

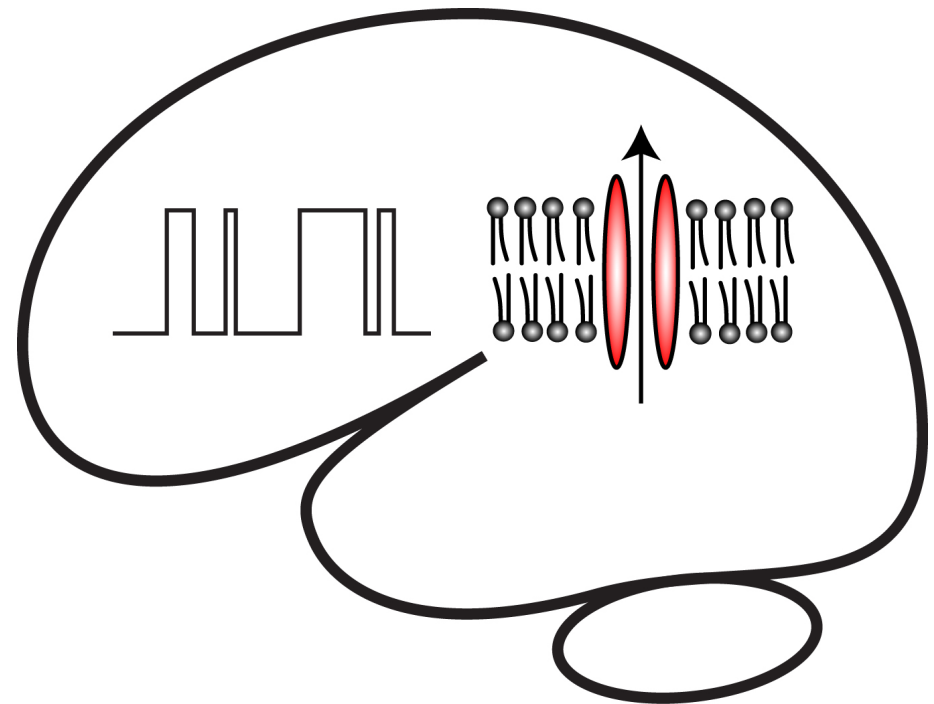
6.1 Brain function and behavior

Cellular Mechanisms of Brain Function

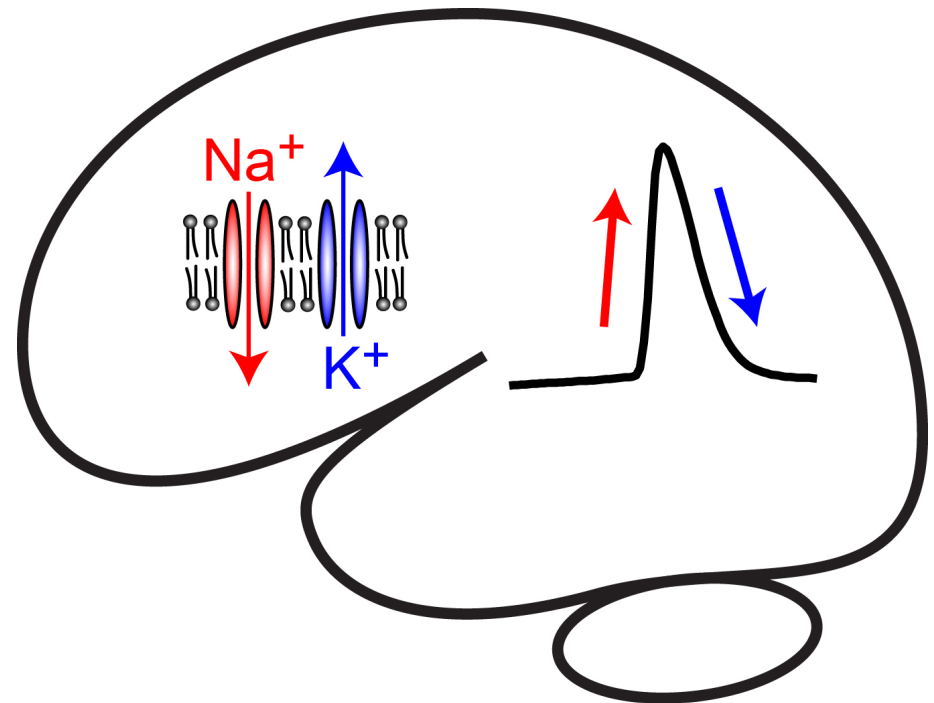
Prof. Carl Petersen

Brain function and behavior

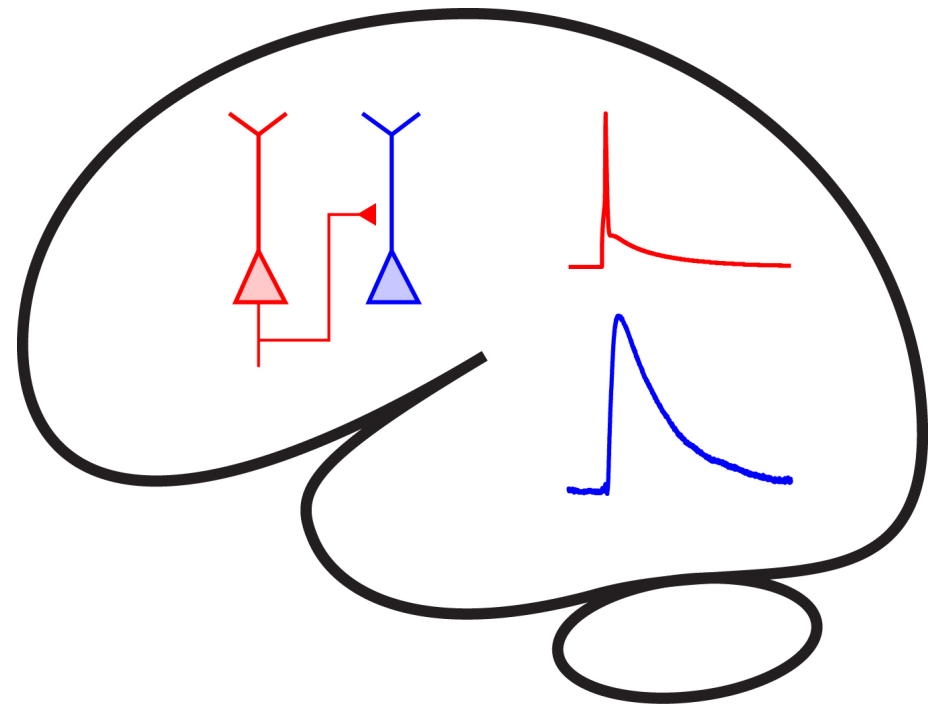
Cellular mechanisms of brain function



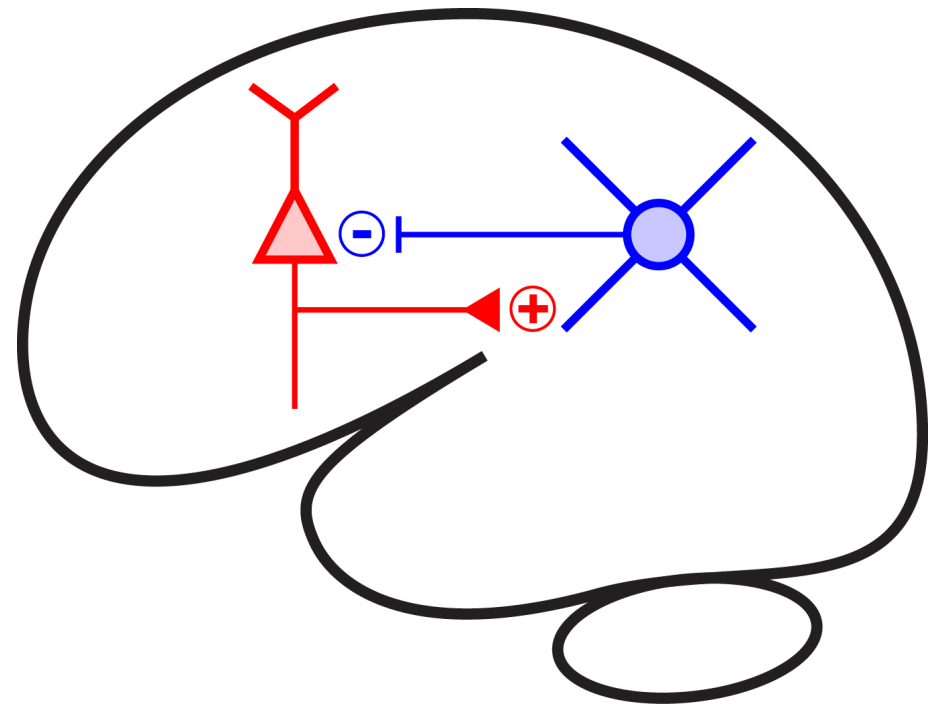
Cellular mechanisms of brain function



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Causal mechanisms of behavior

Our goal is to obtain a causal understanding of behavior, so we need to investigate brain function at the level of individual neurons and their synaptic interactions within the complex neuronal networks of the living mammalian brain.



Cellular measurements of brain function *in vivo*



Measure neuronal activity in the living brain and correlate with behavior.

1. Electrophysiology

- Whole-cell patch-clamp recordings of membrane potential

- Extracellular recordings of action potentials

2. Optical imaging

- Fluorescence microscopy

- High resolution structural and functional measurements

Perturbations of brain function

Measurement and correlation of neuronal activity with behavior is essential, but correlations do not necessarily imply causality.

In order to investigate the causal impact of a specific neuronal activity, we need to specifically perturb that activity.

Optogenetics – offers combinatorial specificity through:

- i) Optical control - spatiotemporal resolution
- ii) Genetics - cell-type specificity

Quantitative modelling of brain function

Having made measurements and perturbations of specific neuronal activities, it is essential to quantitatively model the phenomena in order to gain causal mechanistic insight and to test specific hypotheses.

We currently have a very incomplete understanding of neuronal circuits in the mammalian brain and we are far from having a quantitative mechanistic understanding of even the simplest behaviors.

Although many brain regions are highly interconnected there is also a high degree of modularity, through so-called *small world networks*. Detailed cellular and synaptic modelling of selected subnetworks of the brain is now becoming feasible with increases in computing power.

On the scientific method

Karl Popper (1934) *The logic of scientific discovery*.

We can falsify hypotheses, but we cannot not prove them.

Causal mechanisms of brain function and behavior



- Correlate the activity of specific cells with behavior.
- Perturb the activity of specific cells during behavior.
- Quantitatively model the causal interactions driving brain function and behavior.