Basic Circuit

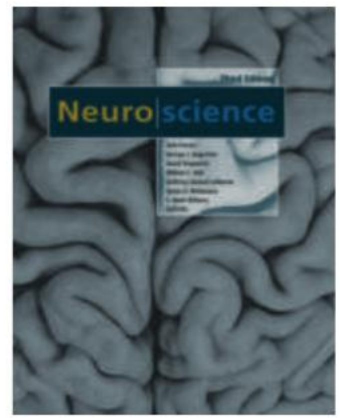
Spinal Cord

Working together for fast reflexes...

Topics I	Topics II
Introduction	Synaptic Transmission
Electrochemical Gradients	Electrophysiology Techniques
Passive Membrane Properties	Basic Circuits (Spinal Cord)
Action Potential	Sensory Systems Overview
Voltage-Gated Ion Channels	Synaptic Plasticity
Ligand-Gated Ion Channels	Recapitulation

Study Material

- NEUROSCIENCE Third Edition
  - Dale Purves
- Chapter 15



THE COVER
Dorsal view of the human brain.
(Courtesy of S. Mark Williams.)

NEUROSCIENCE: Third Edition

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Aims for this Lecture

- Know what a reflex is and how testing for them informs us about the function of the nervous system.
- Understand the basic anatomy of the muscle stretch reflex.
- Know the basic physiological processes that lead to the expression of the stretch reflex response.

Recapitulation L9

- Basic electrophysiology techniques give us information on electricl signals in neurons and neural tissue.
- In most cases this tissue has to be prepared for ex-vivo investigation and kept alive for a while.
- Field recordings provide information on larger groups of neurons, while patch clamp recordings give us precise control over single neurons or even individual channels.

The Patellar Tendon Reflex

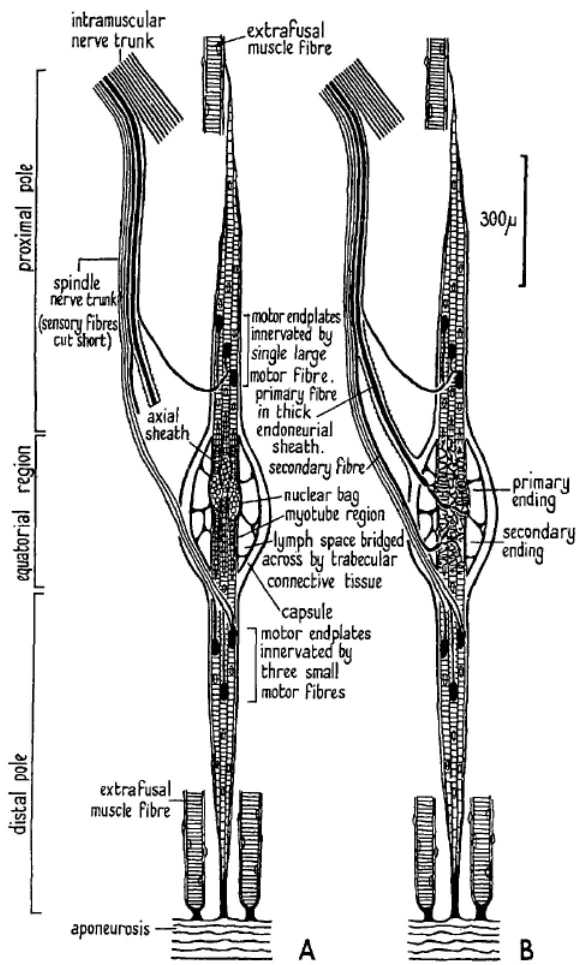
How to do it ..... and how not to do it.

Can you spot the differences?

Let‘s Put It Together

- What are the elements necessary for this function?
- How do they work individually and how do they work together?

Muscle Spindle



TEXT-FIG. 6. Diagrams of an idealized rabbit's muscle-spindle; polar regions shortened to about half their typical length. In A the motor innervation is shown, but the sensory innervation has been omitted to demonstrate the morphology of the equatorial region. Motor end-plates represented as black disks. B shows the same spindle with the addition of a sensory innervation comprising one primary and one secondary ending. Full description in text.

The Innervation of the Muscle-spindle

BY

D. BARKER

(Leverhulme Research Scholar, Royal College of Surgeons of England; Senior Demy of Magdalen College, Oxford)

With three Plates and thirteen Text-figures

(From the Department of Zoology and Comparative Anatomy, Oxford)

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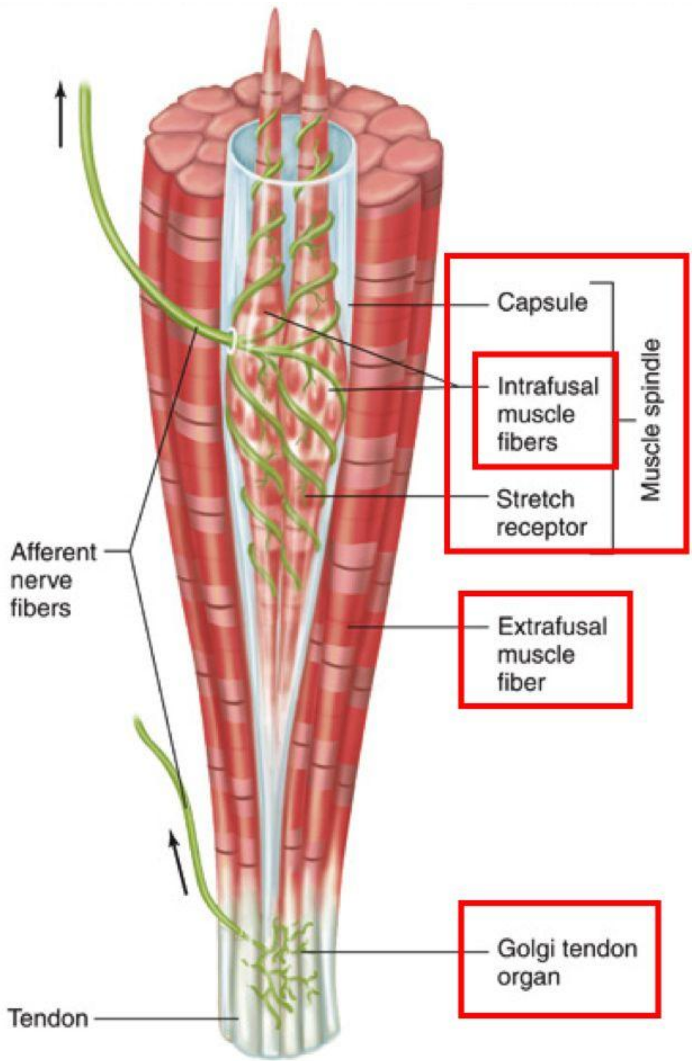
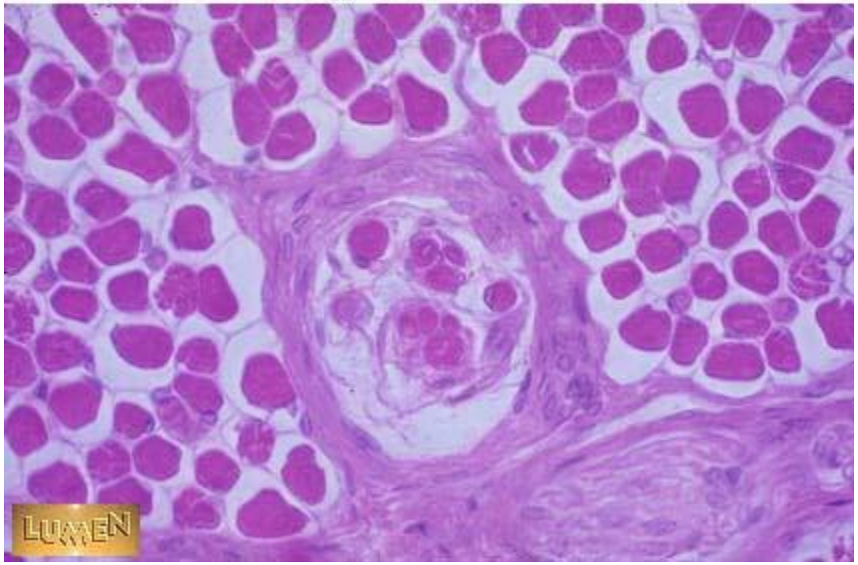
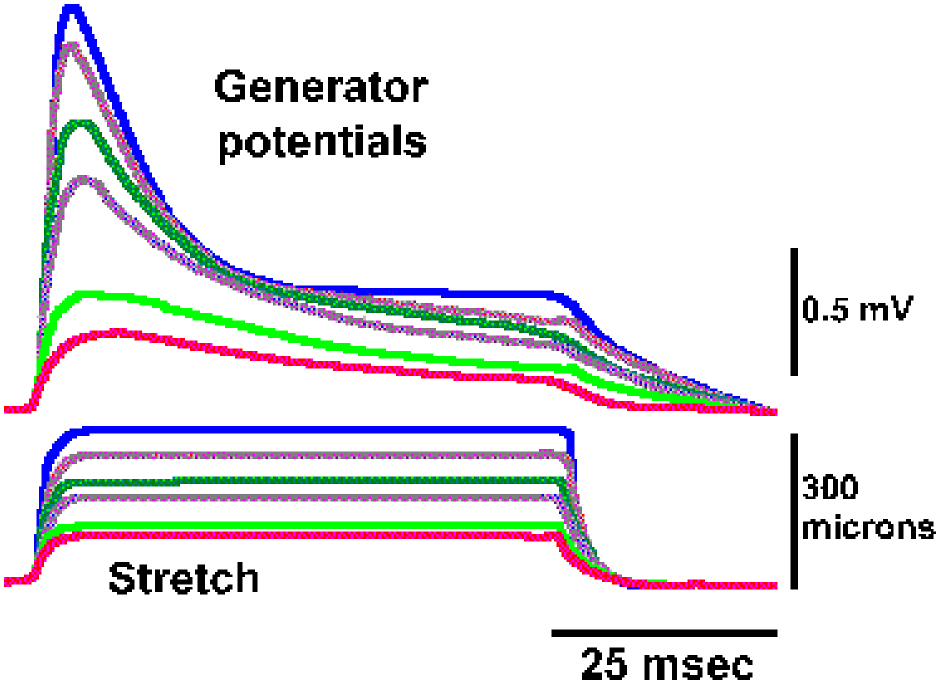
Muscle Spindle



Histology Lab Part 6: Slide 23

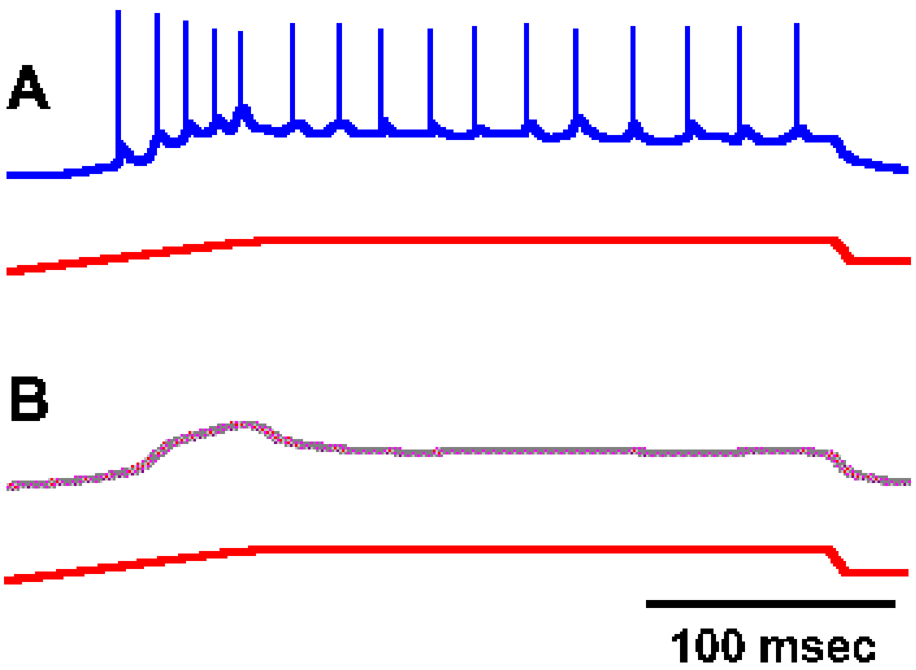


Muscle Spindle Response



Graded responses of a muscle spindle receptor to stretch. Graded stretches are indicated by the stretch monitor in the lower traces; graded generator potentials are shown in the upper traces (Ottoson D and Shepherd GM: *Cold Spring Harbor Symp Quant Biol* 30:105-114, 1965)

Muscle Spindle Response

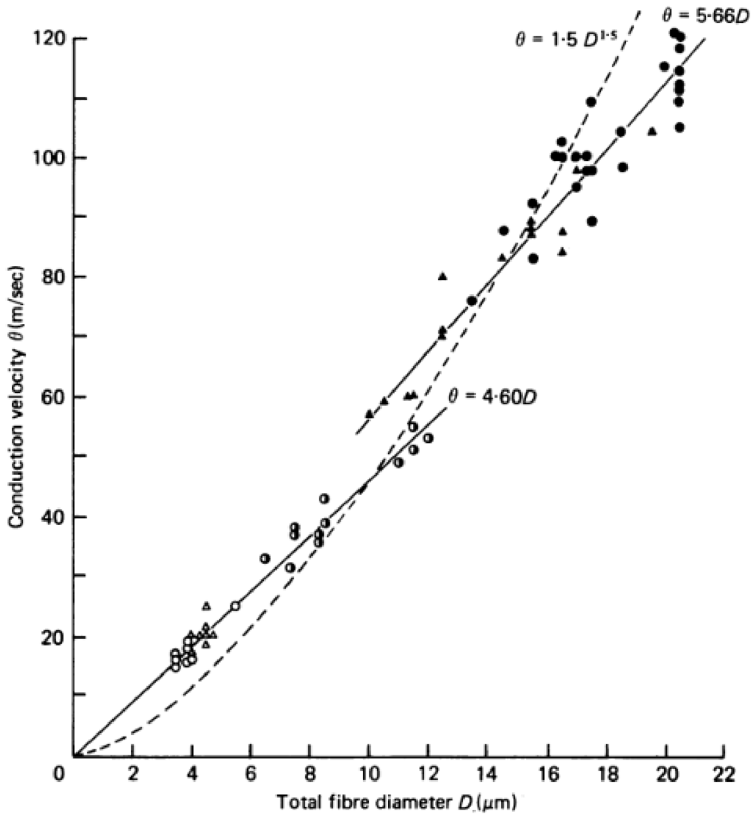


Relation between impulse response and underlying generator potential. A. Response of a muscle spindle receptor to prolonged stretch, with nerve recording shown in the upper trace and monitor of the stretch of the muscle in the lower trace. B. The same response after bathing the spindle in 0.2% lidocaine (Ottoson D and Shepherd GM: *Acta physiol scand* 79:423-430, 1970).

Action Potential Propagation

....this page is deliberately left blank...

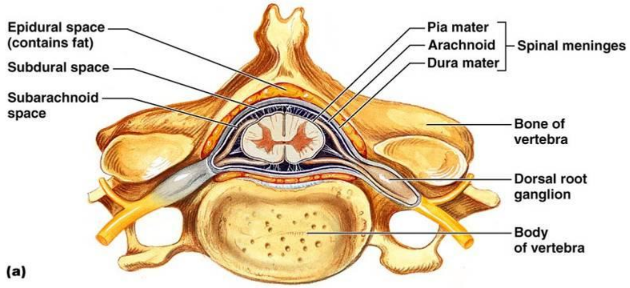
Diameter and Velocity

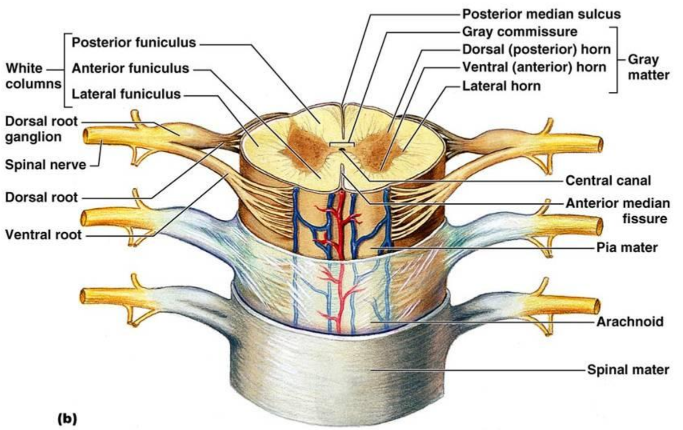


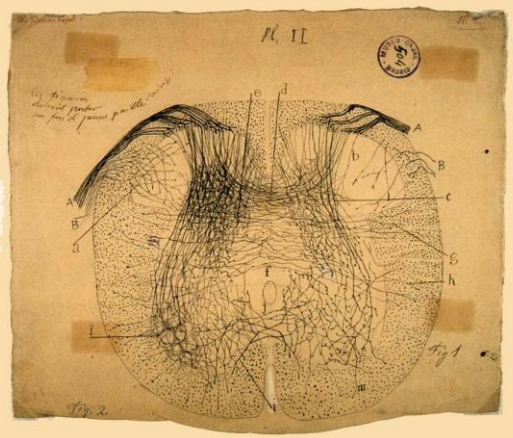
Text-fig. 6. Relation between conduction velocity (θ) and total fibre diameter (D) for different functional groups of myelinated afferent fibres in chronically de-efferentated cat hind limbs. Each point represents the matching of one peak in the afferent fibre-diameter histogram of a nerve with the corresponding peak in the compound action potential of the same nerve, or of the mean diameter of the three largest fibres in a group with the conduction velocity derived from the latency of the start of the rising phase of the corresponding wave in the compound potential. ●, group I muscle afferents; ◑, group II muscle afferents; ○, group III muscle afferents; ▲, group I cutaneous afferents; △, group III cutaneous afferents. Regression line for all group I afferents, $\theta = 5{\cdot}88D - 3{\cdot}6$. Regression line for all group II and III afferents, $\theta = 4{\cdot}59D + 0{\cdot}02$. Error assumed to the present in both θ and D, with error ratio equal to the slope of the line.

The group I muscle afferents are amongst the fastest fibers

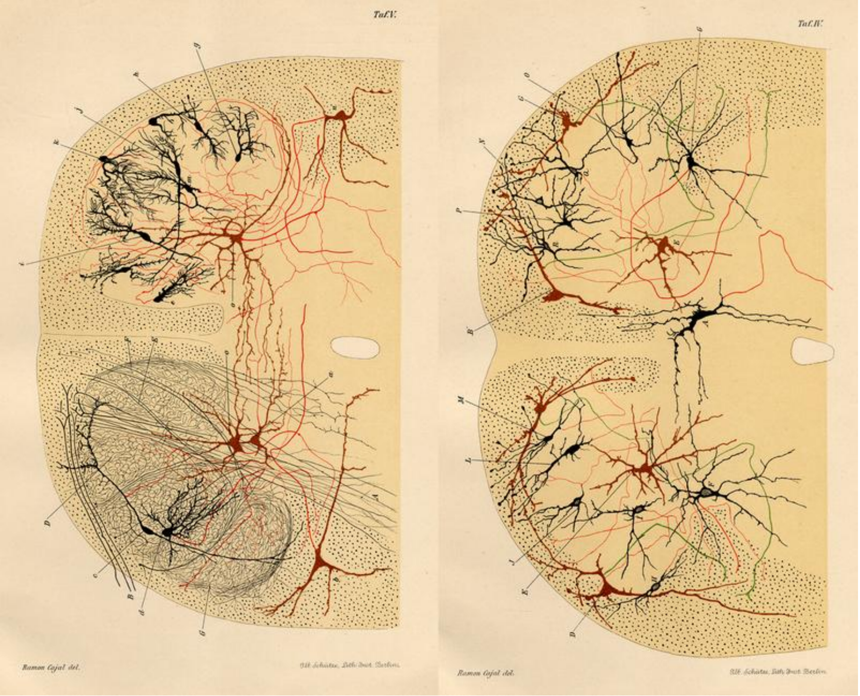
Spinal Cord







"Collaterals in the spinal cord of a chick embryo on thr 15th day of incubation". A, bundle of thick fibers; B, bundle of thin fibers; C, thick sensory-motor collaterals. Modified from a photograph taken from the original (21X17 cm). Drawn on sheet/paper. P.Y. 1899. S.R. y Cajal Institute - CSIC - Madrid, Spain.



Synaptic Transmission

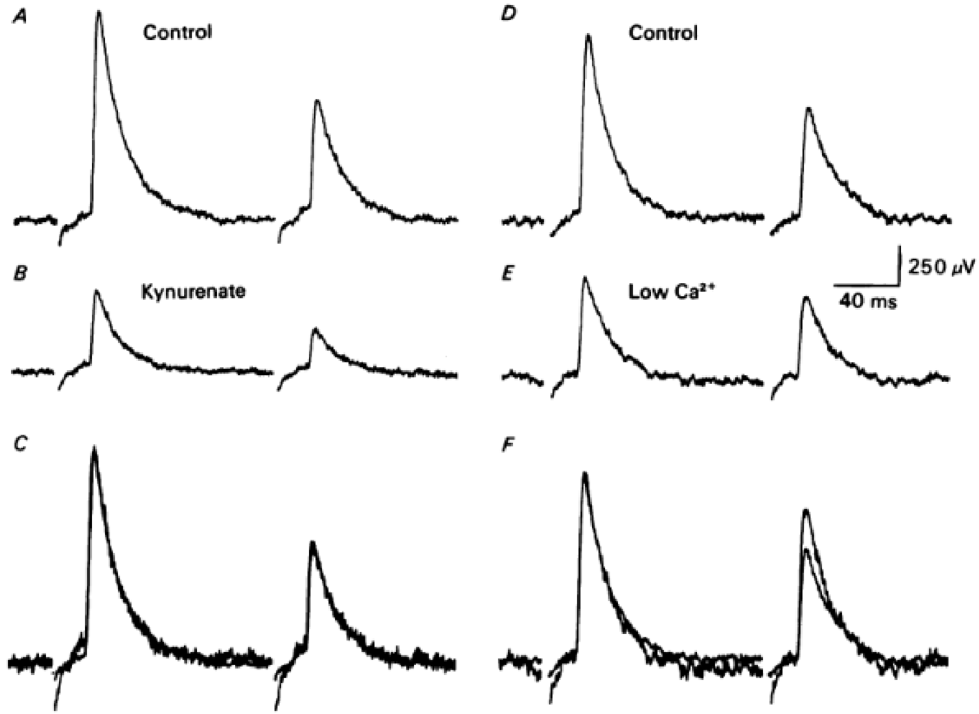


Fig. 4. The effects of kynurenate and lowered external Ca^{2+} on the depression of a I a e.p.s.p. evoked in a p.b.s.t. motoneurone by p.b.s.t. muscle nerve stimulation. *A*, control records of e.p.s.p.s evoked by two stimuli applied at 100 ms intervals in the presence of 4 mM-Ca^{2+} and 8 mM-Mg^{2+}. *B*, e.p.s.p.s resulting from stimulation parameters identical to those in *A*, but after the introduction of 0·5 mM-kynurenate to the superfusate. *C*, superimposition of the records in *A* and *B* after the gain of the record in *B* had been increased such that the amplitude of the first e.p.s.p. matched that of the first e.p.s.p. in *A*. *D*, control records resulting from identical stimulation as in *A* after the wash-out of kynurenate. *E*, e.p.s.p.s resulting after changing the divalent cation concentration to 2 mM-Ca^{2+} and 10 mM-Mg^{2+}. *F*, superimposition of the records in *D* and *E* as in *C*. All traces are averages of sixteen records. Resting potential = −68 mV.

J. Physiol. (1986), **370**, *pp.* 515–530 515
With 9 text-figures
Printed in Great Britain

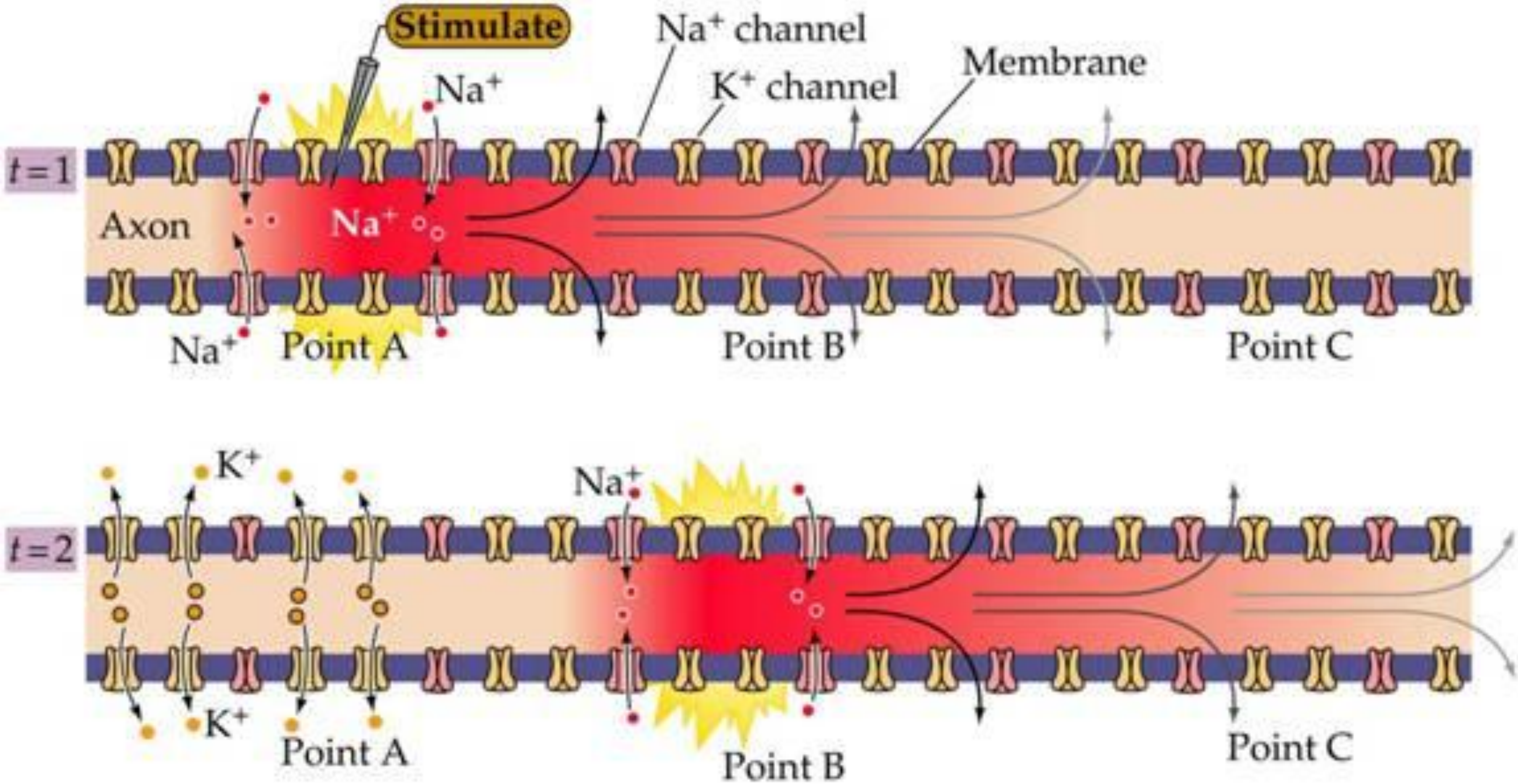
Ia AFFERENT EXCITATION OF MOTONEURONES IN THE *IN VITRO* NEW-BORN RAT SPINAL CORD IS SELECTIVELY ANTAGONIZED BY KYNURENATE

By C. E. JAHR* and K. YOSHIOKA†
From the Department of Neurobiology, Harvard Medical School, 25 Shattuck Street, Boston, MA 02115, U.S.A.

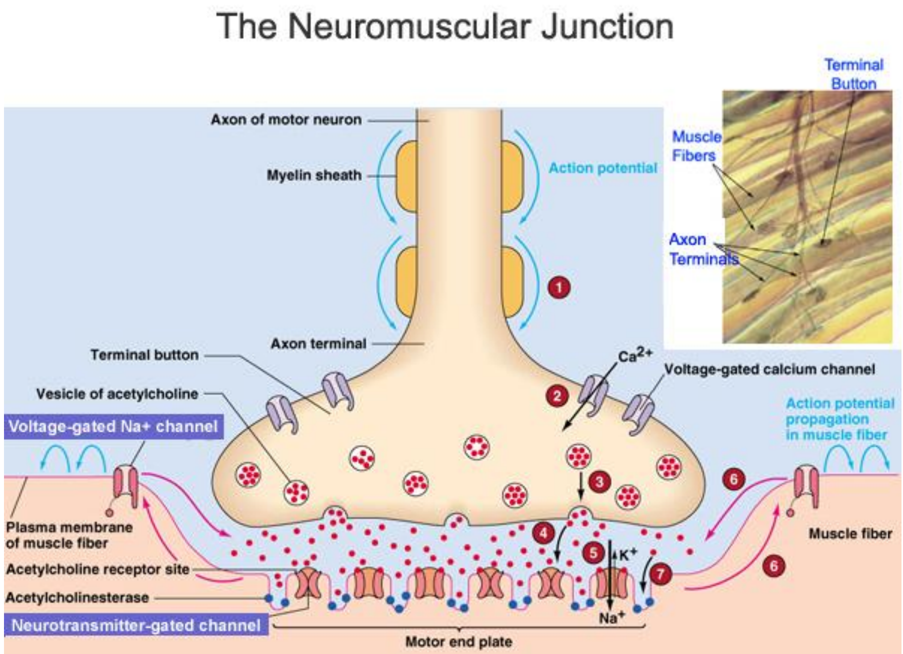
(*Received 19 February 1985*)

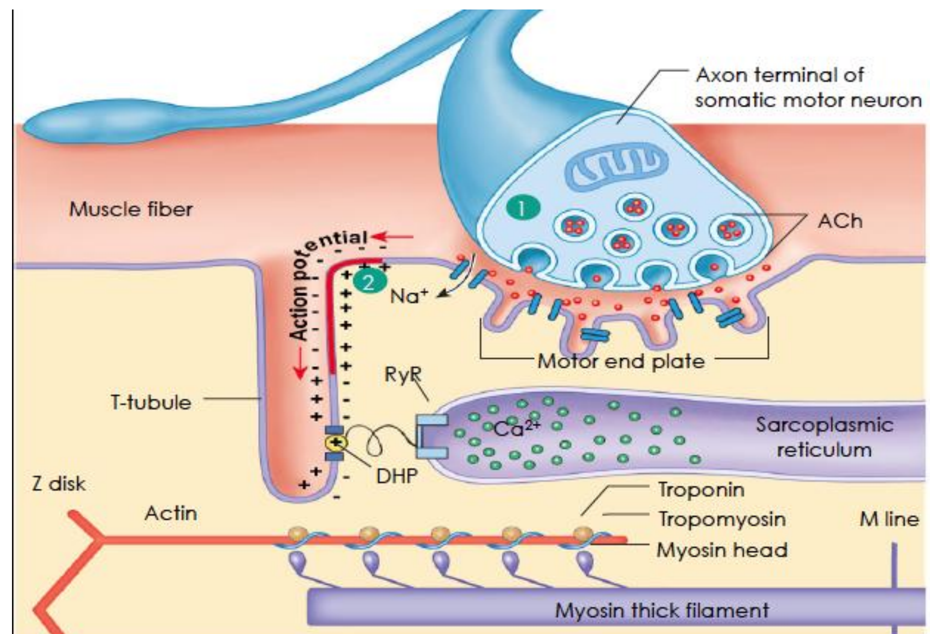
Why would you perform this test?

More Action Potential Propagation

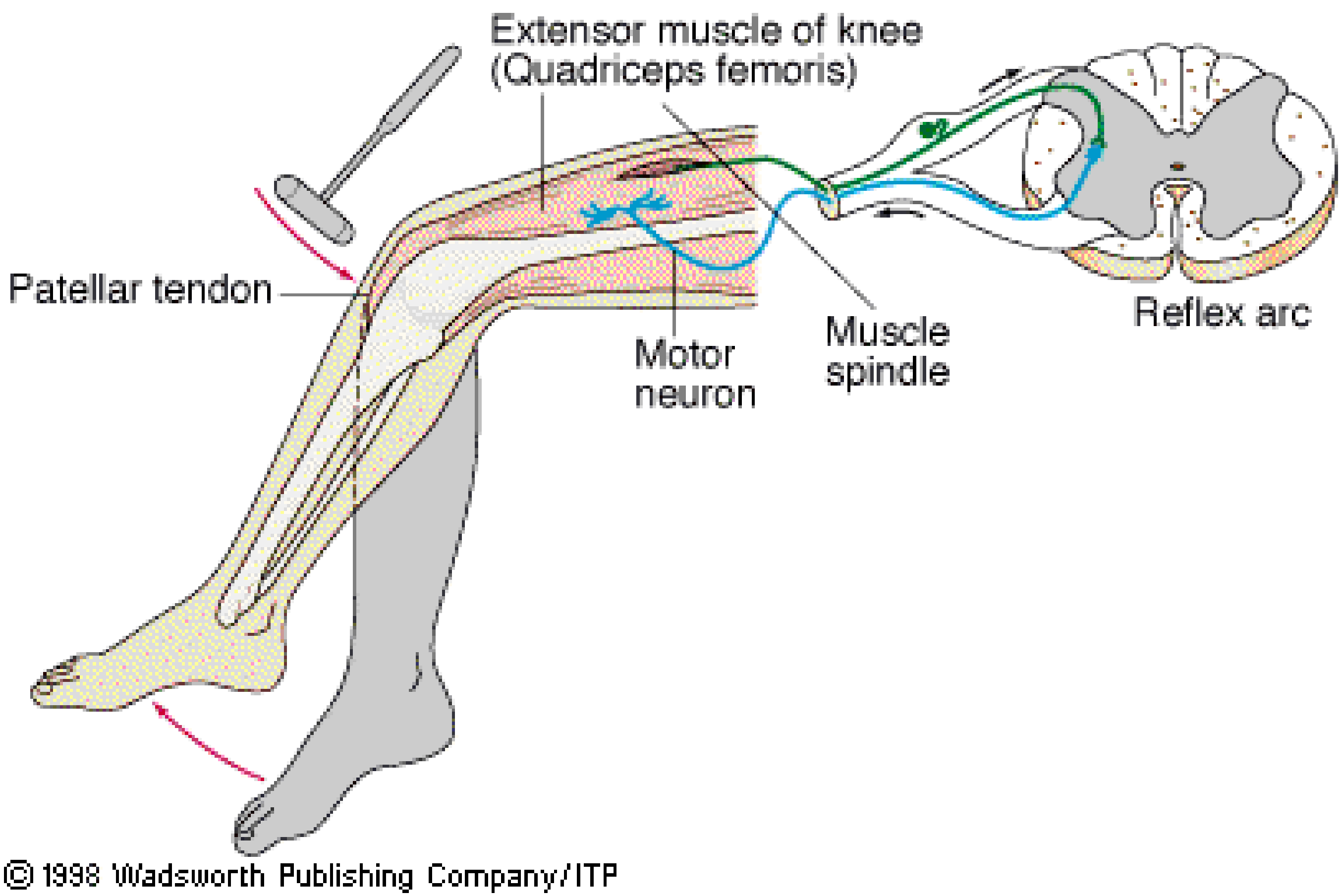


Electricity to Contraction

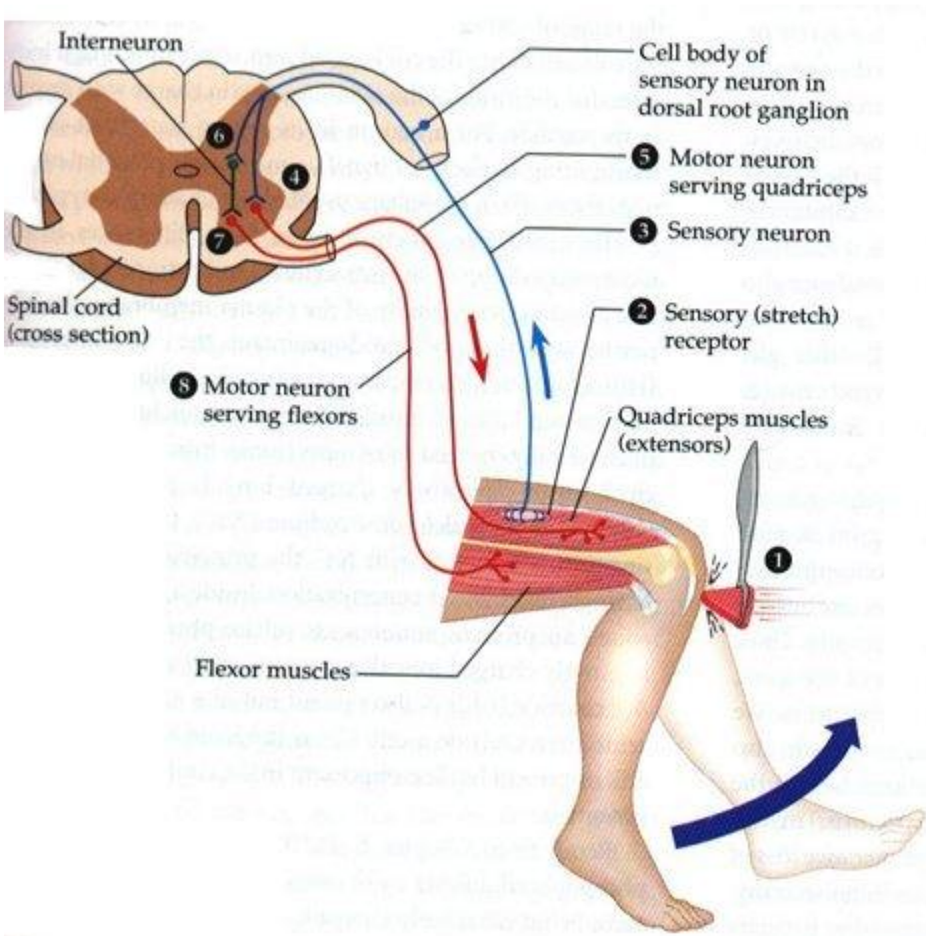




A Basic Circuit



Basic Circuit



More Synapses