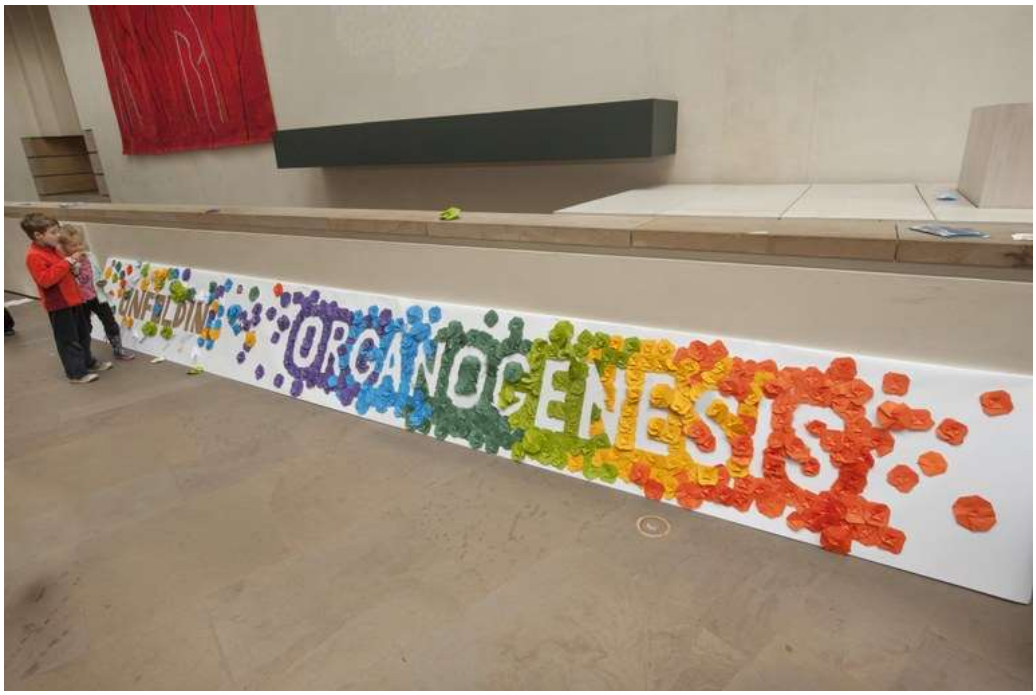
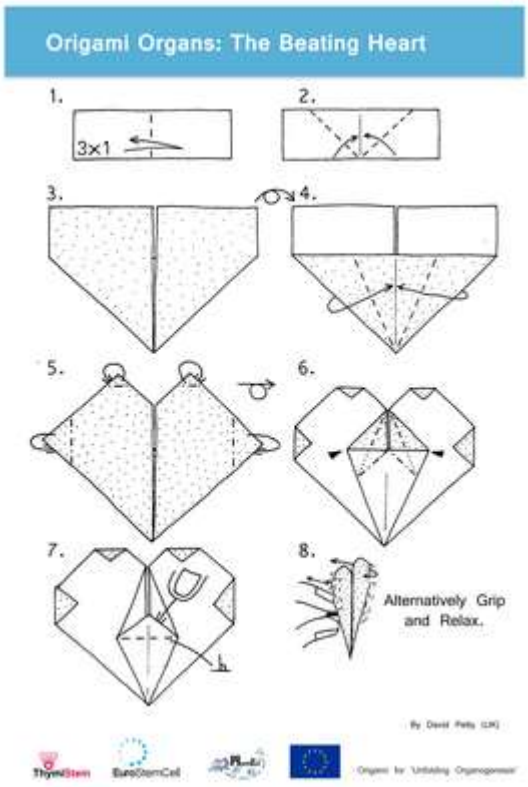
Unfolding Organogenesis

Karen Jent, May '16



I folded many 'beating hearts' during the two days that the interactive walk-in exhibition *Unfolding Organogenesis* about organ development and origami art was on display at the Edinburgh International Science Festival 2016. Located in the vast and spacious Hawthornden Court in the modern annex of the National Museum of Scotland, *Unfolding Organogenesis* brought stem cell scientists into conversation with the colourful audience of science festival visitors. In the encounter, families with children and scientists - who normally spend their days teasing out the biological mechanisms of organ development and who had travelled to join the exhibition from several different European countries - collaboratively folded origami organs. In particular, origami art provided an entry point for discussing regenerative medicine's recent interest in replicating organogenesis and building three-dimensional organoids (organ-like structures) from stem cells in the laboratory.

The making of a beating heart



"Now, fold the corners of the small triangle to align with the crease; make sure you press down on the crease to make a clear imprint and unfold again. Next comes the hardest part, press down the tips at the top with your thumb and use your index finger to turn the flap in the middle outward, while collapsing the sides of the triangle back inside towards the crease with your other hand, and fold the resulting handle in the middle into shape - like this'

Four children sat cross-legged in front of me on the floor and, mirroring my gesture, they flashed their colourful sheets of a yet unfinished origami in my direction. Behind them, a mum and a dad had also knelt down to assist the two younger ones. In spite of my efforts though, the children and parents demanded that I show them again. During this and many similar encounters, I learned that it proved difficult for festival visitors to repeat folding patterns, when I simply described the movements of hands. Folding was easier when I assisted them by guiding their hands across the paper to make the creases step-by-step. And so, after overcoming these obstacles, all the children finished their beating heart.

In the finished beating heart origami, the handle is a crucial part: when squeezed between thumb and index finger, the handle is the 'organ' with which children can make the heart beat. I thus revealed the beat feature of the origami triumphantly, saying *"It's a beating heart!"*, while simulating heart beats with the squeeze of my hand. *Thup, thup… thup, thup… thup, thup.* Amazingly, the children's faces lit up and beamed in delight. Touching her chest, a small girl exclaimed: *"It is beating like the heart in my chest!"* At this instance, the origami had become a veritable beating heart that the girl simultaneously held in her hand and her chest.

How the idea developed

About eighteen months ago, Dr Cathy Southworth of EuroStemCell and I had become interested in joining our respective skills in science communication/biology/teaching and anthropology of science to develop an exhibition about regenerative medicine. I still have a vivid memory of a car journey from Edinburgh to Inverness in my mind, on a day I joined Cathy as she travelled to give a workshop on stem cell communication. As we were driving through the impressive scenery of the Scottish Highlands, Cathy and I started a conversation, and those mountain ranges still remind me, every time I see them, of the fledgling steps of a creative process that I have enjoyed immensely. In a trial-and-error process, we talked about different ideas, thought about metaphors, and the importance of narrative in science. During this time, I have benefited greatly from Cathy's profound expertise and creativity in giving shape to and communicate ideas. I also got to know a great number of fantastic contributors - scientists and a medical student, science communicators and teachers, artists and a storyteller as well as festival visitors with their families - who all have contributed to *Unfolding Organogenesis* at different stages.

While developing the exhibition, we thought much about the folding of origami as a metaphor for the three-dimensional plasticity of organs. The folding, unfolding and refolding of paper affords exciting comparisons to think about organogenesis: the blank sheet of paper can be thought of as cells that yet need to arrange into organ shape during the development of an organism; the paper of an already folded origami organ, in turn, can be unfolded and formed into another shape leaving creases that might impact subsequent refoldings, much like the traces that in induced pluripotent stem cells impact their further use; origami, like developing organs, have folding instructions (gene expression patterns) that are not easy to follow.

The laboratory handling of organogenesis

Yet, sitting underneath the gazebo decorated with origami while folding organs with children and their parents and repeating instructions like the one described above, I learned in a new way how origami addressed issues of tactility and plasticity in contemporary biotechnology that I hadn't previously thought about. During the two days of the exhibition, I demonstrated the various steps of making a beating heart time and again. But my words felt clumsy and were often more misleading than instructive, revealing to me their limitations for conveying the complexities of touch, dexterity and folding. As more and more festival visitors required 'manual' folding demonstrations, I became aware that the mastery of origami is rather a matter of first-hand knowledge: Children and their parents needed to be shown where to place their hands, how to move them relative to the paper and, through demonstration, subsequently developed a 'feel' for how the sheet of paper might respond and enfold in a desired way.

As in the folding of paper, the worded instructions of the scientific world, such as manuals and protocols, often fall short of mediating how biological matter, such as cells or organoids, need to be touched and how they are going to respond, too. For scientists, first-hand knowledge is crucial know-how for the experiment to succeed. Frequently, when cell cultures fail, it turns out that the experimenter's hand simply didn't have a feel for the cells or organoids in their care. In this way, the folding of origami organs reveals not only biological concepts, but also proves handy in showing how practically challenging the care of biological substance is: origami turned out to be a fantastic illustration of what Sarah Franklin has called the "handling" of cells that scientists need to develop in tedious experimental procedures. In the laboratory, as in the bodies of people, cells are agentive characters, and scientists need to painstakingly learn how to grasp them.

Further unfoldings

Unfolding organogenesis, in addition to the origami gazebo, included a number of further activities for festival visitors to explore organ development in conversation with scientists and artists. Home-made smartphone microscopes enabled a perspective on the beating hearts and other live organs in translucent zebrafish. In the *Cell Pet* activity, children-scientists grew and passaged their own cell lines (couscous), exploring the care-taking and handling that stem cell scientists offer to their cells. And, an origami artist folded super-size organs in fantastic patterns for visitors to watch. And not least, we also 'grew' a collaborative organ from *Unfolding Organogenesis* by collectively adding origami cells in rainbow colours to a board throughout the time of the exhibition. The connections that are represented in this collaborative organ and the creative persons that I have met in the making of *Unfolding Organogenesis* have made this a fantastic experience that has memorably imprinted in my mind.

References:

Franklin, Sarah (2013) *Biological Relatives: IVF, Stem Cells, and the Future of Kinship* Durham, NC: Duke University Press.