Embryo development obeys the laws of hydrodynamics

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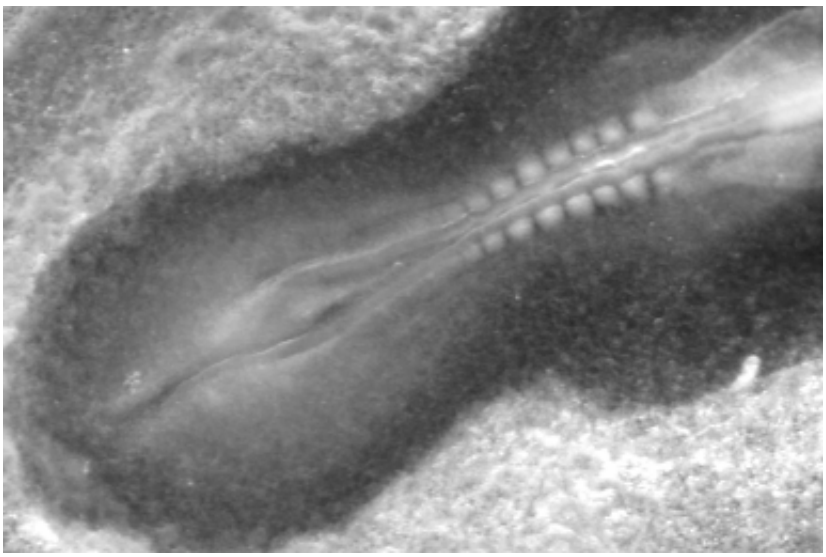

Credit: Vincent Fleury

Vincent Fleury, a researcher at the Paris Diderot University, studied the early stage of development when embryonic cells first form a flat sheet of cells before folding into a U-shape, resembling a folded pancake. He demonstrated that the formation of a chicken's head is a consequence of the collision between both sides of the embryo flowing at constant speed towards each other.

This study captured for the first time on film highly accurate observations of how a chicken embryo evolves during its first two days

of development, using time-lapse microscopy. Prior attempts relied on complex imaging techniques that were costly and not as accurate as direct filming. In this study, the embryo was first taken out of its shell, its yolk removed (as it is not needed in the first 48 hours) and it was kept under appropriate temperature conditions.

Previous developmental studies focused on studying each cell individually. In this study, the embryo was considered in its entirety, like a type of plasticine material able to flow like Dali's melting clocks. The study involved measuring the speed of all points of the embryo and its viscoelasticity in vivo. Combining this data with the biological parameters of the embryo (cells' viscosity, thickness and overall size), the author created a model of the growing embryo's movement.

He discovered that the mathematical formula describing magnetic fields could also be used to model fields of vectors representing the hydrodynamic flow of embryonic cells. When the two sides collided, the embryonic cells were subject to forces that can be described as those of two magnets oriented head on, which resulted in the formation of the head.

These findings demonstrate that the head formation does not merely result from a series of discrete events activated by genetic switches. It also shows that chemical gradients are not the prevailing force responsible for movement of cells in early embryo formation, as had been previously thought.

These studies shed new light on vertebrate development, and could ultimately provide some clues for scientists involved in regenerative medicines.

Similar work on limb development is due to be published in the August issue of the *European Physical Journal Applied Physics*.

More information: V. Fleury (2011). A change in boundary conditions induces a discontinuity of tissue flow in chicken embryos and the formation of the cephalic fold. *European Physical Journal E.* DOI:10.1140/epje/i2011-11073-0

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