Introduction
In this laboratory, you will measure compound action potentials (CAPs) from an isolated frog sciatic nerve to explore the basic physiological properties of nerve impulses.

Background
The fundamental unit of the nervous system is the neuron. Neurons and other excitable cells produce action potentials when they receive electrical or chemical stimulation. The action potential occurs when specialized voltage-sensitive membrane sodium channels are activated. The large increase in sodium permeability results in membrane depolarization. This is followed by repolarization as the sodium permeability returns to its low baseline value and potassium permeability is transiently increased. (Note. The actual numbers of ions moving during each action potential, however, are very small and cell ion concentrations are not altered measurably). From the beginning of the action potential to the restoration of the resting membrane potential, the neuron is incapable of producing another action potential. This period is referred to as the refractory period, which can be divided into two phases. Initially there is the absolute refractory period, where it is impossible to initiate a second action potential. This is followed by the relative refractory period, where a stimulus of greater than normal intensity can elicit a response.

Action potentials are “all-or-none” events. Once an action potential begins, it propagates down the length of the axon. When the action potential reaches the end of the axon, a neurotransmitter is typically released into the synapse.

Measuring action potentials from single axons requires highly specialized equipment. Instead, you will record from an isolated peripheral nerve, the frog sciatic nerve, which contains some thousands of axons.
These include afferent (sensory) nerves and efferent (motor and autonomic) nerves. The individual axons vary in diameter, myelination, excitability, threshold and speed of conduction. It is important to appreciate that the threshold voltage required to produce an action potential reflects the diameter of the axon – large diameter axons are stimulated at lower voltages than smaller diameter axons. Thus the compound nerve action potentials (CAPs) that you will record at any stimulus voltage represent the summed ‘all or nothing’ action potentials only from those axons that are excited at that voltage. As the stimulus voltage is increased, more and more axons will be excited until eventually all of the axons in the nerve are excited. Thus the magnitude of the CAP will increase with increased stimulus strength. After that point (the maximal response), supramaximal stimuli will have no further effect on the magnitude of the CAP. Also, because axons of different diameters have different conduction velocities, as more and more axons are excited the shape of the CAP will alter.

Note that CAPs arise from extracellular stimulation of the nerve and are recorded by extracellular electrodes. The shape of the CAP is not related to the classical pictures that you see of single nerve action potentials recorded using an intracellular electrode. What you are recording here is the difference in potential between two extracellular electrodes. In the absence of a stimulus, there is no
difference and we have a baseline recording. Following a stimulus, a wave of depolarization passes down the nerve. As this wave crosses the first electrode, it becomes negative to the more distal electrode. By convention this difference is shown as a positive deflection in the recording. Then, when this wave reaches the second electrode, that electrode now becomes negative to the more proximal electrode and this results in a negative deflection in the recording.

The importance of the CAP lies not simply in the fact that it enables us to examine aspects of nerve physiology. Clinically, CAPs are measured in patients to explore the peripheral nerve lesions and diseases. You will record CAPs on yourselves in a later laboratory.
What you will do in the laboratory

There are four exercises that you will complete during this Lab.

1. **Setup and calibration of equipment.** In this exercise, you will check that the stimulating and recording connections are set up correctly.

2. **Determination of threshold voltage and maximal CAP amplitude.** Here you will give the nerve a series of stimuli, each increasing in amplitude. You will then be able to calculate the threshold voltage for the nerve, as well as the voltage required for maximum CAP amplitude.

3. **Determination of the refractory period.** In this part of the laboratory, you will deliver paired supramaximal stimuli to the nerve. The interval between these stimuli will be progressively decreased. The results will enable you to determine the relative and absolute refractory periods of your nerve.

4. **Determination of nerve conduction velocity.** Here you will calculate the velocity of the CAP as it travels down the nerve.