Gene switch makes us look like our animal cousins

March 1 2016, by David Stacey

Dr Bogdanovic (left) and Professor Lister, pictured here in a zebrafish research facility, found that chemical signposts in the DNA account for the incredible similarities seen between fish and other vertebrates early in embryo development. Credit: ARC CoE Plant Energy Biology

An international team of biologists has discovered how the same genes are turned on in mammals, fish and amphibians early in embryonic development, making them look incredibly similar for a brief period of time.

The study, led by researchers at The University of Western Australia and published in *Nature Genetics*, sheds light on why all vertebrate animals (those with a backbone) look alike during a particular phase of embryo development known as the phylotypic stage.

During this time, embryos of birds, fish and even humans start to look the same - before they diverge again and become very different looking animals.

The similarity was first described by pre-eminent nineteenth century embryologist Karl Ernst von Baer, when his sloppy sample labelling led him to accidentally mix up phylotypic stage embryos of different vertebrate species and he was unable to tell which embryo belonged to which species.

"We couldn't bear to make that mistake," ARC Centre of Excellence in Plant Energy Biology genome biologist Ryan Lister said.

"So we looked at mice from Madrid, fish from Seville, and toads from Nijmegen."

The study involved researchers at the Spanish National Research Council (CSIC Spain) and Radboud University in the Netherlands.

Lead author Ozren Bogdanovic, from the ARC Centre of Excellence in Plant Energy Biology, said the study showed how chemical signposts changed in the DNA of mice, zebrafish and toads during the phylotypic stage.

The change in these signposts happens in a wave and activates the same developmental pathways in each animal, contributing to their similarity.

Dr Bogdanovic said the time taken to reach the phylotypic stage varied between species.

"In fish and toads it would be at one to two days after fertilisation, and at 9.5 days in mice, while humans go through the phylotypic stage about four weeks after conception," he said.

"It's likely that we also have a similar type of epigenetic control in our development during that period.

"If you were to put a human embryo next to a fish, a toad and a mouse at that stage, the human embryo would look very much like the others."

Professor Lister said it was thought that vertebrates showed such similarity during this developmental period because that was when the fundamental structure of the body was being set up.

"Correct establishment of the body plan and organ formation at that early stage is so critical to life that the molecular processes underlying it have remained very similar despite millions of years of divergence between these species," he said.

"It's fascinating to see these similarities right down to the molecular level, and we can do so only because of recent technological advances in DNA sequencing that give us the power to dig much deeper into biological systems than ever before."

Professor Lister said that some critical experimental techniques the team used to study vertebrate embryogenesis were first developed through his earlier plant genomics research, demonstrating how advances in one scientific field and system could rapidly be embraced to make advances in another.

"This is basic research into how normal development takes place in a mouse, a fish and a toad," he said.

"But through this we also open a window onto the processes that likely occur during human embryo development.

"Although when I described this work to my son he remarked that he

wasn't surprised that I once closely resembled a toad."

More information: Ozren Bogdanović et al. Active DNA demethylation at enhancers during the vertebrate phylotypic period, *Nature Genetics* (2016). DOI: 10.1038/ng.3522

Provided by University of Western Australia