single-cell problems: fast, elegant, high-throughput. Until the day the workflow asked for something droplets don't give you easily – a clean way to change conditions, wash, and move through multi-step protocols without turning the experiment into a super technical high-wire act. That tension, between what single-cell biology demands and what current formats make convenient, is where Prof. Jeroen Lammertyn and Dr. Karen Ven have been building. And it's what eventually led them to add Semi-Permeable Capsules (SPCs) into their toolkit: not as a replacement, but as a missing block for certain kinds of science.

Twenty years ago, the group began as a technology-driven biosensing team.

Today it has grown into a dynamic lab of around forty people, still anchored in the same instinct: work at the interface of biology and technology, and build things that others can use – in academia and in industry – to test their hypotheses and move faster through every part of discovery.

They develop diagnostic tools. They build life science research tools. They do both, and they treat those two directions as deeply connected rather than separate lanes. Find biomarkers with one set of technologies, translate that knowledge into point-of-care tests with another. Keep an eye on application without losing the joy of invention. And if you ask Prof. Jeroen where that instinct came from, his answer doesn't start with "single-cell". It starts with fruit.

FROM PEARS TO BIOSENSING: PROF. JEROEN LAMMERTYN'S LONG ARC



Prof. Jeroen Lammertyn trained as a bioscience engineer, with a major in food science and plant protection. His PhD focused on storage disorders in fruit – a problem that sounds deceptively gentle until you hear what it demanded: he needed to “decompose” a pear into its layers (skin, tissue, flesh), turn tissue into cells, and measure respiration and other signals.

To do that, he had to build tiny bioreactors. Those bioreactors needed sensors – for oxygen, carbon dioxide, sucrose, etc. It was practical science: if the measurements don't exist, you build the measurements.

From there, the pathway makes sense in hindsight: electronic noses, electronic tongues, biosensing. A period in the United States in the early 2000s to learn more about it. And after – a return to KU Leuven, where he had the chance to start a team, at a moment when nanotechnology and bio-nanotechnology were accelerating.

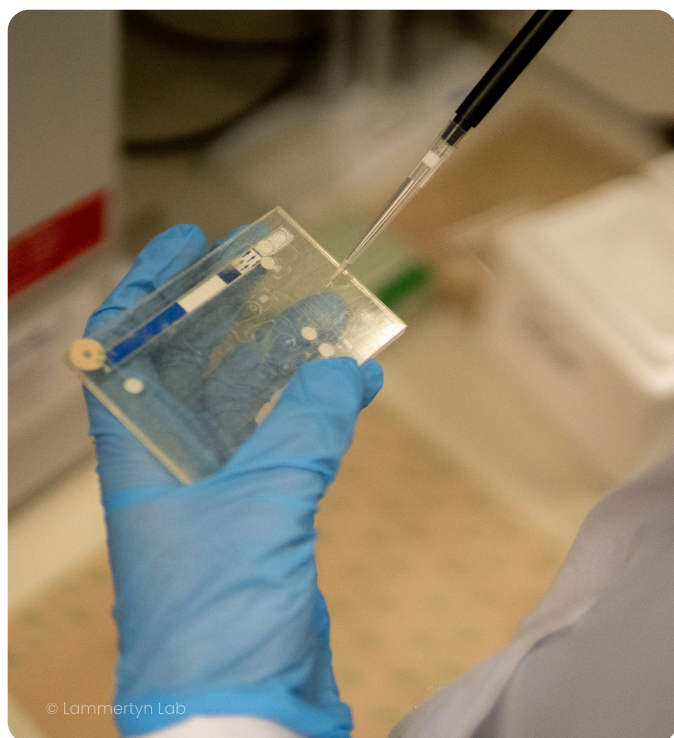
He was “lucky”, he says, to attract a first wave of strong PhD students – the kind who can help build not just projects, but culture. The group grew through European and national projects, and through a pattern that still defines them: listen closely to real application partners, treat their constraints as design requirements, and work until biology and technology meets in the middle.

KAREN'S PATH: TECHNICAL, AND MISSION-DRIVEN



Dr. Karen Ven's story is a bit different in tone – more direct, and very strong in dedication to science. She's also a bioscience engineer. After graduating, she actively looked for PhD opportunities and found one in Prof. Jeroen's lab. She hadn't done her thesis there, so it was new territory, but she was pulled in by the same interface: technology and biology.

Her PhD focused on developing novel concepts for digital bioassays – extremely sensitive biomolecule sensing. She learned microfabrication and microfluidics early,



THE MICROWELLS BREAKTHROUGH: MAKING TINY STRUCTURES, OPENING BIG DOORS

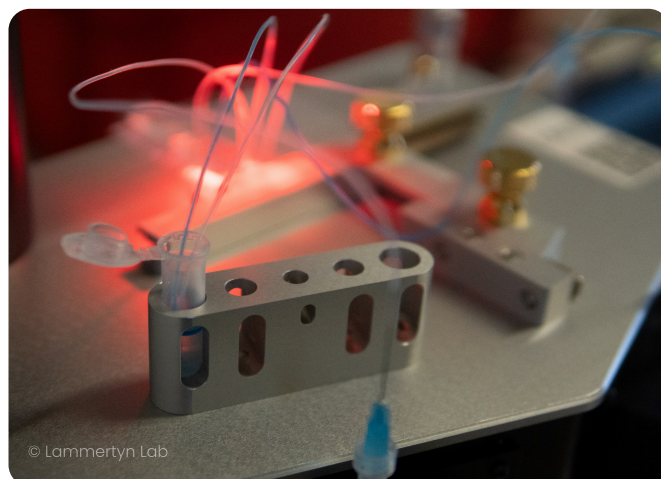
If you ask what microfluidics enabled that might not have happened otherwise, Prof. Jeroen points to a breakthrough that has the clean logic of good engineering: once you can fabricate tiny structures, new experimental worlds become accessible.

but not through the “single-cell” lens. It began with single proteins and DNA molecules, with diagnostics in mind.

A detail that stayed with me: she defended her PhD the week before the first COVID lockdown. The timing is almost absurd – a marker of how quickly the world can shift. Before that shift, though, the group were already exploring ways to extend microfluidics toward single-cell studies – specifically antibody discovery. Then the pandemic arrived, and the scientific demand wasn’t abstract anymore. They secured a large project, and Karen’s postdoc moved into continuous microfluidics for antibody discovery, then into droplets, directed evolution, and a widening set of collaborations. For six years, she did postdoctoral research in the group – first hands-on, later increasingly project management – because the questions kept coming: from KU Leuven, from outside partners, from people who needed microfluidics as a missing capability.

And within LISCO – the KU Leuven Institute of Single Cell Omics – that pull becomes even stronger: there the Lammertyn lab builds platforms and tools that advance single-cell and spatial omics as something researchers can actually run, interpret, and trust.

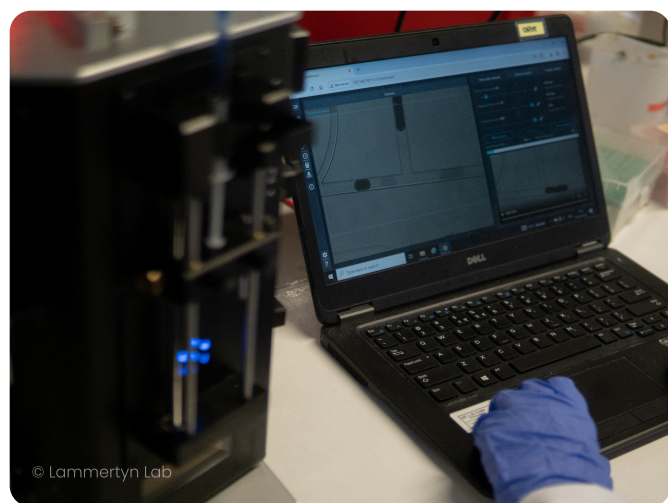
They built wells of three by three micrometers, tiny microstructures in a substrate. In each well, they put one bead. A company (Quanterix) works on related ideas, but Prof. Jeroen’s team combined this with electrowetting-based digital microfluidics. They patented it, and it led to a long-term collaboration with a leading American multi-national health care company – a concrete reminder that “tool-building” isn’t secondary science. It is the kind of science industry notices because it changes what is possible. Then came a thought that feels almost obvious once spoken: “If you make the wells a bit bigger, you don’t have to put beads in them. You can put cells in them,” Prof. Jeroen said.



That idea became their FLUIDOT platform (modular, PDMS-based microfluidic microwell platform that shares "Fluidigm-like" functionality for single-cell analysis and retrieval, as they describe it in the conversation) for studying individual cells (including B cells), measuring secreted antibodies or surface expression, and selecting the B cells that produce antibodies against a target such as the RBD fragment of SARS-CoV-2. That, too, was patented.

Microwells offered a particular modality: "you can screen cells and follow them over time. You can check them, revisit them, observe dynamics. The trade-off is throughput. Medium throughput", Karen explains, "valuable, but limiting". So, they moved toward droplets.

DROPLETS: HIGHER THROUGHPUT, LARGER SCALE



Droplet microfluidics changed the scale. Throughput became higher, and with it, a different set of constraints. Droplets can be powerful for screening, perturbation studies, antibody discovery, and directed evolution. "We did a lot," Karen remembers, "like improving pico-injection and sorting methods for single and double emulsions." Advancing the technology itself while running it for real applications. The group built novelty while strategically incorporating what's available commercially – assembling a full portfolio.

But droplets come with their own physics and practicality. Studying the same cell over time is more challenging unless you trap it. And when you move into downstream processing, especially omics, reality shows up in multi-step protocols that require washing and other manipulations. This is where their story becomes less about "droplets vs something else", and more about understanding that no single tool is the answer.

"There is no general solution," Jeroen says later, "there are technologies you can start from, but every biological problem carries its own specific details: cells stick more or less, vary in size distribution, behave differently in different conditions. Building capability takes time. Convincing collaborators that it takes time is even harder."

"Expectation management," he calls it.

And it's not a complaint – it's the price of turning clever prototypes into workflows other scientists can rely on.

THE MISSING BLOCK: "YOU CAN ALWAYS ADD... BUT IT'S HARD TO TAKE OUT"

At some point, the lab reached a practical boundary that many droplet-using groups encounter: in droplets you can add things, but it's difficult to remove anything. And many protocols, especially those bridging from cellular handling into library preparation and omics, are not just "add reagent A once", they usually are multi-step.

"Yes, you can pico-inject, you can even do multiple pico-injections," Karen explains it, "but it becomes technically challenging, and it's not something "anyone can do". Adoptability drops,

especially for application partners who want to use the method without becoming microfluidics specialists.” So the group looked for something complementary. Not a replacement – a missing block. That’s where Atrandi’s Semi-Permeable Capsules (SPCs) entered their portfolio.

“The capsules [SPCs] were perfectly complementary because they solved a class of problems droplets struggled with – especially workflows where you need to wash, to exchange reagents, to run multi-step procedures.” Prof. Jeroen says.

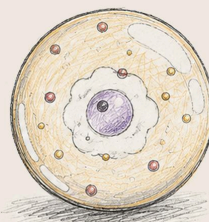
Karen adds the pragmatic dimension: when your strategy includes transferring tools to collaborators, so they can use them in their own research, complexity becomes a real barrier. In their lab, they started with homebuilt droplet microfluidics systems, then adopted more intuitive commercial systems – including Onyx and Styx from Atrandi Biosciences – so researchers from different groups could work with microfluidics more easily. SPCs, in that framing, are another step in making advanced workflows more implementable without demanding “high-end microfluidic setups and expertise”. It’s very operational and it’s exactly what makes it convincing to other scientists.



CHOOSING TOOLS WITH HONESTY: WHERE CAPSULES HELP AND WHERE THEY DON'T

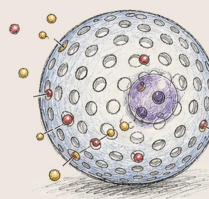
One of the most valuable parts of this conversation is that Karen and Prof. Jeroen don’t treat SPCs as universally better. They treat them as situationally powerful, and they name the situations.

DROPLET



- CLOSED MICROREACTORS
- LIMITED FLEXIBILITY
- LIMITED COMPATIBILITY

SEMI-PERMEABLE CAPSULES



- SEMI-PERMEABLE COMPARTMENTS
- REAGENT EXCHANGE
- MULTI-STEP SEQUENTIAL PROCESSING

What becomes easier with capsules?

- Prolonged culture can be easier because you can replenish medium.
- Multi-step workflows become more straightforward when the components you need to add are small enough to pass through the capsule shell.
- Preparation for libraries and omics can be more practical when washing and stepwise processing are required.

And where do limitations appear?

- If you care about smaller secreted molecules or cell-cell communication, you have to think carefully about whether the molecules of interest will leave the capsule – pore size matters.
- For high-throughput screening with bigger cells, you may need bigger capsules, and those can't necessarily be sorted with standard FACS because nozzle size becomes limiting.
- For certain directed evolution / protein library screening workflows, SPCs may not fit because some proteins are too large to enter the pores, so droplets stay "equally interesting," as they put it.

That's the kind of nuance that is very important: "The story isn't "we upgraded", it's we expanded our toolbox, because biology keeps demanding new innovation," Karen and Prof. Jeroen state.

WHAT THEY'RE EXCITED ABOUT: SCIENCE WITH CONSEQUENCE

When the conversation turns toward what they're working on now, both Karen and Prof. Jeroen reveal something else about their lab: they like projects where the technical challenge connects to real-world consequence.

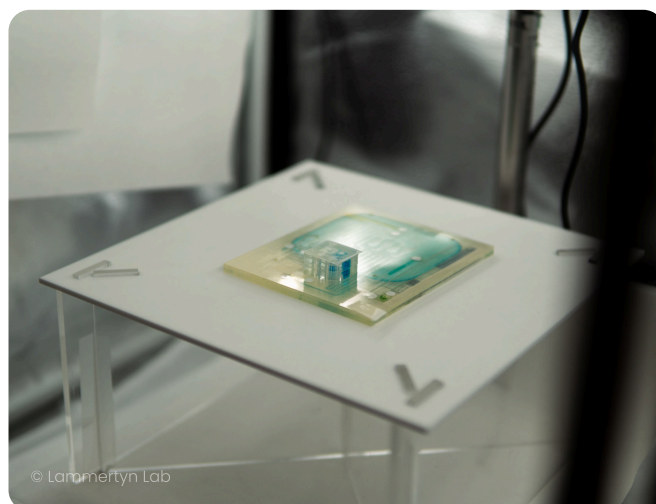
Karen mentions exploring SPCs in standard workflows for forensic sample analysis, in collaboration with Prof. Bram Bekaert from KU Leuven and partners across Europe within the context of [CapCell](#), a Horizon Europe Research and Innovation Action funded under HORIZON-CL3-2024-FCT-01. The constraints are stark: forensic budgets are limited, but the cases demand advanced solutions. The example she gives is difficult and human: samples from sexual assault cases where there may be multiple contributors, perpetrators, consensual partners,

and the question becomes: who contributed what? In that context, single-cell analysis is crucial. And they are exploring whether SPCs can become a versatile, easy-to-use tool for processing casework samples through multi-step procedures that were hard to solve in droplets.

Prof. Jeroen, in parallel, talks about configurations in both droplets and SPCs involving genomics and transcriptomics analysis of single cells in collaboration with Prof. Thierry Voet and LISCO, the KU Leuven Institute for Single Cell Omics, to gain unprecedented insight in the link between genotype and phenotype of individual cells in health, ageing and disease. And they have also established complex droplet-based library screening workflows where they start from plasmids in droplets, create proteins and screen for active compounds – an elaborate, multi-part workflow that took two years to develop and is now beginning to deliver truly exciting results. And then, deeper motivation shows up.

Prof. Jeroen says he is always drawn to developing tools and concepts that help others achieve their goals. It's woven into how he defines the lab's mission: build devices and concepts that other people can use for testing their research hypotheses.

Keep collaborating with "real application partners." Listen first and solve together.



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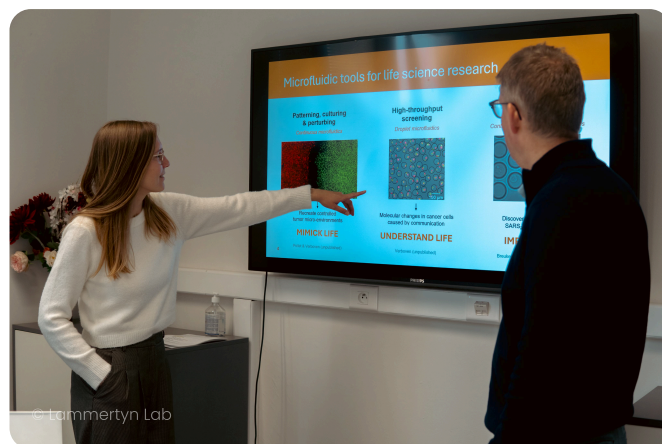
A FIELD GROWING OUTWARD: SINGLE-CELL, CONTEXT, AND THE ECOSYSTEM VIEW

Toward the end, Prof. Jeroen offers a perspective that feels like a professor is speaking to both engineers and biologists at once. “From the technology side, single-cell is a challenge: you want one cell in a droplet, one cell in a capsule – push the efficiency toward 90–95%, and be proud when you get there. But then you talk to biologists, and they remind you: if you isolate cells from their environment, you may change the biology you’re trying to understand. So, the field has to hold both truths.” Professor Jeroen explains.

There is the technological urge to isolate, control, and measure. And there is the biological reality that cells are ecosystems – communicating, influencing each other, behaving differently in different contexts. This tension is part of what pulls the field toward spatial biology, where you can keep cells in their context and still analyze them at high resolution. In Prof. Jeroen’s view, the future isn’t one technology conquering everything – it’s complementary approaches that reduce bias by giving you multiple angles on the same biological question.

He tells his students: “study something with many different technologies, and bring the information together, because every technology creates a bias. The solid conclusion comes from synthesis.” Karen sees the same arc from a different vantage point: interest is growing, requests are increasing. Often researchers first want to “explore what the possibilities are” because they’re not familiar with them. But once tools become accessible, once people learn and see the value, adoption follows, especially if they have a portfolio of questions to test. “The work of a center of expertise is not just to run experiments. It’s to lower the barrier to learning until single-cell stops being a specialist thing and becomes something more labs can meaningfully use,” Karen says.

A PORTRAIT IN MOTION



If you step back, what’s striking about this KU Leuven story isn’t a single platform or a single project. It’s the way the lab moves.

Prof. Jeroen’s intelligence shows up as breadth with structure: sensing, DNA nanotechnology, micro- and nanofluidics, point-of-care devices, spatial biology – all treated as building blocks that can be recombined depending on the problem. Karen’s directness shows up as operational clarity: what a workflow needs, what’s technically hard, what collaborators can realistically adopt, and why “it depends” is not a weakness but an honest summary of the field.

And together, their trajectory – microwells to droplets to capsules, plus everything still running in parallel – looks less like a linear upgrade path and more like what science is when it’s done with care about other researchers in mind. Build capabilities. Test them in real collaborations. Learn the limits. Add the missing blocks. Keep listening. Keep iterating.

In the end, what stays with you after talking to Karen and Jeroen is the same thing that runs through their work: curiosity with responsibility – toward collaborators, and users downstream, toward the questions that matter.