

Neural information transmitted in ONE direction

Afferent  $\rightarrow$  Ascending  $\rightarrow$  Sensory

Efferent  $\rightarrow$  Descending  $\rightarrow$  Motor



Bundled together in the same nerve

Humans have fascicles

Pigs do, monkeys don't

Action potential on each one of the neurons  $\rightarrow$  compound AP

Large diameter fibers  $\rightarrow$  travel faster

1 neuron can innervate many muscle fibers

Actin & Myosin move against each other with  $\text{Ca}^{2+}$   
Requires ATP or ADP?

ACh

AP along the membrane of the muscle fiber  
Causes the release of  $\text{Ca}^{2+}$

Only pull, no push

Neuromuscular junction

## Internal Organs

Parasympathetic (break pedal) vs. Sympathetic (gas pedal)

Vagus Nerve - Hits a lot downstream, but used for specific therapies

## Pituitary Bulk

Global announcement through the blood via chemical messengers  
Neuron  $\rightarrow$  Endocrine cell  $\rightarrow$  Hormonal release in bloodstream

## Brain

Protected by meninges packaging

Subarachnoid space  $\rightarrow$  space for brain to move around

Spinal cord  $\rightarrow$  continuation of brain

Dura mater, Arachnoid mater, Pia mater

Isolated from blood

CSF surrounds brain

Between CSF and neurons, there is a barrier

Neural implants break the barrier and must deal with immune response

CSF goes around CNS including spinal cord

Choroid plexus → generates CSF

CSF is white-colorless, gets used and recycled

Larger brain might be needed for larger and more muscle control

## Brain Organization

Organization based on histology

Based on function

Cerebrum → thinking

Cerebellum → coordinating motor tasks, timing

Top of brainstem is evolutionarily the oldest

Thalamus → relay station between brain and outside

Medulla → autonomic nervous system; breathing, digestion

## Cranial Nerves

Injury higher up spinal cord → more loss of fxn

Sensory → back of brain, back of spinal cord

Motor → front of brain, back of spinal cord

Ganglion: where the cell bodies are for neurons, no processing

White → myelin

Middle → interneurons → processing → no myelin

Nucleus: cell bodies & processing

## Thalamus

Relay station

Useful of neural engineering as a target region

Processing at each step along path between CNS and PNS

## Vestibular

Mostly for reflexes

Cortex for higher order processing

## Cortex

General divisions, but most have substantial overlaps

Neural circuits perform computations

Homunculus → more precision requires more brain region space

## Somatosensation

Receptive fields have overlap

Spatial orientation

Center surround organization

Center → stim

Surround → inhibit

Applies to other sensations as well

## Cortical organization of cortex

Cortical columns

Inputs from thalamus → Layer IV

diam = 500 $\mu\text{m}$  to 4,000 $\mu\text{m}$

## Convergence of info

## Visual Receptive Fields

Ganglion cells

High center

Low off center

Low when center & off center (broad)

Edge detection

## Motor Control

Proprioreceptive cells

Cerebral cortex ↔

Feedforward & Feedback

Motor signal generation

Well-evolved system modelled as control system

## Motor Cortex

Basal ganglia in center

Thalamus → GABA or Glut?

Motor cortex → GABA or Glut?

Stopped before cerebellum



