Muscle Metabolism Research to Music

TODAY'S OUTLINE

- Your final songs can be on any STEM topic and can be in any musical genre, but should go beyond textbook facts to touch on research methods and data.
- Example: Dr. C's doctoral dissertation on the control of glycolysis in exercising muscles (reference: G.J. Crowther et al., *American Journal of Physiology* **282**: E67-E79, 2002)
    - Background
        - what is glycolysis?
        - ATP production and consumption in muscle cells
    - Observation: rates of glycolysis go way up during exercise
    - Question: what controls glycolysis?
        - Traditional answer: metabolites from ATP breakdown (ADP, AMP, P_i)
    - Methods: NMR spectroscopy
        - General principles of NMR
        - Phosphorus spectra
        - Glycolysis estimate #1: based on muscle pH
        - Glycolysis estimate #2: based on PCR levels
        - Human volunteers and exercise protocol
            - Force transducer
            - Blood pressure cuff to cut off circulation
            - Metronome and LED device to guide contractions
    - Results
        - Start of exercise: delay in onset of glycolysis
        - End of exercise: glycolysis decays over a few seconds even without restoration of blood flow
    - Conclusion: 2 factors are needed for high rates of glycolysis
        - a contraction-related factor like calcium
        - high levels of metabolites from ATP breakdown (ADP, AMP, P_i)

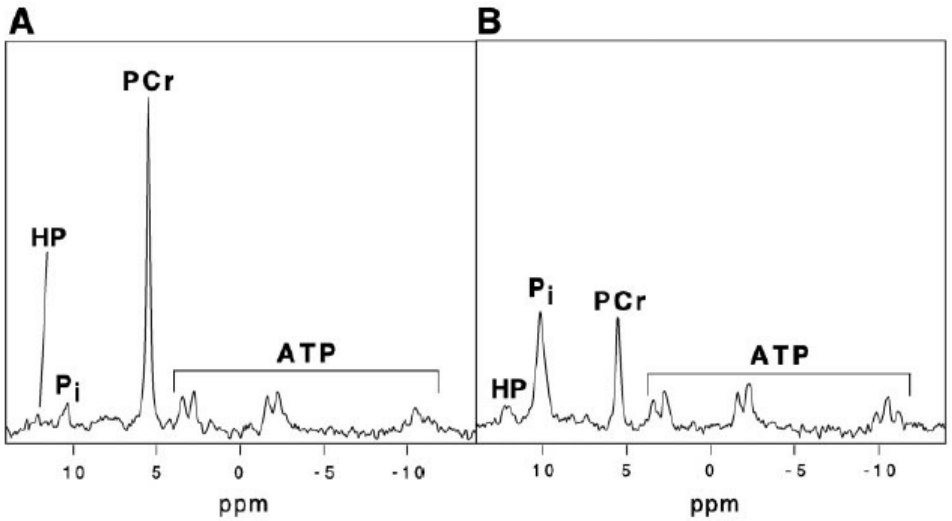

Fig. 1. Typical ^{31}P magnetic resonance spectra of the ankle dorsiflexors at rest (*A*) and after 60 s of ischemic 1-Hz exercise (*B*). HP, hexose phosphates; PCr, phosphocreatine.

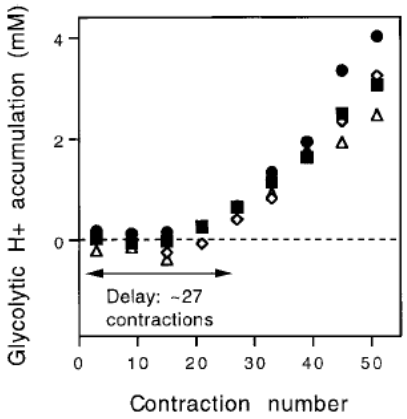

Fig. 4. Condensed version of Fig. 3 showing cumulative glycolytic H^+ production vs. contraction number. For each of the four exercise protocols, the flux is minimal during the first 27 contractions or so; at a contraction frequency of 1 Hz, this corresponds to a delay of ~27 s. Error bars are omitted for clarity. Symbols are as in Fig. 3.

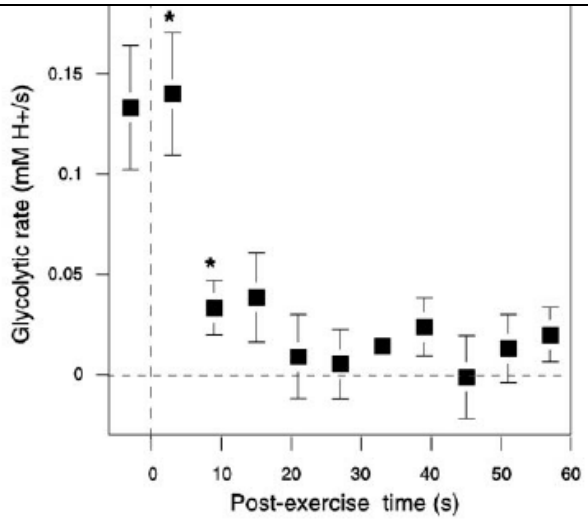

Fig. 6. Time course of glycolytic flux rate calculated by the pH method in human muscle at the end of and after an exercise bout lasting 12 (*A*) or 60 s (*B*). Dashed vertical line indicates the end of exercise. Values are plotted as means ± SE (n = 8). The first 3 postexercise points in *B* were compared with zero (i.e., baseline) using 1-tailed *t*-tests with a sequential Bonferroni correction; *3- and 9-s points were found to be significantly greater than zero.

Necessary But Not Sufficient
Performed by Science Groove

Audio: http://science-groove.org/Now/Necessary.mp3
Video: http://www.youtube.com/watch?v=8HX34kHHDow

Verse 1:
The muscle starts to pull its load, but glucose use is slow
Because [Pi] and [ADP] and [AMP] are low.

CHORUS:
Necessary but not sufficient:
Something's there and yet something's missin',
And the textbook authors sure will be surprised.
High metabolites? Not sufficient.
Muscles pulling tight? Not sufficient.
The two must coexist for flux to rise.

Verse 2:
Contraction ends, and once again, the glucose use subsides.
This sudden drop cannot be stopped by high metabolites.

CHORUS

[bridge]

CHORUS