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Surrey Uni study may show way to reverse vision loss

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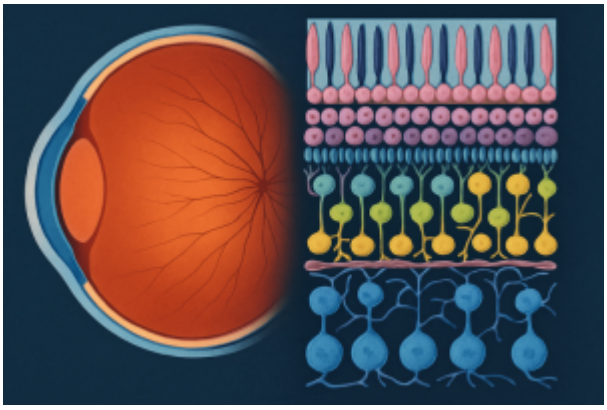

New computer modelling could help scientists better understand how the retina regenerates, opening the door to new treatments for vision loss, according to a study from the University of Surrey.

The first-of-its-kind model is capable of detailing how the retina – the light-sensitive layer at the back of the eye – can build its complex structure from just one type of stem cell, deepening our understanding of how sight develops and how its development could inform studies of injury or disease.

Using advanced agent-based modelling, the research team have simulated key stages of retinogenesis – the process by which identical progenitor cells diversify into the six types of neurons that make up the retina.

The model shows how simple genetic rules and subtle randomness work together to form the retina's precise layered architecture, a structure essential for how we see.

The paper was presented at IWWBIO 2025 and published in Lecture Notes in Computer Science (LNCS).

Cayla Harris, lead researcher from the University of Surrey's Nature Inspired Computing and Engineering Group, said:

"The beauty of biology is that complex structures can emerge from simple rules. Our simulations show how genetically identical cells can, through intrinsic bias and chance, self-organise into the retina's highly ordered layers – a pattern that underpins how we see the world."

Using the BioDynaMo software platform, the team modelled virtual "cells" that grow, divide and make fate decisions based on internal gene-regulation logic, mimicking biological behaviour. They tested different network designs for how genes might interact when cells decide what kind of neuron to become.

Two particular designs – called the Reentry and Multidirectional models – reproduced real biological data most accurately, suggesting that retinal cells may make their fate decisions through overlapping and

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flexible genetic pathways, rather than a fixed sequence.

This approach could help researchers better understand not only healthy eye development but also what happens in retinal diseases and in regenerative research exploring how stem cells might rebuild tissue.

Dr Roman Bauer, senior author on the study from the University of Surrey, added:

“Computational modelling gives us a powerful way to explore biological processes we can’t easily observe in real time. By simulating every cell’s decision and interaction, we can test hypotheses about how tissues like the retina form – and how to restore them when damaged.”

This research is supported by the Engineering and Physical Sciences Research Council (EPSRC).

Cayla Harris added:

“We think that our research is a step forward in linking genetics, computation and developmental biology to understand one of the body’s most complex neural structures.”

Surrey University