# The 2000-Meter Row: A Case in Homeostasis

*by*
Nathan Strong
Chemistry/Biological Sciences Department
New Hampshire Technical Institute

Sixty minutes before the race, Jim was sitting quietly on the bank of the Schuylkill River. He was visualizing the race he was about to row. Two thousand meters of intense physical activity, pushing his body to the very limits of its capabilities. But sitting there, he was calm and relaxed, mentally willing his heart rate and respiratory rate down. He had done his stretching and warm-up exercises, but his heart rate was now just 65 beats per minute and he was breathing 12 breaths per minute. His body temperature was 37° C (98.6° F). He was well hydrated. His weight was 180 pounds.

That was an hour ago. Now, he was sitting in the bow seat of the Men's Varsity Eight. In lane four on the starting line, he could see two boats to his left and three boats to his right. The rowers all looked bigger than him and his crew, but then they always did. The starter on the shore was saying something over the loudspeaker but Jim wasn't paying attention. He was concentrating on being ready and was listening to his coxswain. These last few seconds before the race were the most stressful—you could feel the tension in the air. He knew that all 48 rowers and even the six coxswains on that starting line were feeling the same as he was. He was sweating although the air was cool. His heart rate was now 85 beats per minute and he was breathing 18 breaths per minute. He felt a nervous excitement. His mouth was dry. He took one last sip of water.

"All hands are down," he heard the starter say. He tensed his muscles in his starting position.

"Prêts... PARTEZ!" which was French for "Ready... GO!"

Three short strokes to get the 60-foot-long shell moving, and then 20 strokes at maximum power. His crew was rowing 39 strokes per minute and water was flying everywhere. It seemed like he could hear everything—coxswains yelling, rowers grunting, oars and rigors banging. Mostly he heard himself breathing. He was putting all of his strength into each stroke, knowing that after those first 20, the pace and the power would come down some.

At the end of that first minute, Jim's heart rate was 201 beats per minute. He was taking two breaths per stroke, fast and forced. Their stroke rate was now 34 strokes per minute. He was sweating more now. His body temperature was 37.5° C (99.5° F). His muscles hurt—they felt like they were burning.

Two minutes later, they had traveled just over 1000 meters. They were still rowing at 34 strokes per minute. Jim tried to put himself into a trance, shutting out the pain and the external distractions, concentrating on keeping the power up. He was giving each stroke about 80% of his maximum power. His heart rate was 180. His respiratory rate was also down slightly. His body temperature was 38° C.

With 250 meters to go to the finish line, Jim was sitting even with the bowman of the boat in lane three. They were trading the lead with every alternate stroke. His cox was talking to the team, keeping them focused, getting them ready

for the sprint. The crew next to them started to move—they were up one seat! He heard his coxswain call for what he was dreading—five strokes to bring it up for the sprint. He focused on a spot between the shoulder blades of his number two man and forced his muscles to respond. Thirty-seven strokes per minute, then 38 strokes.

Bow ball to bow ball, the winner of this race was going to be whichever crew got in the last stroke. As Jim crossed the finish line, six minutes and 58 seconds after starting and one-tenth of a second behind the triumphant crew in lane three, his heart rate was 208 beats per minute. He stopped rowing and slumped over his oar, breathing nearly 80 times per minute but still not feeling like he could get enough air. It felt like his arms and legs were on fire. Sweat was pouring out of every pore of his body. He felt light-headed. His body temperature was 102° F.

Ten minutes later after a dejected row back to the docks, Jim's heart rate and respiratory rate were almost back to normal. His body temperature was still half a degree above normal. He felt drained of energy. He was still very thirsty. He had allowed himself only small sips of water on the row back. He weighed 176 pounds.

## *Instructions to Students*

Working in your assigned study groups, each group will describe what is going on in Jim's body and why at each of the five moments described: on the starting line, one minute after the start, three minutes after the start, at the finish, and on the return trip to the dock. Specifically, what conditions are changing as a result of the race and what responses are made by the body to try to maintain homeostasis? What are the *results* of those responses? You should concentrate on changes in the *nervous* system, the *respiratory* system, the *cardiovascular* system, and the *muscular* system. But don't forget the endocrine system and the urinary system.

One suggestion would be for each student to take a body system or two and report to the group on the activities of those systems throughout the course of the race. Another approach would be for each student to take one of the five moments and describe the stresses encountered and the responses made.

Be sure that the answers to these questions are included in your report, but your report should not consist only of the answers to these questions.

## *Questions*

### *At the start*

1. What is responsible for raising Jim's heart and respiratory rate and stimulating sweating just before the race?
2. Why is the sympathetic division of the autonomic nervous system active just before the race?
3. What changes do you think are occurring in the digestive and urinary systems at this time?
4. What is happening to Jim's blood glucose levels just before the race?
5. Why is Jim's mouth dry?

*One minute in*

1. Rowing full speed is putting new demands on Jim's body. What are these new demands and how does the body respond to them?
2. What changes in Jim's muscles promote unloading of $O_2$ from hemoglobin for use by the muscle cells?
3. Why do Jim's muscles feel like they are burning?
4. What conflict is produced between Jim's need to keep his body cool and his need to remove nitrogenous wastes from his blood? What did he do before the race to help alleviate this conflict?

*At the halfway mark*

1. Since the end of the first minute, Jim has decreased the demands his muscles are making. How has he done this? And why has he done this?
2. What are the changes in his conditions as a result?

*At the finish*

1. Jim has stopped rowing and his muscles are now at rest. Why are his heart and breathing rates still so high?
2. Why is he sweating more now than during the race?
3. What changes have occurred to his blood chemistry since the start of the race? Think about glucose levels, pH, lactate levels, creatinine levels, and temperature.

*Back at the dock*

1. What changes have occurred in the last 10 minutes to allow Jim's heart and respiratory rates to come down?
2. Why is Jim four pounds lighter than at the start of the race?
3. What effect has this water loss had on his endocrine system?
4. Why did Jim only take sips of water after the race? What could happen if he drank as much as he wanted to?

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