Hanging Drops: A Surface-Tension Based System for the Study of Cell-to-Cell Interactions

Priyan Weerappuli, Ge-Ah Kim, Shuichi Takayama

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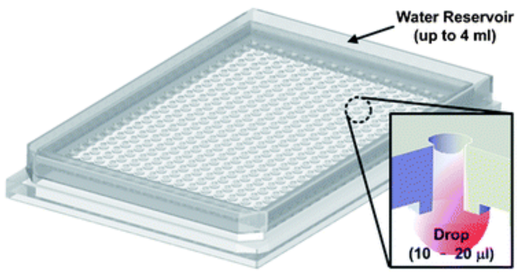


WHAT ARE HANGING DROPS?

Hanging drops are small volumes of liquid that are held - by surface tension - within narrow cylindrical pores (above) arrayed, in this demonstration, across a rectangular grid.

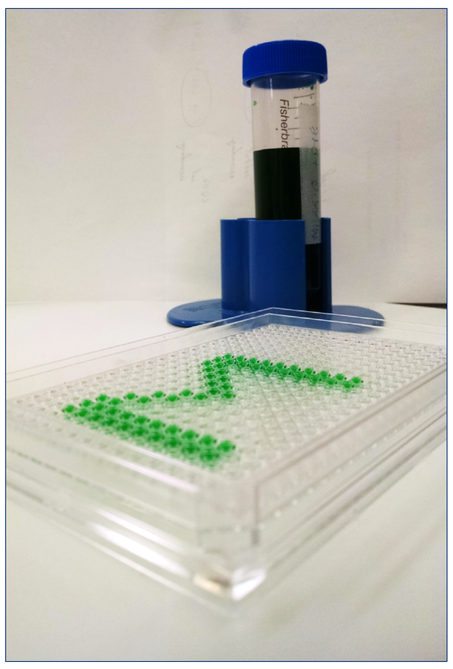
WHAT IS SURFACE TENSION?

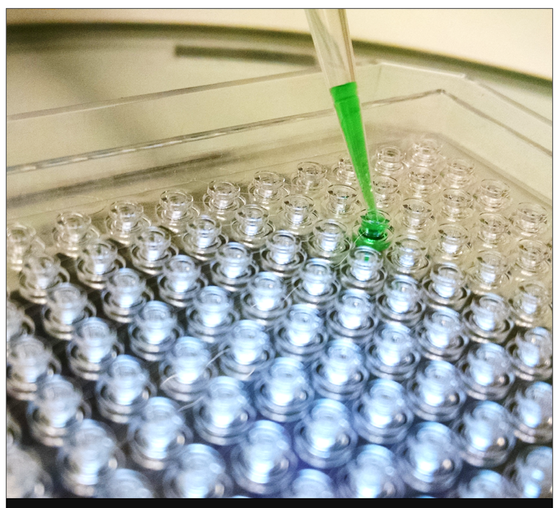
Surface tension is a phenomenon that we see and experience on a daily basis. It is what allows insects to 'walk' across liquid surfaces, and why water seems to *stick* to our fingers when we place our hand at the surface of a pool.

HOW ARE HANGING DROPS USED BY BIOMEDICAL ENGINEERS?

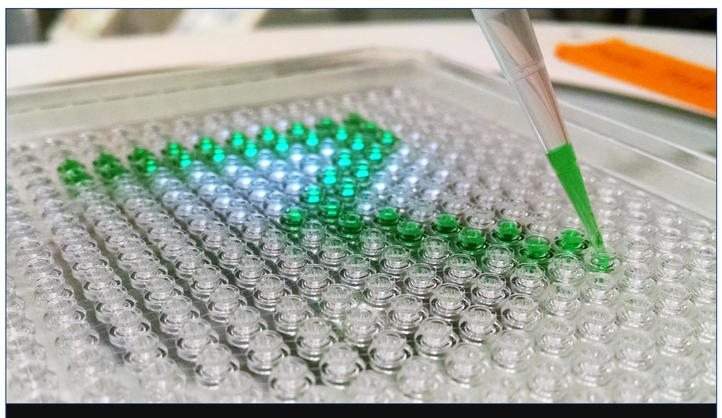
Traditionally, cell culture has involved growing cells on plastic or glass surfaces where cells attach most strongly to these surfaces. Because there aren't generally glass or plastic surfaces in the body, however, the behavior of cells in these cultures can be very different from what would be seen in tissues. Hanging drops allow us to culture cells without using a solid surface. This forces cells to interact with each other, and allows us to study the cell-to-cell interactions that better represent what would occur within the body.

The Demonstration





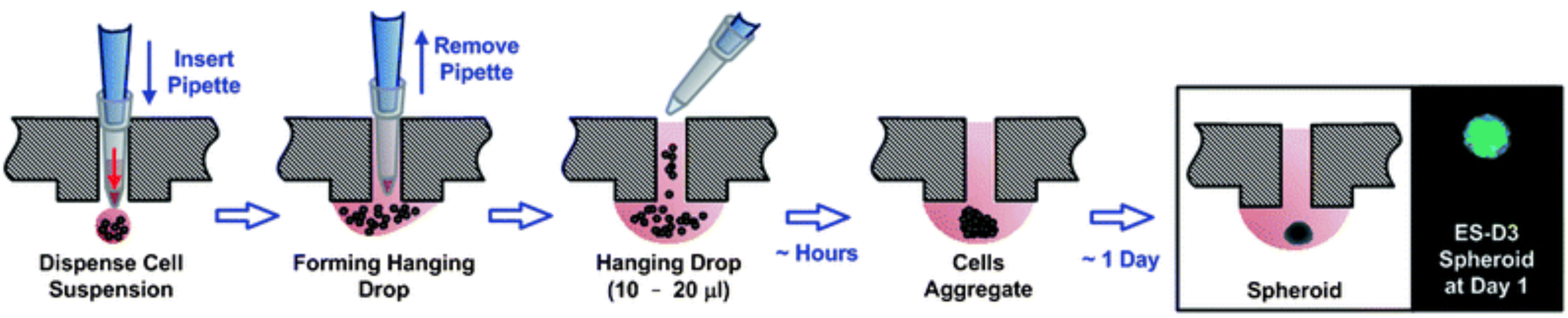
Using a pipette, we can dispense liquid droplets into each well within the hanging drop plate.



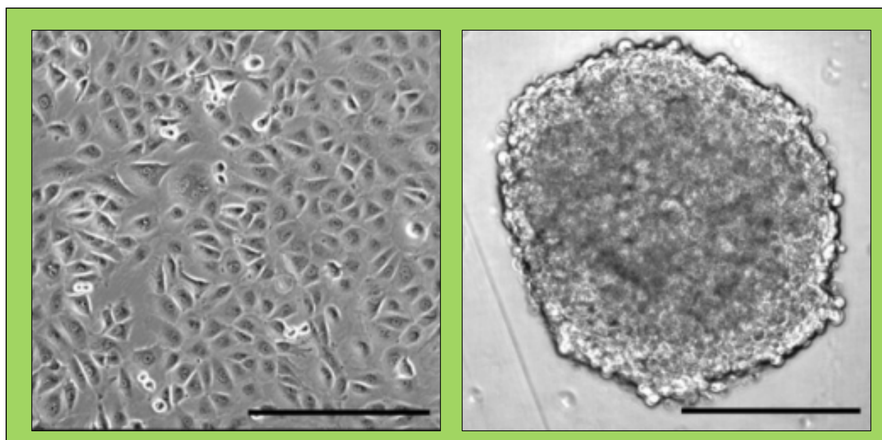
The spacing between the wells, and the size of each well, will determine how much liquid we are able to add, and

Once the droplets have been dispensed, surface tension will hold them in place, allowing them to remain stable even though there is no underlying surface!

Hanging Drops as a Platform for Three-Dimensional Cell Culture



Tung et al., *Analyst*, 2010, **136**, 473-478



Kim et al., *PLoS ONE*, 2012, **7(6)**, e39556

In traditional cell culture, cells are grown on a hard surface (such as glass of plastic) where the dominant interaction is between each cell and its substrate (above-left). In hanging drops, cells are forced to interact with one another, and consequently form large three-dimensional structures referred to as spheroids (above-right).

Traditional cell culture, which is performed on a solid substrate such as plastic or glass, is referred to as two-dimensional cell culture because cells are largely allowed to grow and spread in two-dimensions across a flat surface.

In hanging drop cell culture, we are placing cells in an environment where they are unable to attach to a solid surface, which forces them to form aggregates, referred to as spheroids, that extend across three dimensions. By doing so, we are able to study the cell-to-cell interactions that better represent what might be seen inside the body. This allows us to better understand how cells move, grow, and communicate with one another in tissues such as tumors.