

Smooth muscle structure and types, smooth muscle innervation and potentials

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Smooth Muscle

- Lack the cross-striated banding pattern “smooth”
- The nerves to them are part of the autonomic division of the nervous system rather than the somatic division
 - Not under direct voluntary control
- Uses cross-bridge movements between actin and myosin filaments to generate force, and calcium ions to control cross-bridge activity
 - organization of the contractile filaments are different

Smooth Muscle Cell

- No sarcomeres
- Thick myosin-containing filaments
- Actin-containing filaments
 - Tropomyosin (unknown function)
 - Troponin absent
 - Caldesmon
 - in some types
 - regulating contraction

Spontaneous Electrical Activity

- Spontaneous action potential generator cells
 - plasma membranes do not maintain a constant resting potential
 - gradually depolarize until they reach the threshold potential and produce an action potential
 - Following repolarization, the membrane again begins to depolarize
 - Rhythmic state of contractile activity
 - *Pacemaker potential*: membrane potential change occurring during the spontaneous depolarization to threshold

Spontaneous Electrical Activity

- Slow waves: The membrane potential drifts up and down due to regular variation in ion flux across the membrane
- Excitatory input is superimposed, slow waves are depolarized above threshold, and action potentials lead to smooth muscle contraction
- Pacemaker cells are found throughout the gastrointestinal tract

Nerves and Hormones

- No specialized motor end-plate region, entire surface covered with receptors
- Varicosities: postganglionic autonomic neuron branches
 - Filled with neurotransmitter
 - Released when an action potential passes the varicosity
- Some neurotransmitters enhance contractile activity, others decrease contractile activity
 - Skeletal muscles only excitation
- Receptors for hormones
 - Changes in contraction
- Local factors

Autonomic Innervation of Smooth Muscles

- Sympathetic and parasympathetic axons
 - Sympathetic → norepinephrine
 - Parasympathetic → acetylcholine
- Synapses en passant (*synapses in passing*)

Single Unit Smooth Muscles

- Synchronous activity; the whole muscle tissue responds to stimulation as a single unit
 - Gap junctions
 - Pacemaker cells
- The axon terminals are often restricted to the regions of the muscle tissue that contain pacemaker cells.
- The activity of the entire muscle tissue can be controlled by regulating the frequency of the pacemaker cells' action potentials
- Activation by stretch
- Intestinal tract, uterus, and small-diameter blood vessels

Multi Unit Smooth Muscles

- No or few gap junctions
- Each cell responds independently, and the muscle tissue behaves as multiple units
- Richly innervated
- The contractile response of the entire muscle tissue depends on the number of muscle cells that are activated and on the frequency of nerve stimulation
- The smooth muscles in the large airways to the lungs, in large arteries, and attached to the hairs in the skin