Motor Programs

- Motor system: Muscles and neurons that control muscles
- Role: Generation of coordinated movements
- Parts of motor control
  - Spinal cord $\rightarrow$ coordinated muscle contraction
  - Brain $\rightarrow$ motor programs in spinal cord

The Somatic Motor System

- The Lower Motor Neuron
  - Lower motor neuron: Innervated by ventral horn of spinal cord
  - Upper motor neuron: Supplies input to the spinal cord
**Spinal cord injuries**
- Motor neurons below the injury remain intact.
- Motor cortex commands do not reach muscles and muscles atrophy.
- Electrodes can artificially activate muscles and prevent atrophy

**UPPER MOTOR NEURON SYNDROME DAMAGE TO DESCENDING PATHWAYS**
Damage to the pathways driving the motor neurons
- Tonicity
  - **TONE AND REFLEXES INCREASED**
  - Spastic cerebral palsy for example

**LOWER MOTOR NEURON SYNDROME - DAMAGE DIRECT TO MOTOR NEURONS**
Diseases or lesions at the level of the motor neurone or its axon
- Atrophy - loss of muscle volume
  - **DECREASED TONE AND REFLEXES**
  - Poliomyelitis for example

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**Guillain Barre syndrome**
(ghee yan bah ray)
- Syndrome not disease (unclear what disease)
- Paralysis (can be total)
- Attacks Schwann cells, then axons
- Autoimmune
- Similar to MS in CNS
- 70% recovery! Why? ???
- Following vaccine (rabies, swine flu)
- 1 case per million 1 death per 20 million (normal?)

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**The Somatic Motor System**

**THREE Inputs to Alpha Motor Neurons**

![Diagram of three inputs to alpha motor neurons]

- Feedback on muscle length (dorsal root ganglia)
The Somatic Motor System

- Types of Motor Units
  - Red muscle fibers: Large number of mitochondria and enzymes, slow to contract, can sustain contraction
  - White muscle fibers: Few mitochondria, anaerobic metabolism, contract and fatigue rapidly (but POWERFUL - escape)
  - Fast motor units: Rapidly fatiguing white fibers
  - Slow motor units: Slowly fatiguing red fibers

FAST twitch (fatigue rapidly – white)  SLOW twitch (fatigue slow – red)

Forced change in input – switch phenotype (physical characteristics)

- 30-60/sec bursts   -   10-20/sec steady

Excitation-Contraction Coupling

- Muscle contraction
  - Alpha motor neurons release Ach
    - Innervate muscle fibers
  - ACh produces large EPSP in muscle fibers (via nicotinic Ach receptors)
  - EPSP evokes action potential
  - Action potential (excitation) triggers Ca\(^{2+}\) release, leads to fiber contraction
  - Relaxation, Ca\(^{2+}\) levels lowered by organelle reuptake
Duchenne Muscular Dystrophy

- Genetic – Duchenne 1 in 3500
- ONLY males, so X-linked (single X is enough)
- X region codes for protein “dystrophin”
- In MD, no mRNA for this cytoskeletal protein
- Muscles tear
- WHY normal phenotype for early life?
- Could virus help????? (gene therapy)
- Could stem cells help?

Excitation-Contraction Coupling

- The Generation of Spinal Motor Programs for Walking

Excitation-Contraction Coupling

- The Generation of Spinal Motor Programs for Walking