In time and space inside a cell

Getting a coherent picture of what actually happens inside a cell when the building blocks of life, proteins, come into being is a challenge. It is a complex, dynamic system that has kept researcher Magnus Johansson busy for twelve years. As a PhD student, he investigated protein synthesis biochemically, with purified molecules and experiments in test tubes. Nowadays, the focus is on live bacteria, in the hope that living cells will contribute to a more holistic picture of how proteins come into being.

"We are doing these experiments for the first time, without knowing what to expect, how it should be, or whether we are right or wrong. That is also what makes it so exciting. Because to get things right, we do have to make all the mistakes, too. There is no manual, and the level of control is not as good as it is in a test tube," says Magnus Johansson, a researcher at the Department of Cell and Molecular Biology, Uppsala University.

By studying protein synthesis in vivo, i.e. in a living system, he hopes to be able to complement the test-tube data and get a more accurate picture of how the cell's protein synthesis machinery operates in time and space. Cells and individual molecules are being studied using real-time fluorescence microscopy. This involves close collaboration with a departmental colleague, professor Johan Elf. The department also has about a dozen other researchers who are experts in protein synthesis, but with somewhat different specializations.

"When you do what I do, there is no better place to be than here. We can study the dynamics of protein synthesis in living cells using very high temporal and spatial resolution. And at the same time we have, for example, traditional biochemical methods available for control experiments," says Magnus Johansson.

Every cell has numerous ribosomes, the macromolecular machines responsible for protein synthesis. They perform different tasks at different times and interact simultaneously with several other processes. So, while scientists generally have a good picture of the molecular mechanisms, difficulties remain in linking them in a broader context to cell physiology and population biology, Magnus Johansson explains. But nothing is impossible. It just takes a little time, he says. And perseverance. Another important aspect of being a researcher is daring to question prevailing theories, and to be critical. That makes science what it is, he says, and recalls how as a PhD student he "overthrew a prevailing truth," as he puts it. He showed that contrary to the established view at the time, it certainly seems possible to measure directly one of the key chemical steps of protein synthesis.

"This was a 'truth' that was only a presumption. We questioned it, and succeeded in refuting it."

He also believes it is important not to look too narrowly at the object of study. It might seem convenient to look at just one or two aspects, but you then risk losing the bigger picture.

"For example, we know very little about how certain antibiotics actually work, how they inhibit protein synthesis and what kills cells or prevents them from growing. We are hoping to get closer to understanding the mechanisms behind the antibacterial effect by studying the drugs in our system. Once we can get it to work," says Magnus Johansson.

Understanding how something really works is what spurs him on, and something he hopes to succeed with. Provided I have the time, he says. This is because he has no proper permanent post, but is at the department thanks to his own external funding. These are sufficient to last at least four more years, however.

"I enjoy it enormously, and it is a huge challenge. It is hard to imagine a better job, focusing on what interests you because someone has faith in you and says, 'Solve the problem. We believe in you.' It is a responsibility, but very exciting," Magnus Johansson concludes.