Swan & Stone

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Hello all,

A couple of months ago ***Nature*** published an important new article that is extremely relevant to Coherent Breathing® and the science thereof. (See *Nature*: Scientific Reports Volume 8, Article number: 4947 (2018). The article is titled "Structure and Distribution of an Unrecognized Interstitium in Human Tissues". On March 27th, *Scientific American* followed with an article, "Meet Your Interstitium, a Newfound "Organ". The Scientific American title being slight hyperbole as the interstitium has been known about, about as long as lymph has been known about. My interest and the reason this article caught my attention is that it completes my simple model of circulatory physiology where the interstitium fills the space between the capillary membrane and the cells, where I knew my model to be "functionally" incomplete. Once a molecule is emitted by either the capillary membrane or a cell, is it to find it's way through the extra-cellular domain in a random haphazard manner or does it find its way there via an established pathway or pathways? With this discovery, it becomes clear that it is the latter. In Figure 1, I've added a section of the interstitium in the lower right hand corner, indicating that it is the "matter" that fills the extra-cellular fluid environment.

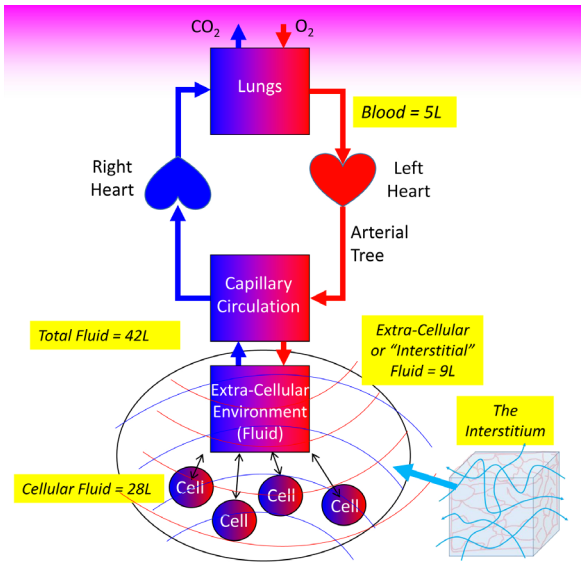

Figure 1: There are 9L of extra-cellular or "interstitial" fluid in the body. That fluid resides in a collagen construct - the "interstitium".

Interstitium derives from the word "interstice", something that is in-between things. In physiology, the term has been used to describe the space between cells, hence "interstitial fluid", the fluid between cells. Referring to this "microscopic space" between cells, the "extra-cellular fluid" environment is also properly referred to as the interstitial environment, medical literature often using the terms interchangeably. The purpose of the interstitium is many-fold but two of its major functions are to provide conduit through which interstitial fluid, principally lymph, can flow, and to provide structure to the body. Water, nutrients, gases, and waste products must all find their way between the capillary membrane and cells through this space.

This discovery was made using confocal laser imaging of living human tissue after the injection of a fluorescent dye, where previous observations of like tissues had been limited to non-living samples under a microscope. The researchers say that once a tissue sample is removed from a living host, the interstitial lattice and its conduits collapse and are not evident. Referring to my crude replica of a section of the interstitium the interstitium is made principally of collagen and fluid filled spaces giving it a physical sponge like quality, hence contributing to the shape of the physical body, organs, skin, and the compliance and elasticity we feel when we press gently on a body part come partly from the interstitium. So when its all added up, it is being estimated that the interstitium construct (that I presently like to conceive of as being like microscopic honeycomb) is the largest organ of the body, larger than the skin, which has held this honor for many years. This is because, whereas the skin covers the exterior of the body, the interstitium fills many of the microscopic voids internal to the body, where the volume it fills exceeds the area covered by the skin and its volume.

The context of the research being done during which this discovery was made is lymphatic cancer, where the role of the interstitium in facilitating the motion of lymph is vitally important to health. Lymph is by definition "concentrated interstitial fluid". Interstitial fluid itself is created as a consequence of small amounts of proteins leaking out of the capillary circulation – the capillary circulation also being a pervasive microscopic construct. It is the role of the interstitium to collect this protein leakage, and the ultimate role of the lymphatic system to return it for recycling, ultimately keeping proteins leaking out of the bloodstream and those collected and recycled in balance, where there is a closed loop feedback system under autonomic control that manages it all. The fundamental breakthrough of the study behind the article is a new "macroscopic" understanding of the

interstitium and its flow functions, apprehended only via in vivo observation vs. conventional observation of non-living tissues under a microscope. This recent emphasis has been nice because it helps me fill in a blank in my model. The "extra-cellular fluid environment" isn't empty at all but filled by the interstitium, allowing it to accommodate 21% of body fluid in a functional manner - where it participates in the flow of that fluid.

Whereas it has been known to medicine that the interstitium is the lymph collection system since the dawn of modern medicine, its function has not been understood fully, and per the authors, based on their findings, certainly still isn't. They suggest that there are interstitial fluid dynamics at work that have previously not been apprehended, and that "proper" fluid flow may be necessary for proper biological functioning of the interstitium and may have significant implications on disease, specifically diseases relating to the lymphatic system, cancer being at the top of the list.

Paraphrasing, the authors propose that the current understanding of anatomical concepts relating to interstitial tissues throughout the body be revised, specifically as it relates to "fluid flow". Whereas certain tissues have been understood to be static collagen structures (think of pipes), they find that instead that they are dynamic conduits for the flow of fluid, that actually demonstrate peristaltic action to facilitate flow. They say that the realization that the interstitium is actively participating in fluid flow is a profound discovery.

My argument has been and continues to be that the diaphragm action modulates *flow* in the body, *everywhere in the body - flow of everything.* Per Figure 1, the circulatory system modulates blood (5L), and blood modulates interstitial fluid (9L), interstitial fluid modulates cellular fluid (28L). This is blood alone modulating pressure and flow as a function of diaphragm motion. And it turns out that there is a dynamic living construct that exists between the capillary membrane and the cells, managing flow. Add to it pneumatic pressure differentials created in the thoracic and abdominal cavities via mechanical action of the diaphragm. We also know now that pressure differentials are also created in the skull effected by blood flow to the head as a function of breathing. A few years ago Rochester University was able to observe the movement of cerebral spinal fluid through the brain as a function of pressure differences generated by the heart beat alone (where there is no mention of breathing). Circa 2013, Elliott and colleagues demonstrated that the Valsalva Wave is present in the brain, where it is known that breathing roughly doubles blood wave amplitude where it is approximately equal to amplitude seen at the earlobe if not greater. The EEG signals of the study while clients were breathing "coherently" were 10X those of functional waves, delta, theta, alpha, and beta. I don't think there can be any question that breathing also modulates the flow of CNS in the brain.

So its exciting for others to find a dynamic construct that operates under control of the autonomic nervous system that facilitates flow between microscopic spaces of the body, because this is where the capillary circulation meets the cells, each cell being within 30µm of a capillary, and while we wouldn't know it by looking at the outside, from the inside, we are but a collective of cells that are working in a cooperative manner to maintain life and fight off entropy, decay, and death.

Issue 6 was titled "Breathe For Beauty". It was about breathing for fluid flow. This discovery underlines the importance. *"After age 40, the outside begins to look like the inside."* It has to do with hydration and effective fluid flow, and ultimately, probably hydration and flow integrity via the interstitium. Time and science will tell. But we are after more than beauty: We want health, well-being, performance, & longevity!

My thesis is ***to breathe well****. By breathing well, much of the rest will take care of itself, including the health of the interstitium – now believed to be the body's largest organ.*

Stephen Elliott, President, COHERENCE LLC