

CAN YOU TELL US ABOUT YOUR CURRENT RESEARCH AND WHAT EXCITES YOU MOST ABOUT IT?

I'm driven by the frustrating fact that we often talk about cell metabolism as if it were a fixed set of biochemical pathways that always operate in the same way. In reality, cellular metabolism is highly dynamic and far more heterogeneous than we used to acknowledge. For many years, we didn't look closely at the differences or ask what drives them, partly because we lacked the tools to observe metabolic changes at the level of single cells or during real-time interactions.



My research tackles this head-on by asking how cells rewire their metabolism as they interact with each other as well as with diseased tissues, and by developing tools that can finally capture those changes at the single-cell level and in real time. To do this, we are creating an integrated platform that combines NV-based quantum sensing, optical spectroscopy, and microfluidics to study metabolic plasticity from individual cells up to more complex, tissue-like systems.

What excites me most is that quantum sensing turns what used to be "background noise" into a biologically meaningful signal. We can detect subtle, fast metabolic changes, including free-radical-regulated processes, exactly where they happen. It feels like opening a completely new window into cell behaviour, one that has the potential to guide better immunotherapies, improve bioprocess monitoring, and ultimately support more precise clinical decisions. It's the combination of applied physics, careful biology, and the belief that this work can make a real-world difference that keeps me motivated every day.

WHAT'S ONE TOOL, TECHNIQUE, OR CONCEPT YOU USE THAT OTHERS MIGHT FIND SURPRISING?

One concept that surprises some people is that the most challenging part of quantum sensing in biological systems isn't the quantum measurement, it's the biology itself. We often approach experiments with a clear idea of where our sensors "should" go or how cells "should" behave, but living systems rarely follow our plans. Even cells of the same type in the same dish can internalise or process sensors differently, creating heterogeneity that often has nothing to do with the sensor and everything to do with biology.

I've seen researchers, myself included, puzzled when their data looks inconsistent, assuming the quantum sensor is the problem, when in fact the variation comes from the cells themselves. The quantum measurement is only one component; the real determinant of data quality is careful biological preparation and a deep understanding of the system you're studying. That's why we rely heavily on correlative measurements (at least for now), and why you must stay in "good conversation" with the biology to interpret quantum results meaningfully.

In short, the surprising concept is that quantum biosensing doesn't just require deep understanding of physics, it forces us to engage closely with biology. And that's where the real discovery happens, and where new directions for quantum sensor development emerge.

WHAT ARE YOU MOST EXCITED ABOUT IN THE FUTURE OF QUANTUM BIOMEDICAL SENSING?

What excites me most about the future of quantum biomedical sensing is seeing it become a go-to tool in biomedical labs everywhere. I imagine quantum sensing devices sitting right next to flow cytometers and microscopes as a standard way to watch cells shift their metabolism in real time.

Once non-physicists start using quantum sensing routinely, the field will explode with new ideas and unexpected discoveries. And that's the part I can't wait for, the moment when quantum measurements stop being a niche capability and start actively shaping better treatments, smarter diagnostics, and entirely new ways of understanding living systems.

WHAT ADVICE WOULD YOU GIVE TO EARLY-CAREER RESEARCHERS OR STUDENTS INTERESTED IN THIS FIELD?

My advice is to be patient and resilient, progress in this field often comes in small, carefully earned steps. Don't be discouraged when experiments take time or biology behaves unpredictably. Also, share your knowledge and learn from others. Quantum biomedical sensing is inherently interdisciplinary, and the best ideas grow when physicists, biologists, and engineers exchange experience openly. Stay curious, stay collaborative, and let the challenges guide your growth rather than intimidate you.

WHAT DO YOU ENJOY DOING OUTSIDE OF RESEARCH?

Outside of research, I can't sit still. I'm usually boxing, doing yoga, dancing, or disappearing into the outdoors to hike, sail, or cycle. It all sounds very wholesome... but honestly, one of my main motivations for moving to Scotland was to explore a good whisky in its natural habitat, ideally well-earned after a successful day of quantum science.