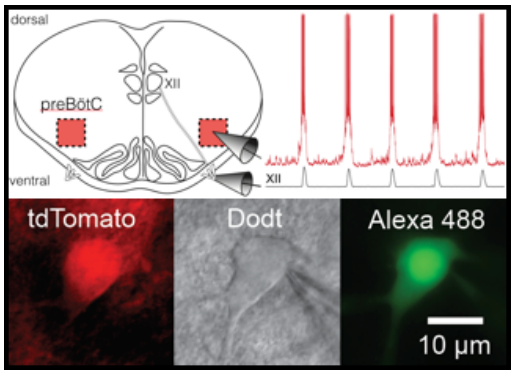
Electrophysiology

…involves measuring the electrical properties and recording the electrical events associated with neural activity, and is an integral component of our research in the Systems Neuroscience Lab.



The breathing rhythm is produced within a region of the brainstem called the preBötzinger complex (preBötC). The core oscillator is composed of excitatory cells that engage in periodic bursts of activity. Using isolated brainstem preparations, the breathing rhythm can be maintained and studied *in vitro*.

We perform patch clamp recordings of rhythmogenic neurons using glass microelectrodes connected to an amplifier. This technique allows us to determine the electrical properties of preBötC neurons, and test hypotheses regarding the mechanisms that underlie respiratory rhythm generation.

Molecular Biology

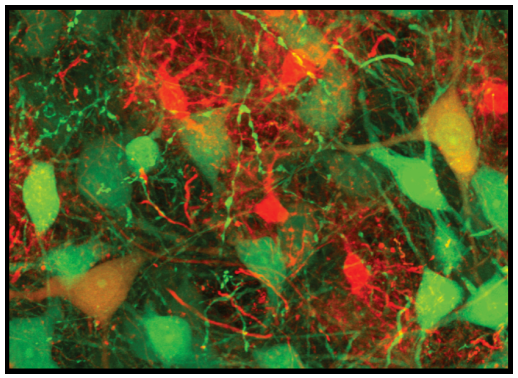
…involves learning about the structure, function, and expression of macromolecules in the nervous system, and is an integral component of our research in the Systems Neuroscience Lab.

In addition to electrophysiology, we use molecular techniques like RT-PCR, RNA-Seq, immunohistochemistry, and *in situ* hybridization to determine the presence and quantity of proteins that contribute to respiratory rhythmogenesis.

A set of proteins called transcription factors influence cell fate determination during development. One transcription factor, called Dbx1, is expressed in neural progenitors that give rise to rhythmogenic preBötC neurons. In the Systems Neuroscience Lab, we exploit a molecular technique called Cre/lox recombination to selectively record from and manipulate Dbx1-derieved neurons.

Optical Microscopy

…involves using light and lenses to acquire static and dynamic images of brain tissue and cellular processes, and is an integral component of our research in the Systems Neuroscience Lab.

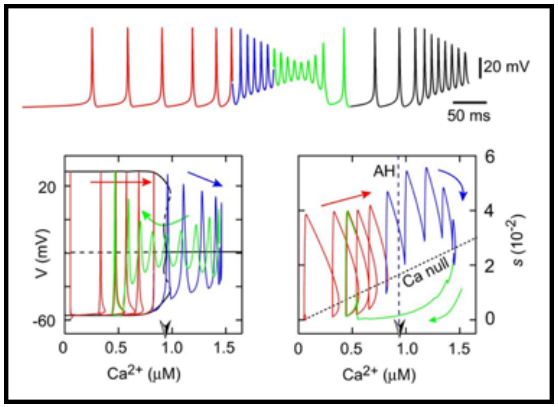


Microscopy is a powerful tool that we use in combination with electrophysiology and molecular techniques to identify neurons and glia, characterize their morphology, measure their activity, and even destroy them one by one!

We have recently employed a technique referred to as 'laser ablation' to sequentially kill preBötC neurons and measure the influence that cell death has on respiratory rhythm generation and pattern formation. This has helped us learn more about how the preBötC operates, and how cell death during neurodegenerative disease might influence breathing behavior.

Computational Modeling

…involves the use of mathematics to provide a framework for analyzing neural systems and experimentally testable predictions, and is an integral component of our research in the Systems Neuroscience Lab.



Alan Hodgkin and Andrew Huxley won the 1963 Nobel Prize in Physiology or Medicine for their pioneering mathematical work on the initiation and propagation of action potentials. Now, modeling is a vital tool of contemporary neuroscience, used to describe how cells and networks function to produce behavior.

We combine physiology data with nonlinear differential equations to create computational models of the respiratory network. These data can be used to describe how respiratory failure occurs during disease states, and make testable predictions about the mechanisms that underlie respiratory rhythm generation.

Ph.D. in Applied Science

Students with undergraduate training in biology, chemistry, biochemistry, psychology, physics, and applied mathematics are generally prepared for graduate study in the Systems Neuroscience Lab.

Students who are interested in working in the Systems Neuroscience Lab are encouraged to contact Christopher A. Del Negro directly. A Ph.D. in the Systems Neuroscience Lab prepares students for post-doctoral research fellowships, faculty jobs in academia, or careers in biotechnology or pharmaceuticals.

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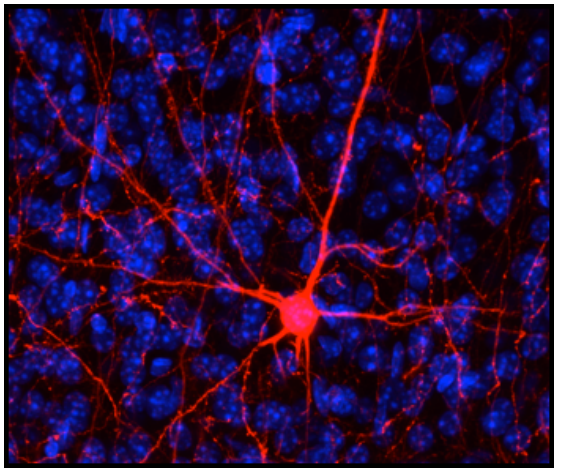
Systems Neuroscience



The systems neuroscience group led by Prof. Christopher A. Del Negro seeks to understand the neural origins of breathing behavior in mammals. Brain circuits that generate breathing movements are set up during embryonic development, ready to function autonomously at birth, and operate continuously for the lifetime of an animal. In humans, their dysfunction contributes to pathologies including apnea of prematurity, SIDS in babies, obstructive sleep apnea in adults, as well as respiratory failure in geriatric patients and sufferers of neurodegenerative disorders. To better understand the neural origins of breathing behavior we employ the following techniques:

- Electrophysiology
- Molecular Biology
- Optical Microscopy
- Computational Modeling