It looked as if lactic acid was there for a reason. It was a source of energy. Dr. Brooks said he published the finding in the late 70's. Other researchers challenged him at meetings and in print.

"I had huge fights, I had terrible trouble getting my grants funded, I had my papers rejected," Dr. Brooks recalled. But he soldiered on, conducting more elaborate studies with rats and, years later, moving on to humans. Every time, with every study, his results were consistent with his radical idea.

Eventually, other researchers confirmed the work. And gradually, the thinking among exercise physiologists began to change.

"The evidence has continued to mount," said L. Bruce Gladden, a professor of health and human performance at Auburn University. "It became clear that it is not so simple as to say, Lactic acid is a bad thing and it causes fatigue."

As for the idea that lactic acid causes muscle soreness, Dr. Gladden said, that never made sense.

"Lactic acid will be gone from your muscles within an hour of exercise," he said. "You get sore one to three days later. The time frame is not consistent, and the mechanisms have not been found."

The understanding now is that muscle cells convert glucose or glycogen to lactic acid. The lactic acid is taken up and used as a fuel by mitochondria, the energy factories in muscle cells.

Mitochondria even have a special transporter protein to move the substance into them, Dr. Brooks found. Intense training makes a difference, he said, because it can make double the mitochondrial mass.

It is clear that the old lactic acid theory cannot explain what is happening to muscles, Dr. Brooks and others said.

Yet, Dr. Brooks said, even though coaches often believed in the myth of the lactic acid threshold, they ended up training athletes in the best way possible to increase their mitochondria. "Coaches have understood things the scientists didn't," he said.

Through trial and error, coaches learned that athletic performance improved when athletes worked on endurance, running longer and longer distances, for example.

That, it turns out, increased the mass of their muscle mitochondria, letting them burn more lactic acid and allowing the muscles to work harder and longer.

LACTIC ACID IS ACTUALLY A FUEL, NOT A CAUSTIC WASTE PRODUCT. MUSCLES MAKE IT DELIBERATELY, PRODUCING IT FROM GLUCOSE, AND THEY BURN IT TO OBTAIN ENERGY.

Just before a race, coaches often tell athletes to train very hard in brief spurts.

That extra stress increases the mitochondria mass even more, Dr. Brooks said, and is the reason for improved performance.

And the scientists?

They took much longer to figure it out.

"They said, 'You're anaerobic, you need more oxygen,' "Dr. Brooks said. "The scientists were stuck in 1920."

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