A Rigorous Investigation:
The Relationships Between Cellular Respiration, Muscle Contraction, and Rigor Mortis

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Learning Objectives

- Review the basic steps of ATP production (i.e., cellular respiration, lactic acid fermentation).
- Identify the molecular steps involved in muscle contraction.
- State the importance of ATP generation to muscle contraction.
- Understand the relationship between rigor mortis and muscle contraction.

The Story

Steve Knox is a hard-working research biochemist. He has been married to his wife Jackie for over eight years. The project he is working on is a continuation of a project he began in graduate school examining metabolic processes in the mitochondria of *Xenopus laevis* frogs. His technician Leslie is also very devoted to the project and often works late hours on the weekends with Steve.

Late one Saturday evening, Steve and Leslie are alone in the lab trying to finish up an experiment. As a surprise, Jackie has decided to bring Steve and Leslie a late-night snack since both of them have missed dinner. Around 11:30 p.m., Jackie enters the lab with drinks and brownies. The lights are on but no one seems to be around.

"I wonder where they are," Jackie muses to herself. "Steve? Leslie? I brought you a surprise!"

Turning a corner into the back of the lab, Jackie sees Steve and Leslie involved in a passionate kiss near the fume hood. Shocked, Jackie drops the food onto the floor, making a clatter. Looking equally shocked, Steve and Leslie immediately disentangle themselves and start sputtering excuses and straightening their clothes.

"Hi, honey, uhhhh ... what are you doing here?" mutters Steve.

Jackie is enraged. She lunges toward Steve, grabbing his shoulders and shaking him. "What are you doing? Don't you love me any more? I HATE YOU! I HATE YOU!"

Steve suddenly loses his balance and begins to fall. On his way down, he hits his head on the corner of the lab bench, falling unconscious. Jackie screams.

Leslie, meanwhile, has been watching in horror. Seeing Steve on the floor, she fears for her own safety. Jackie might attack *her* next! Reacting quickly, she grabs a flask of a clear solution sitting on the counter in the hood and tosses the liquid into Jackie's face, and then runs out of the lab.

Early Monday morning, a colleague discovers Steve and Jackie's dead bodies and calls 911. The coroner later releases information about the estimated time of death for the two based on the extent of rigor mortis. Steve, whose body was still warm and barely stiff, is estimated to have died approximately five hours before being discovered. Jackie, whose body was completely cold and stiff, is estimated to have died approximately 30 hours before being discovered.

Homework Questions

1. Construct a time-line of the events from Saturday evening through Monday morning as described in the story.

2. Cellular Respiration Questions:

    a. Which part of cellular respiration uses 2 ATP and produces 4 ATP per glucose molecule? Where does this set of reactions occur in the cell?

    b. Which part of cellular respiration produces the most ATP? How does it work?

    c. Which part of cellular respiration produces the most NADH? How many?

    d. What molecules are needed to produce ATP by oxidative phosphorylation?

3. In a living organism, what happens to ATP production when there is no oxygen available (anaerobic conditions)?

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In-Class Questions

4. What are the characteristics of a dead body?

5. Consider the processes involved in muscle contraction. Summarize in a few sentences the relationship between ATP and muscle contraction.

6. What is rigor mortis? Why does rigor mortis develop? What are the different stages of rigor mortis?

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