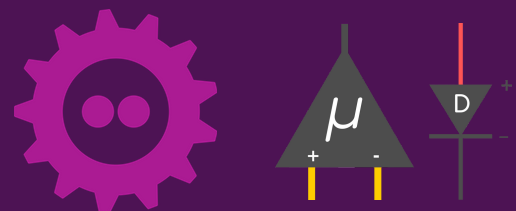




# Low-cost open-source hardware designs for biopotential amplification for neuroscience, prosthetics and more

Deepak Khatri - Upside Down labs



# Things you are going to learn today!

## WHAT

What are Biopotentials?  
EEG, ECG, EMG, & EOG.

## HOW

How to design hardware for  
Biopotential signal Amplification?

## WHY

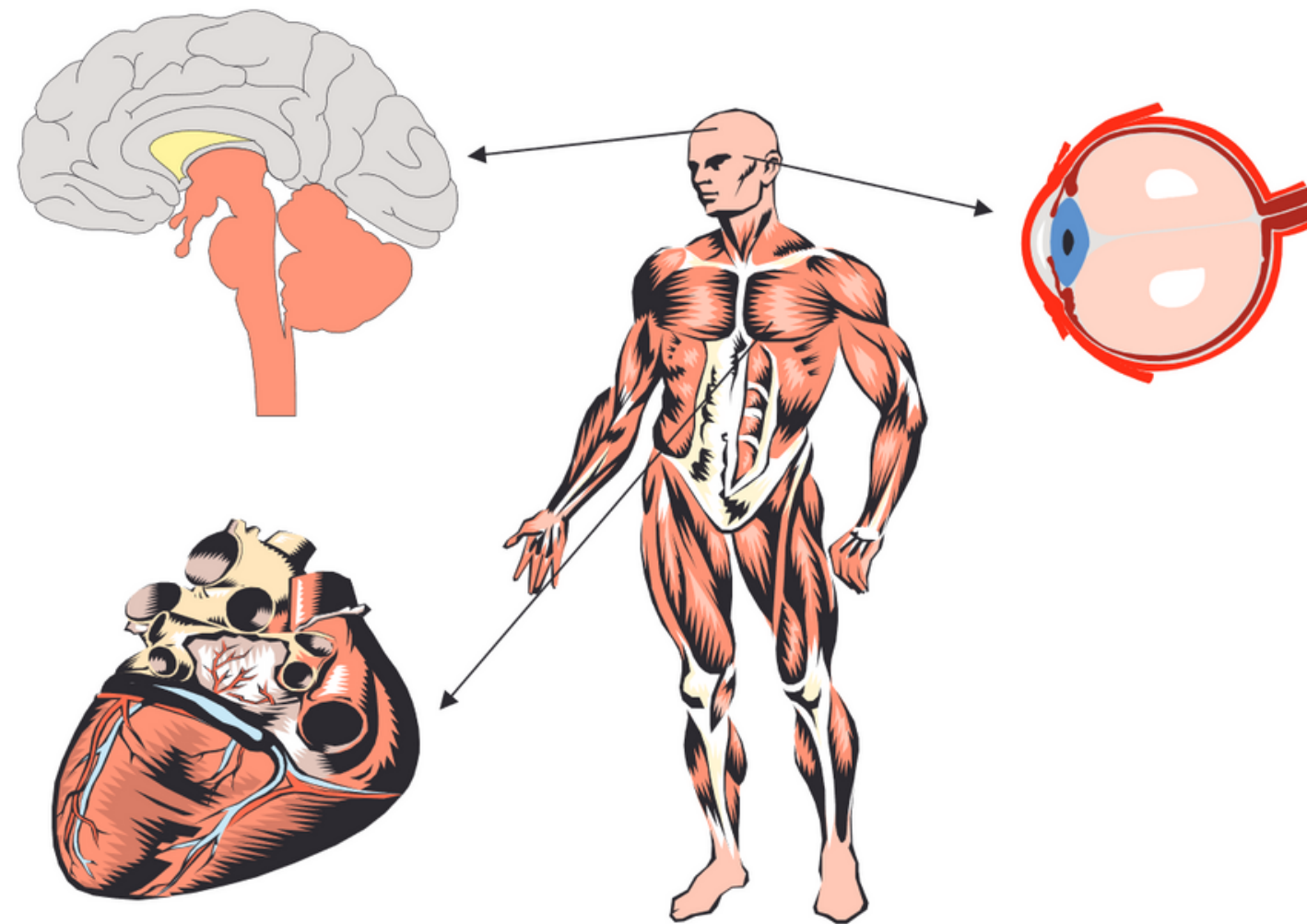
Why do we need affordable  
BioAmp hardware?

01

# What are Biopotentials?

Biopotentials are electrical signals (voltages) that are generated by physiological processes occurring within the body. They are produced by the electrochemical activity of a type of cell, called an excitable cell. Excitable cells are found in the nervous, muscular, and glandular systems in the body. When an excitable cell is stimulated, it generates an action potential, which is the essential source of biopotentials in the body.



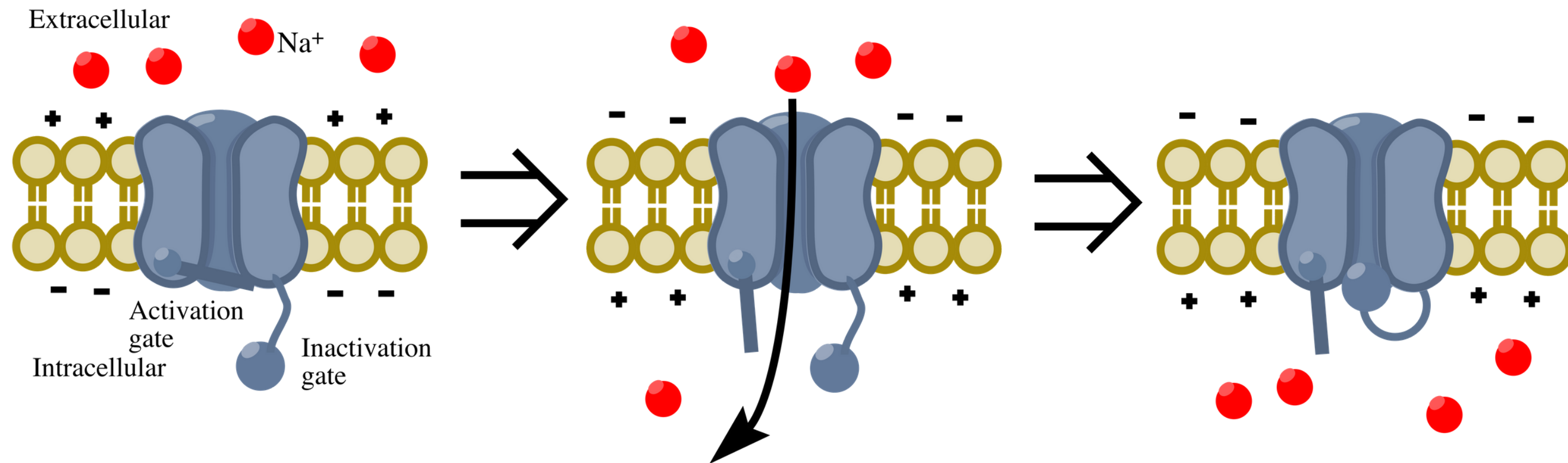


**EEG - Brain**  
**ECG - Heart**  
**EMG - Muscle**  
**EOG - Eye**



Action potential generation!

# Sodium Potassium Ion channels



# How to design hardware for Biopotential signal Amplification?



# Requirements of a BioAmp

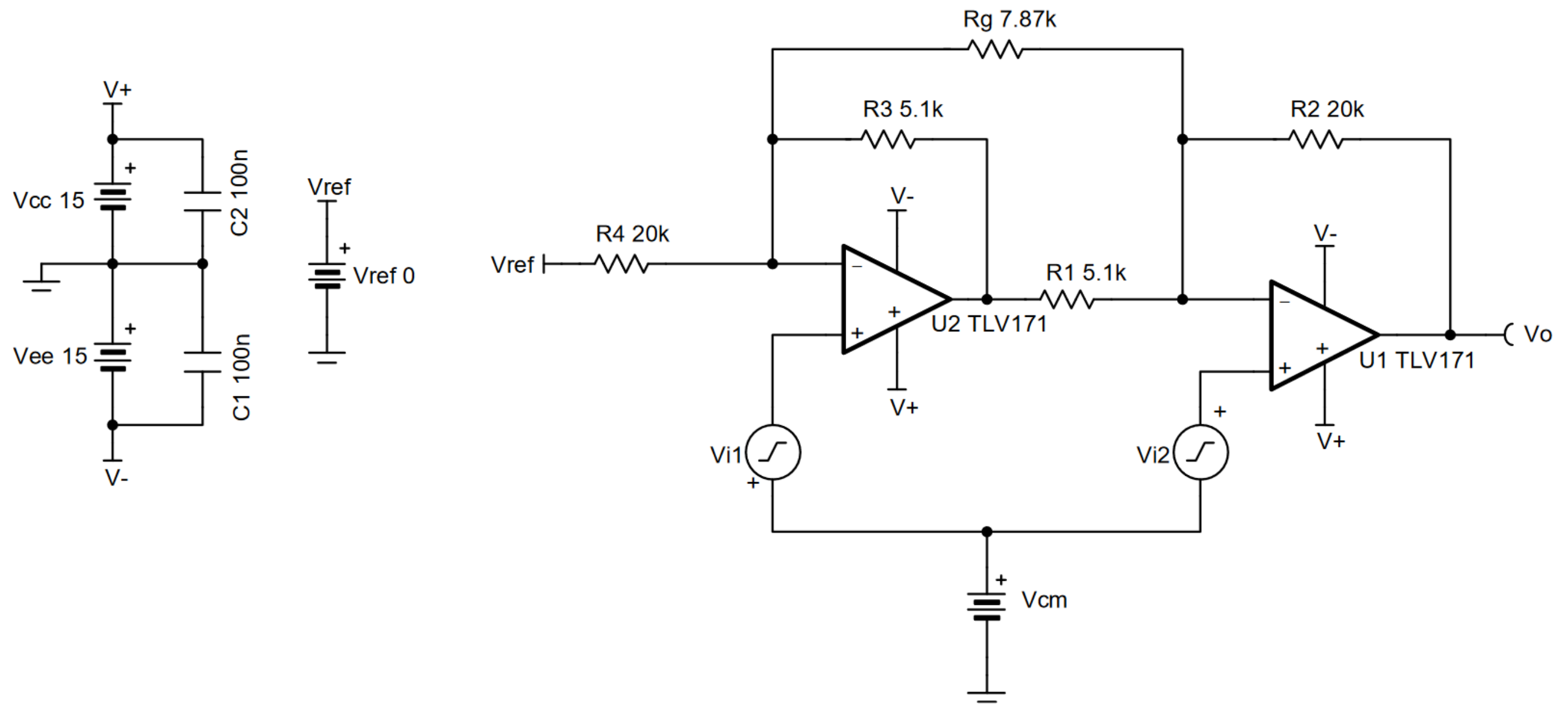
- High input impedance.
- High CMRR ( $>100\text{dB}$ ).
- Low output impedance.
- Flexible Gain control.
- Target protection.
- Low power consumption.





# **Instrumentation Amplifiers**

# 2 opAmp Design



## An abstract graphic featuring two overlapping, rounded shapes. The top shape is a smaller, darker purple oval. The bottom shape is a larger, lighter blue-purple oval. Both shapes have a soft, blurred gradient, giving them a dreamy, ethereal appearance. They are set against a plain white background.





The background is a deep purple color. On the right side, there is a large, irregular, organic shape in a lighter shade of purple and blue. In the upper center, there is a small, glowing sphere with a blue and purple gradient. In the bottom right corner, there is another smaller, glowing organic shape in blue and purple.

03

# Why do we need affordable BioAmp hardware?

I believe Biology with technology is the next big revolution. To make sure everybody gets the equal opportunity to make a change, we need a supply of affordable development tools!

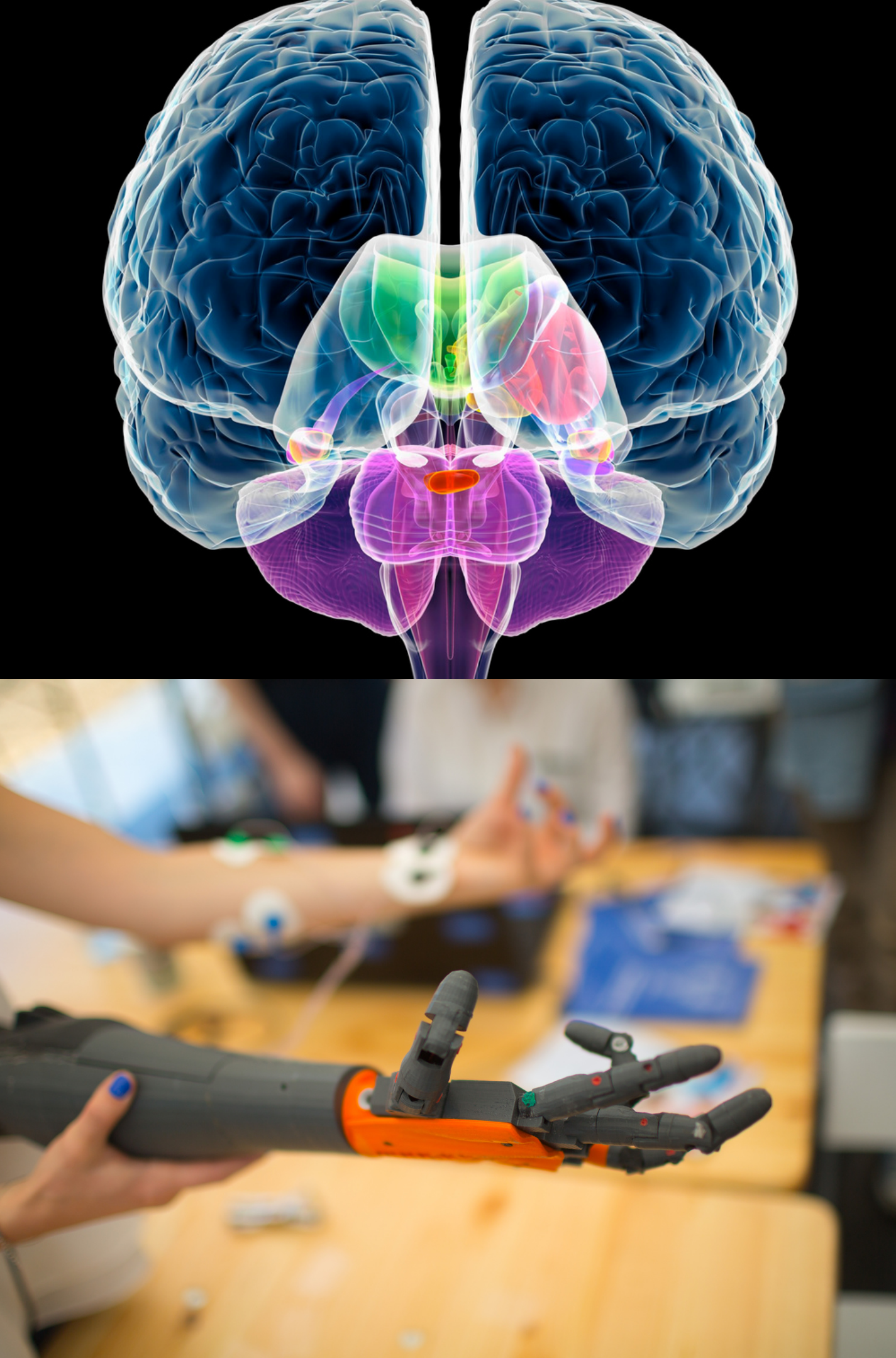
# Starting with

## 01

Research-grade Neuroscience hardware .

## 02

Affordable AFE for prosthetics control.

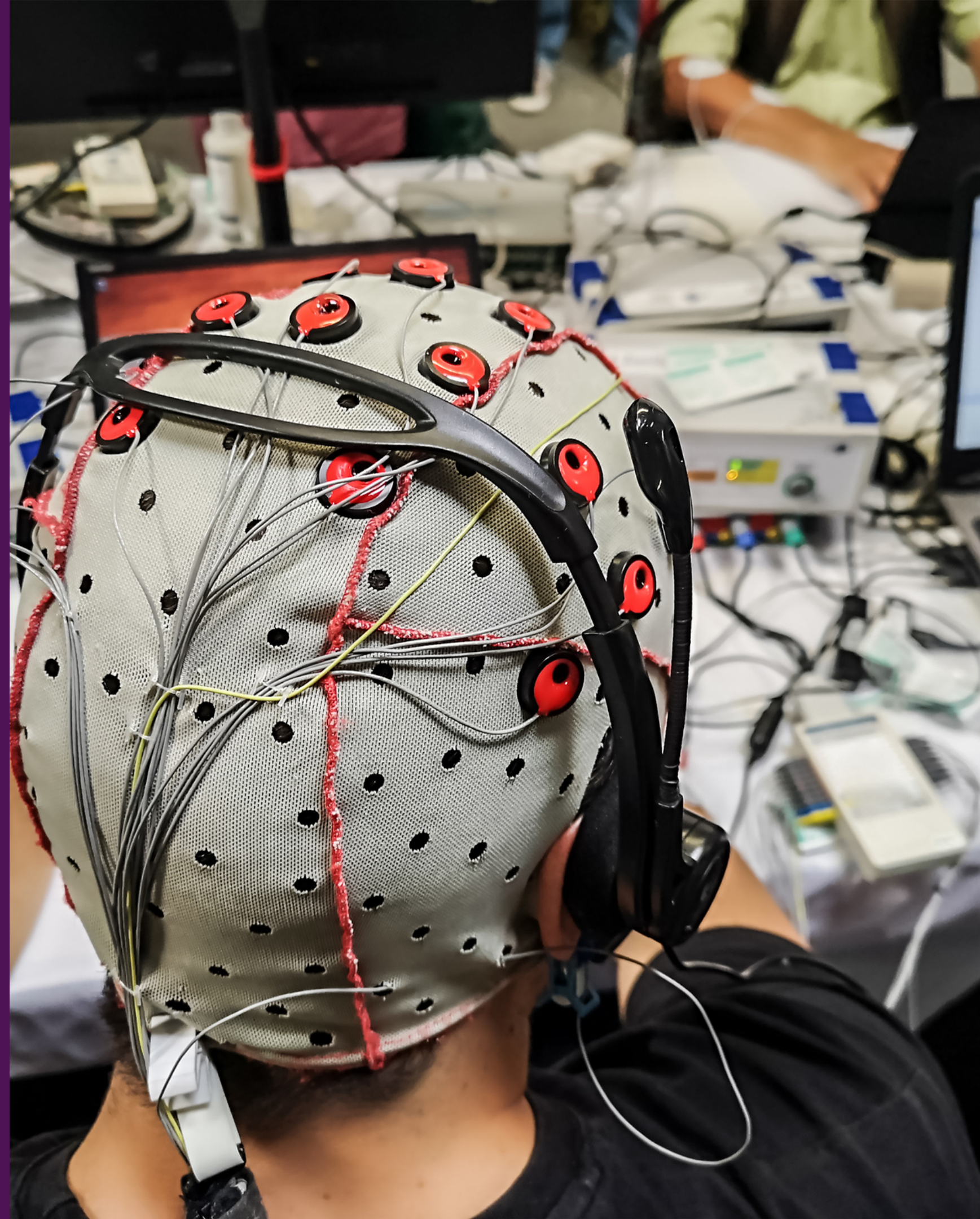




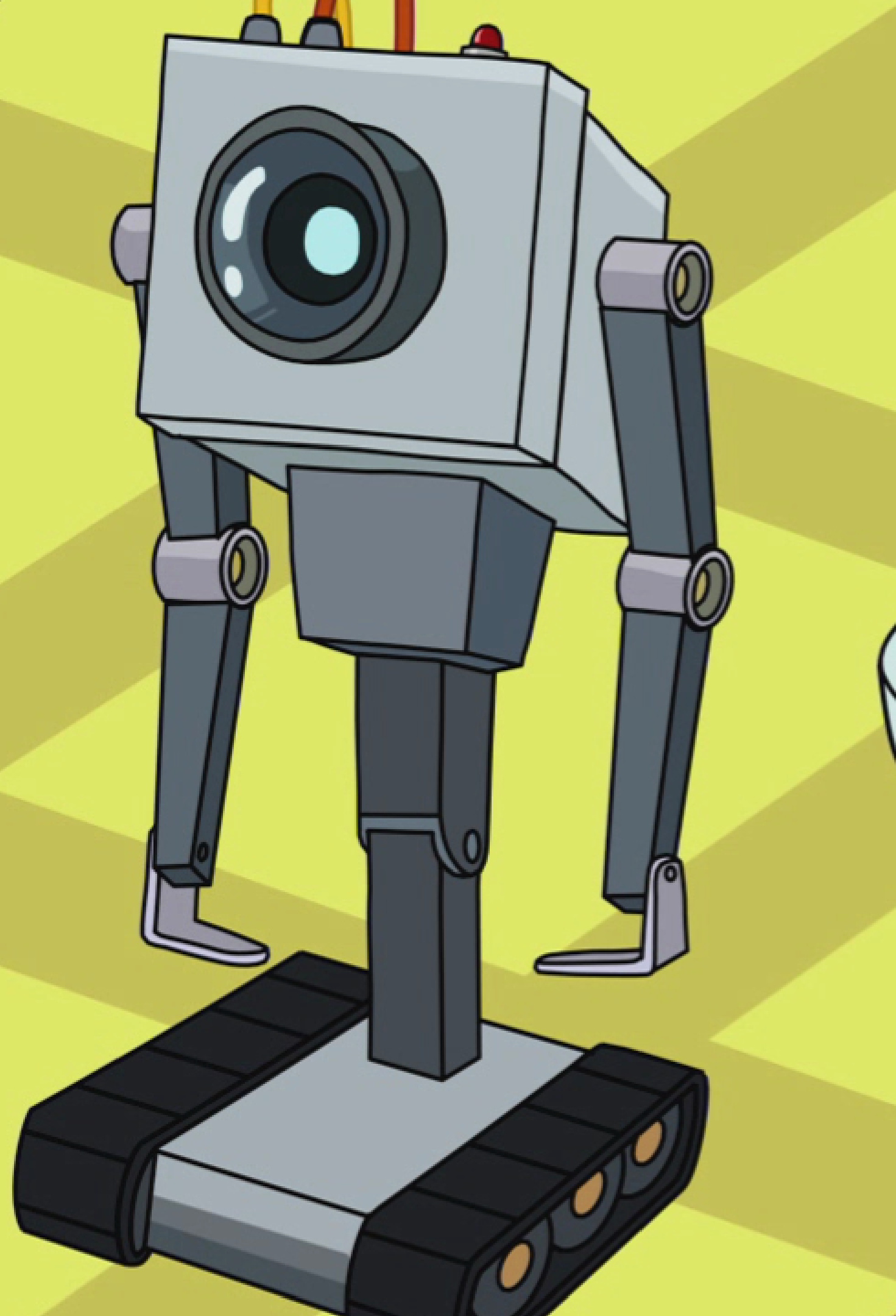
# Digital telepathy

In the future there will be a way to automate responses based on pre-written keywords and through machine learning.

Presentations are communication tools that can be used as demonstrations, lectures, speeches, reports, and more. It is mostly presented before an audience.







# Butter Robot

A real mesh of living neurons trained to pass butter with sensory inputs like vision, orientation, and motor control.

This idea is not my own, I stole it from Rick from "Rick & Morty".

