

The Role of Nitric Oxide Feedback in the Thermally Robust Lobster Cardiac System

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The electrical and chemical complexity of the neuron makes it very sensitive to small changes in temperature. American lobsters are poikilothermic animals, meaning that they cannot internally regulate their body temperature. Therefore, the body temperature is controlled by the local water temperature, which often shows rapid changes of over 10°C due to tidal currents (Manning 2009). As a result, the neuronal system that controls the heart has adapted to operate at a wide range of temperatures despite the thermal sensitivity of individual ion channels.

The heartbeat of a lobster is locally generated by a simple network of 9 neurons called the cardiac ganglion (CG). Although the CG is able to produce a rhythm in the absence of external input, the activity of the CG has been shown to be modulated by nitric oxide. The CG is inhibited by the nitric oxide released by an active heart in a negative feedback loop. This negative feedback loop mirrors the countless examples of negative feedback loops in biology that moderate processes and maintain stability.

It has been shown that the heating of a lobster from 2°C to 20°C results in an increase in heart rate. Within this range, a lobster counteracts the heart rate increase by decreasing the strength of the ganglion signal to the cardiac muscle. This causes