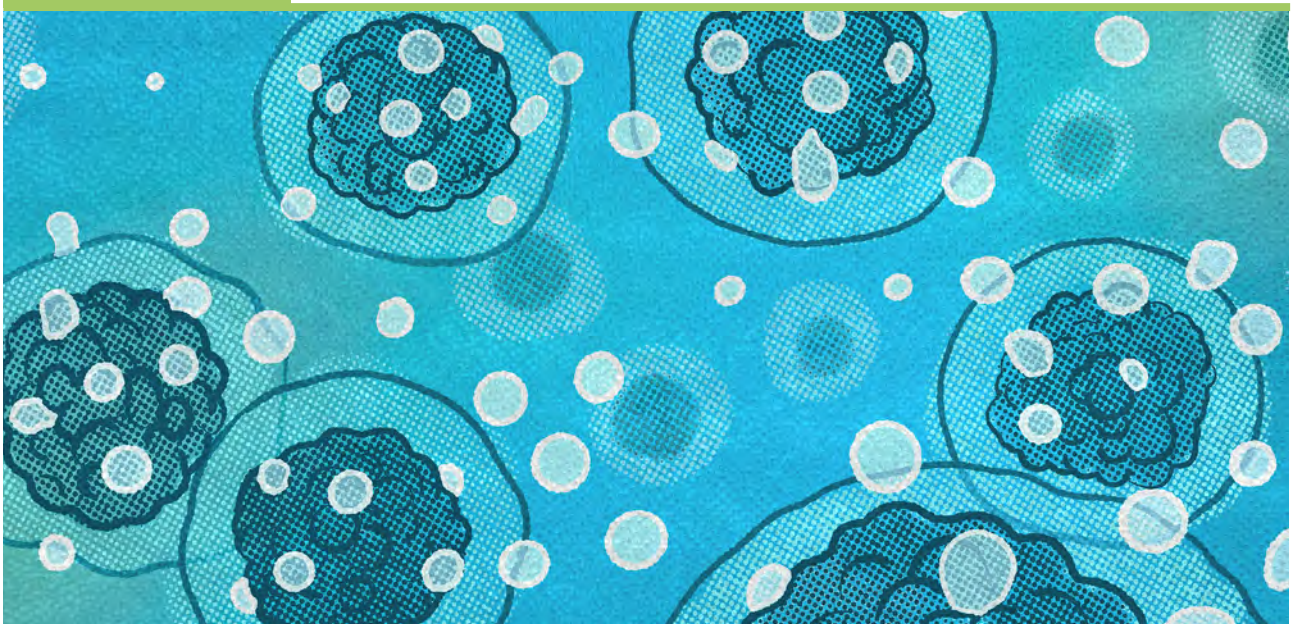
Research



Exosomes as a therapy for glaucoma: could tiny biological "soap bubbles" protect our vision?

Joanna Hodgkinson, Head of Research

In 2021, we awarded our first ever funding to support someone to complete a PhD in glaucoma research. We awarded the grant to Dr Ben Mead at Cardiff University, for his proposal to look at the potential of exosomes from stem cells to prevent the death of retinal ganglion cells. The team have found some interesting results, so Joanna Hodgkinson, our Head of Research, spoke to the PhD student completing the project, Matyas Kutnyanszky, to find out more.

What is the aim of your project?

We're trying to protect the nerve cells which send signals from the eye to the brain along the optic nerve. The particular cells are called retinal ganglion cells (RGCs). When they're damaged or die, the signal can't be sent along the optic nerve, and we have glaucoma. If we can protect the RGCs, we can stop glaucoma.

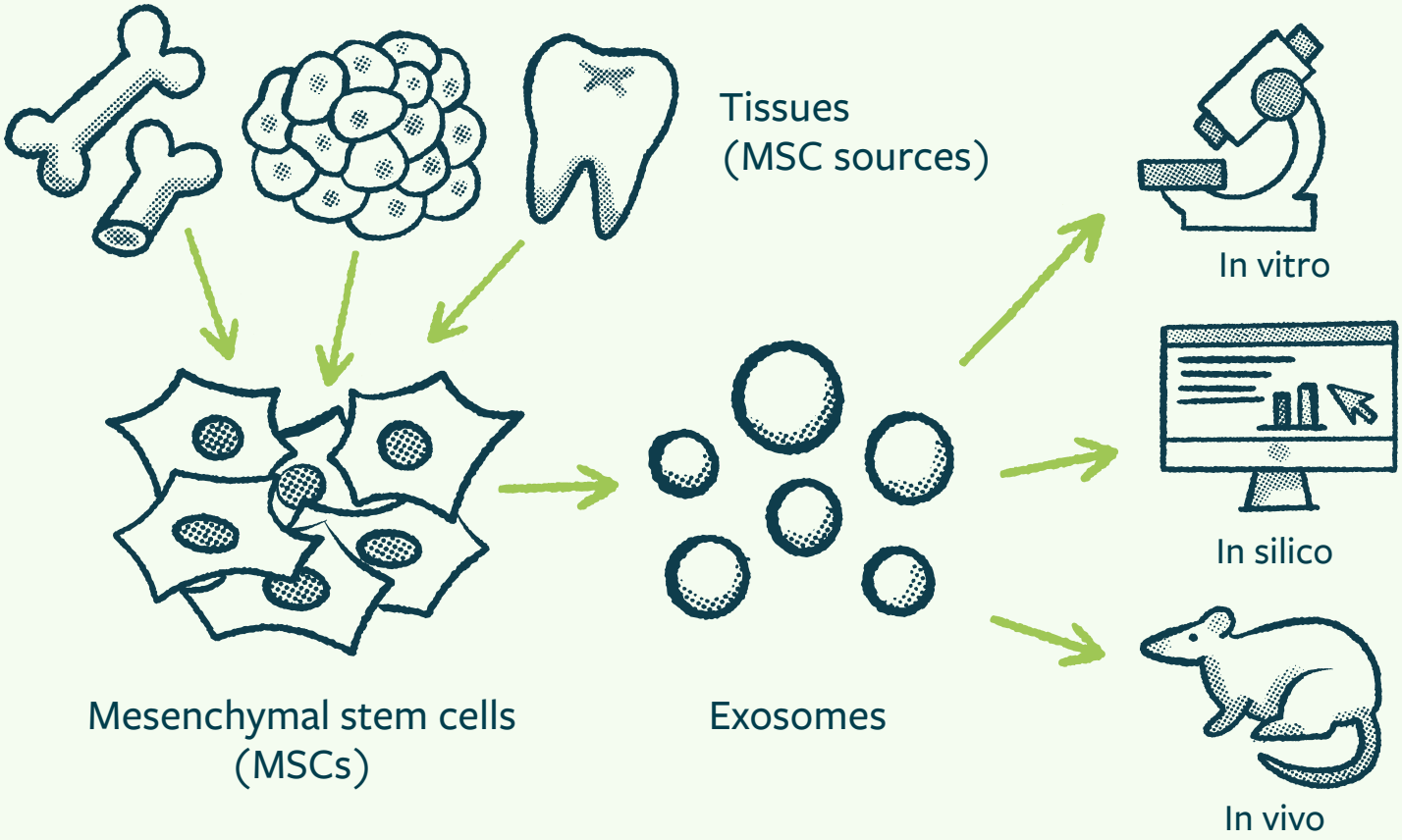
What is the background to your project?

My supervisor, Dr Ben Mead, was looking at stem cells. They're undifferentiated — cells which can turn into other types of cells. He hoped that by injecting them into the eye, they might integrate with the retina, turn into the retinal ganglion cells (RGCs) and restore the signal from the eye to the brain. He found something quite different: the stem cells instead released substances which seemed to protect the RGCs. It was a positive result, just different to what was expected.

He identified that the cells release extra-cellular vesicles, or exosomes. We can think of them as tiny soap bubbles which cells release all the time. They're filled with genetic material and proteins that deliver information to nearby cells. They're a normal part of cellular activity and communication. Ben wanted to know more about the contents of these particular vesicles and how they were protecting the RGCs. He wondered whether, in future, we could use vesicles as a treatment for glaucoma, or to stop it from happening. Vesicles are promising generally in medicine, because they're safer than injecting live cells, and more stable than isolated molecules. Cancer researchers are also interested in them.

> “We're trying to **protect the nerve cells** which send signals from the eye to the brain, along the optic nerve

▲ Photo courtesy of Matyas Kutnyanszky



> If we're successful, we might be able to protect retinal ganglion cells from dying. **If we can do that, we can protect people's vision**

What is the focus of your PhD?

I'm looking at stem cells from different sources, to see if the exosomes of some protect RGCs better than others. We're testing that in different ways – in cell cultures and in rats. Then we'll be investigating the substances found in the stem cells' exosomes, to find out more about how they're protecting the RGCs.

What have you found out so far?

We've investigated exosomes from five types of stem cell: bone marrow, adipose (fat tissue), dental pulp (the inside of a tooth), umbilical cord and another oral cell line. In rat cell culture, we found that those from bone marrow and adipose tissue protect RGCs better than the other types. Bone marrow is effective but it's hard to get out from the bone. Dental sources would be ideal because we could use teeth that have fallen out naturally.

> We've investigated exosomes **from five types of stem cell**

You can read more about this on page 22 of our Winter edition of Insight. The article, **It's all about the connections: the intriguing links between glaucoma and spinal cord injury research**, was written with Matyas' supervisor Ben.

What are the next steps for the research?

We're preparing our studies on rats. We'll induce glaucoma and inject the most promising exosomes to see how well they protect RGCs in a living organism. We need to validate the cell culture findings in a more complex biological system. If that yields positive results, we'll repeat the experiments in human cells.

We've identified that the active substances within the exosomes are probably microRNAs. MicroRNAs are tiny strands of genetic material that influence how genes are switched on and off in a cell. We are going to compare the microRNAs in effective and ineffective exosomes to understand what they're doing in the RGCs. In theory, we'll be able to manipulate exosomes so they contain more of the effective microRNAs.

I'm hoping to finish all the experiments by October and to submit my thesis by the end of 2025.

Why is this project useful or important to people with glaucoma?

If we're successful, we might be able to protect retinal ganglion cells from dying. If we can do that, we can protect people's vision and stop them from going blind due to glaucoma. It also has additional importance because retinal ganglion cells are similar to other types of brain cells, so learning how to protect them might benefit research into other neurodegenerative diseases.

Can you tell us a bit about you, and your path to the PhD?

I did my degree in biochemistry and am really interested in regenerative medicine. I wanted to research more, and found this PhD! I really love working in regenerative medicine and would like to find another project in this area after graduating.

How have you benefited from this PhD?

I've learnt a wide variety of skills which I'll use in future research. I've learnt different techniques for working on cells, animals and with computers. I've also worked on soft skills such as time management. The best bit is how independent I can be – exploring my own ideas and finding my own solutions to problems, with the support of my supervisor. This project feels like my own work.