

How exercise works at the cellular level

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We all know that exercise is good for us, but do we know why? How do those hours of sweating it out on a treadmill or pushing yourself in a weight training regimen actually help your cells and tissues to get healthier?

Two papers by separate groups may provide some intriguing answers. One team, led by researchers at the Massachusetts General Hospital, isolated several dozen metabolic byproducts of exercise in the blood and studied how these compounds change before and after exercise, while across the country, a team at the University of California, San Francisco, studied the effect of exercise on how a cell ages. Both groups of researchers shed new light on how the body responds to exercise, and their findings suggest new ways of enhancing the beneficial effects of physical activity on the body.

In the Massachusetts paper, published in the journal *Science Translational Medicine*, the scientists isolated 200 metabolic byproducts in the blood of 300 subjects who agreed to run for 10 min. on a treadmill in the lab. Blood samples were taken before exercise, immediately after the activity, and then one hour later. Of the 200 agents, 20 showed significant changes before and after exercise; most of these were well known byproducts of physical activity, such as increases in lactate and variations in the breakdown of fats, sugars and various amino acids, the building blocks of proteins, in the muscles.

One pathway that had not been identified before emerged from this analysis however — the production of a vitamin that promotes insulin release. It was also clear that more fit individuals were able to burn fat more effectively during exercise, since they released more of the byproducts of fat metabolism than less fit subjects.

Such information, say the authors, could lead to a better understanding of how to test people for fitness and maximize the beneficial effects of exercise for them — for example, by potentially giving them compounds that can make up for deficiencies in their body's ability to breakdown fats, sugars or proteins for energy.

In the second study from UCSF, which appeared in PLoS One, the researchers focused on a specific part of cells known to dictate aging. Telomeres are the portions of DNA at the ends of chromosomes that help to stabilize the genetic material in the cell as the cell divides and its genes are replicated over and over again. With each cell division, however, telomeres tend to shorten, and when the tips are worn down enough, that's a signal for the cell to die.

A growing body of research, some by the same UCSF team, suggests that stress can accelerate the shortening of telomeres, and therefore of cell life. So the research team (which included Elizabeth Blackburn, the scientist who co-discovered the enzyme responsible for whittling down telomeres and earned the Nobel Prize for her work) decided to test whether exercise could counteract that decline and potentially maintain telomere length and cell vitality.

Working with samples of immune cells from the blood obtained from 62 post menopausal women, the researchers analyzed the length of telomeres on these cells during a three day period. The volunteers, many of whom were caring for loved ones suffering from dementia, recorded the number of minutes of vigorous physical activity they completed at the end of each day. After compiling the data, the scientists found that despite similar levels of stress in their lives, those getting the recommended 75 minutes of weekly physical activity that the government advises did not experience a shortening of their telomeres, while the women exercising less than this amount did.

It's an intriguing window into how lifestyle changes such as exercise can affect cellular aging, and perhaps even combat the

negative effects of stress on our cells. But, caution the authors, the study still needs to be replicated before they can comfortably confirm that physical activity can inhibit aging.

Taken together, the two studies hint at how complex — and systemic — the effects of exercise can be on the body. Creating such cell-level windows into how our bodies react to physical exercise may help us to both appreciate the significance of daily activity as well as figure out better ways to make the most of those hours at the gym.