Exploring the mysteries of cell geometry

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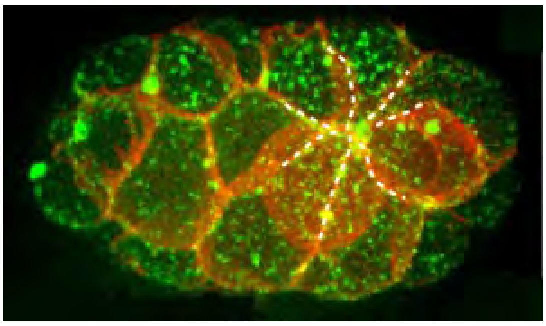
What regulates cell architecture and how does a cell know what size it should be? These are but a few of the questions that *BMC Biology* addresses in its series on Cell Geometry.

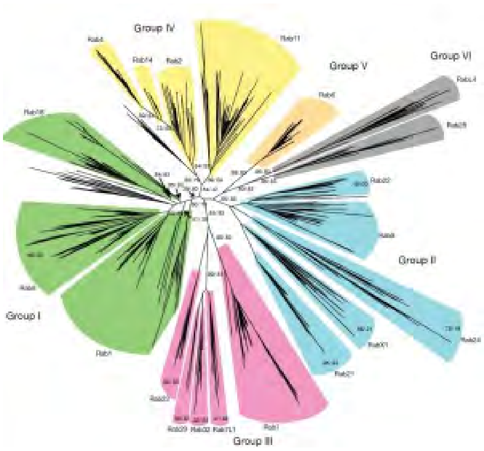
An Opinion article by Wallace Marshall from the University of California, San Francisco, USA, titled 'Origins of cell geometry' launched *BMC Biology*'s series. This started by exploring the complex geometry of free-living unicellular organisms. Marshall is working on and discusses what we understand of the organisation of the unicellular ciliate *Stentor*, which is the emblem of the series, and is a classic example of the complexity of a single cell. Wallace also discusses problems faced by multicellular organisms, for example, forming and coordinating communication in a tissue and why breaking asymmetry is needed during development.



Rosette formation during endoderm internalization in a C. elegans embryo expressing non-muscle myosin (NMY)-2-GFP (green) and stained for the membrane (red). Image source: Pohl et al, BMC Biology, 2012, 10:94

These are themes explored by other articles in the series, including a research article by Zhirong Bao from the Sloan-Kettering Institute, USA, and colleagues, visualizing the role of the cytoskeleton (actin and myosin) in bending epithelial cells during gastrulation to allow the early development of *C. elegans* embryos. This article was commented on by Lance Davidson from the University of Pittsburgh, USA. A second research article by Sean Munro from the MRC Laboratory of Molecular Biology, UK, and colleagues, takes a step backwards to examine the evolution of one trafficking component in cells, Rabs – commented on by Harald Stenmark from Oslo University Hospital, Norway.

Several articles in the series focus on the cell geometry of organelles. Monica Bettencourt-Dias from the Instituto Gulbenkian de Ciência, Portugal, questions why we need a centrosome (indeed some cells don't have one!) and what do we understand of its geometry? A centrosome is composed of a centriole and surrounding 'matrix' (pericentriolar material), yet we have no idea what different protein components do in this matrix or how the striking 'cartwheel' structure of the centriole, which gives rise to its nine-fold symmetry, forms. We are only beginning to realise when centrosome-related structures do not form properly and what problems this causes.



Evolutionary tree depicting the relationship of the different Rab families that were potentially present in the last eukaryotic common ancestor. Image source: Klopper et al, BMC Biology, 2012, 10:71

Susanne Rafelski from the University of California, Irvine, USA, gives her opinion on what shapes an organelle as complex as the mitochondrion. She starts by saying that the single mitochondrion often depicted in textbooks is only one form, and it has more recently been recognised that these small organelles form a large interconnected network within a cell. Taking a multi-scale view and using examples from her own work in yeast, she discusses how understanding size, shape, dynamics and position of this organelle will help us build an integrative view of mitochondrial morphology and function in the cell. What quantitative data do we have to build a computational model of the mitochondria? The answer is we are only just beginning to gather such data – on how the network is built and changes (fission/fusion) – and we have yet to incorporate the physical shape and size of the mitochondria in such models.

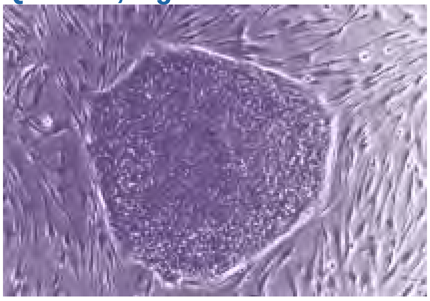
The series also includes a more speculative article on 'What determines cell size?' in which several experts (Kevin Young in bacteria; Matthew Swaffer, Elizabeth Wood and Paul Nurse in yeast; Akatsuki Kimura in *C. elegans*; Joseph Frankel in the multinucleate green algae, *Acetabularia*, and frog eggs, as well as the iconic *Stentor*; John Wallingford in eukaryotic cells; and Xian Qu, Adrienne Roeder and Virginia Walbot in plants) give their answers to this question, which is introduced by Wallace Marshall. In a related podcast, listen to what started Marshall thinking about the question of cell size, why he thinks that parts of the cell are like the components of a chemical factory and how he thinks your research could contribute.

What is there left for cell biologists to do? This provocative question is tackled by Sean Munro in his Open questions. Read more in *BMC Biology*'s series on Cell Geometry – and watch out for new content.

The complete list of series articles:

Cell geometry

Queens, fighters and workers



Stem cell biophysics

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