SMOOTH MUSCLE

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Learning Objectives

• At the end of the lecture the student should be able to:

  • Discuss the generation of action potential in smooth muscle.

  • Differentiate slow wave potential and spike potential.

  • Discuss the action potential with plateau.

  • Discuss the local tissue factors and hormones to cause smooth muscle contraction.
Review of previous lecture
Excitation-Contraction Coupling

[Diagram showing the process of excitation-contraction coupling, including the role of extracellular fluid, sarcoplasmic reticulum, Ca++ ions, CaM, MLCK, ATP, myosin, and actin.]
Latch Mechanism

At rest:
myosin cannot bind to actin in absence of light chain phosphorylation.

Cycling bridges:
myosin rapidly dissociates from actin upon binding ATP during each cycle.
Initial rise in muscle tension.

Latch bridges:
dephosphorylated myosin dissociates from actin very slowly producing slow bridge cycling.
Maintained tension tonic contraction.
ACTION POTENTIAL IN SMOOTH MUSCLE
Action Potential

Membrane Potentials in Smooth Muscle -50 to -60 millivolts,

(1) spike potentials

or

(2) action potentials with plateaus.
Figure 8-7. A, Typical smooth muscle action potential (spike potential) elicited by an external stimulus. B, Repetitive spike potentials, elicited by slow rhythmical electrical waves that occur spontaneously in the smooth muscle of the intestinal wall. C, Action potential with a plateau, recorded from a smooth muscle fiber of the uterus.
Spike Potential

Electrical stimulation,

Action of hormones

Action of transmitter substances

By stretch,

Spontaneous generation in the muscle fiber itself
Action Potential with Plateau

The onset is similar to that of the typical spike potential.

However, instead of rapid repolarization of the muscle fiber membrane,

the repolarization is delayed for several hundred millisecond to as much as 1 second.
Figure 8-7. A, Typical smooth muscle action potential (spike potential) elicited by an external stimulus. B, Repetitive spike potentials, elicited by slow rhythmic electrical waves that occur spontaneously in the smooth muscle of the intestinal wall. C, Action potential with a plateau, recorded from a smooth muscle fiber of the uterus.
Slow Wave Potential

In some smooth muscles, action potentials arise within the smooth muscle cells themselves without an extrinsic stimulus.

This often is associated with a basic slow wave rhythm of the membrane potential.
Slow Wave Potential

It is a local property of the smooth muscle fibers.

**CAUSE:**

1. Waxing & waning of the pumping of Na ions
2. Conductance of the ion channels increase & decrease rhythmically

**Pacemaker waves.**
Action Potential

Slow wave potentials

Pacemaker potentials
SINGLE MUSCLE TWITCH

**Figure 12-22** Duration of muscle contraction in three types of muscle. Skeletal muscle has the quickest contraction and relaxation time. Smooth muscle is much slower to contract and relax. Tension development in a cardiac muscle twitch is more like that in a skeletal muscle twitch than in a smooth muscle twitch.
Local tissue factors and hormones

- Role of calcium sodium and potassium channels
- Role of Oxygen, Carbon dioxide and hydrogen ions.
- Angiotensin, oxytocin, vasopressin
Review
Differentiate

- Action Potential in Skeletal Muscle
- Fast fibers
- EC coupling in skeletal Muscle
- Myasthenia gravis
- Spike potential
- Action potential in smooth muscle
- Slow fibers
- EC coupling in smooth muscle
- Rigor mortis
- Slow wave potential
Differentiate

- Complete tetanus
- Multiple fiber summation
- Isotonic contraction
- Single unit muscle
- Motor end plate
- Tetany

- Incomplete tetanus
- Frequency summation
- Isometric contraction
- Multi-unit muscle
- Motor unit
- Tetanus
Differentiate

- Calmodulin
- Muscle Hyperplasia,
- Or Atrophy
- Contraction in skeletal muscle
- Relaxation in skeletal muscle
- Contractile unit in skeletal muscle
- Calsequestrin
- Muscle Hypertrophy
- Contraction in smooth muscle
- Relaxation in smooth muscle
- Contractile unit in smooth muscle
Differentiate

- Structural and functional difference in skeletal and smooth muscle
Questions?