Dynamic Chiropractic

SOFT TISSUE / TRIGGER POINTS

Protoplasm

Warren Hammer, MS, DC, DABCO

When I went to school years ago, I learned the human cell contained a nucleus and protoplasm. Protoplasm was the stuff in the living cell. Over the years, this "stuff" has come under great scrutiny; with increased knowledge, we now know each cell's protoplasm represents a city unto its own.

Today, biologists refer to everything in the cell except the nucleus as "cytoplasm." While most cells are small, a muscle cell can stretch an inch and a half, while a nerve cell can extend from the spinal cord to the tips of the fingers or toes. Just as we are awestruck by the infinite vastness of outer space, we should now realize that there is an almost-infinite space within every one of our cells.

From a soft-tissue standpoint, "Most of the literature on mechanical load demonstrates that cells detect mechanical deformation as tension, compression, shear or fluid flow."[1] Armed with the knowledge that the use of our hands and instruments affects the function of our cells, this article discusses just one aspect of our cells: its amazing intracellular transportation system. Years ago, when scientists looked under the microscope and saw particles in the "protoplasm" being swept along, they described this unknown motion as being produced by a "vital force."

Rensberger,[2] in his text, upon which this article is largely based, speaks of two properties of cells that are responsible for keeping us alive. The first of these properties is the internal compartments found in cells called organelles. The second property is the transportation network that links the organelles. Each of these properties is absent in bacteria.

The cell is a collection of hundreds of little organs, each with its own form and function - organelles. Each cell is more crowded than the inside of a computer. "There are thousands of specialized structures, each with a job to do."[2] The nucleus is an organelle. The organelles or compartments are enclosed by membranes containing "gatekeepers" or "receptors" which allow only particular molecules to enter or leave. These receptors have been likened to docking sites which only allow a particular kind of molecule that fits.

Once the receptor on the outside of the organelle and the visiting molecule join, the receptor can change shape and the part of the receptor that sticks into the organelle can cause it to take the arriving molecule into the particular organelle, or, depending on the location of the receptor, into the cell as a whole. Sometimes, the attached molecule stays outside and triggers some process within the organelle or cell.

Organelles also are able to send out substances to other organelles within the cell, and they do this by sending out molecules in containers or vesicles. Each vesicle has its own receptor that will fit a similar receptor on another organelle. Organelles provide physical connections between the outside and inside of the cell, and link to signaling pathways that convey mechanical stimuli information to the nucleus.[1] The next amazing property of cells is the transportation system that carries the vesicles from one organelle (compartment) to another. In the 1980s, scientists found that the cell contained long, filamentous highways that lace the cell like a three-dimensional subway system with thousands of lines. Even more amazing was the discovery that on these highways are molecule-sized motors that haul the cargo along the tracks. "At any moment, thousands of chemically-laden vesicles are being transported by tiny molecular motors from place to place in the cell."[2]

Some of the substances being transported are produced deep within the cell; others may be nutrients or hormones from the bloodstream that must reach the cell interior. The actual highways within the cells are called microtubules, which often are concentrated near the nucleus and radiate out to sections of the cell. Scientists have found that a protein molecule, which they named kinesin, functions by flexing and swiveling at points within its structure and using energy from ATP, grabbing on to the vesicle at one end and latching on to the microtubule at the other end, thereby pulling the vesicle forward along the microtubule.

An excellent analogy by Rensberger is that of a man sitting in a rowboat and pulling it along a pier by using his arms and working hand over hand. The pier is the microtubule (the track) and the boat is the vesicle, loaded with molecules to be sent to another part of the cell. The man is the kinesin molecule. As the man flexes and swivels, the boat is hauled the length of the pier. It was found that kinesin can move vesicles at a distance of about 15 inches per day, which is rapid movement in a cell; and that kinesin only moved cargo in an outbound direction, while another motor molecule called dynein moved vesicles in the opposite direction. Since then, many motor molecules have been found, each producing some kind of living motion necessary to transport vesicles. The vesicles are thought to carry address labels on their outer surfaces that eventually are recognized by other organelles, which then take the vesicle off the track.

The 60 trillion cells that make up the human body can be affected by the placement of our hands; the amount of pressure exerted; and even the direction of the pressure. Truly, there is so much more to learn about cells and their response to mechanical load.

References

1. Banes AJ, et al. Mechanical forces & signaling in connective tissue cells. *Current Opinion in Orthopedics* 2001;12(5).
2. Rensberger B. *Life Itself: Exploring the Realm of the Living Cell*. New York, Oxford University Press, 1996.

Warren Hammer, MS, DC, DABCO
Norwalk, Connecticut
softissu@optonline.net
www.warrenhammer.com

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