Scientists publish 'blueprints' showing how the vertebrate body comes from a single cell

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A new theory aims to explain how the complex vertebrate body, with its skeleton, muscles, nervous and cardiovascular systems, arises from a single cell during development and how these systems evolved over time. The theory, called embryo geometry, is the culmination of nearly 20 years of work by a team of researchers and science illustrators.

The new theory is published along with illustrations – or "blueprints" – depicting how it applies to different vertebrate organ systems in *Progress in Biophysics & Molecular Biology*.

According to Neo-Darwinian theory, major evolutionary changes occur as a result of the selection of random, fortuitous genetic mutations over time. However, some researchers say this theory does not satisfactorily account for the appearance of radically different life forms and their rich complexity, particularly that observed in vertebrates like humans.

Embryo geometry, developed by a team from the University of San Diego, Mount Holyoke College, Evergreen State College, and Chem-Tainer Industries, Inc.. in the USA, looks at animal complexity generally and the vertebrate body in particular as more the products of mechanical forces and the laws of geometry than solely the outcome of random genetic mutation.

"At the suggestion of evolutionary biologist Stephen Jay Gould, preliminary attempts at a solution to this problem were undertaken over many years. But these – as well as other, similar efforts – were met with

strong opposition by supporters of the Neo-Darwinian interpretation of natural selection," commented senior author Stuart Pivar. "We hope that the theory of embryo geometry will stimulate further investigation by biologists of all stripes across a variety of fields."

Anatomists have long postulated that animal complexity arises during development of the embryo – called embryogenesis – but despite detailed descriptions of the embryonic stages of all major types of animal, the evolution of organismal complexity and its expression during individual development have remained mysterious processes – until now.

The researchers behind embryo geometry have shown that the vertebrate embryo could conceivably arise from mechanical deformation of the blastula, a ball of cells formed when the fertilized egg divides. As these cells proliferate, the ball increases in volume and surface area, altering its geometry. The theory posits that the blastula retains the geometry of the original eight cells produced by the first three divisions of the egg, which themselves determine the three axes of the vertebrate body.

In their new paper, they present 24 schematic figures – or "blueprints" – showing how the musculoskeletal, cardiovascular, nervous, and reproductive systems form through mechanical deformation of geometric patterns. These illustrations explain how the vertebrate body might plausibly arise from a single cell, both over evolutionary time, and during individual embryogenesis.

The authors have also completed a paper on the origin of the form of the flower and fruit, which they are currently submitting for publication.

More information: "Origin of the vertebrate body plan in the conservation of regular geometrical patterns in the structure of the blastula," *Progress in Biophysics & Molecular Biology* DOI: 10.1016/j.pbiomolbio..2016.06.007

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