Nervous and hormonal control of smooth muscle contraction

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Learning objectives

- Define the nervous effect on smooth muscles
- Define the hormonal effects on smooth muscles
- Differentiate these effects from skeletal muscles
- Observe depolarization in smooth muscle cells *without action potential*

Nervous and Hormonal control of smooth muscle contraction

For **excitation** OR **inhibition** , Smooth muscle fibers have receptors both for nervous and hormonal effects

A difference from skeletal muscle fiber

Nervous control

- Neuro muscular junction in smooth muscle make a diffused junction
- Actual nerve ending is a few micrometer away from muscle cell membrane
- secretion of hormones and other transmitters are responsible for initiation of action potential

Neuro-muscular junction

Quiet different from skeletal muscle motor end plate

- In smooth muscle the nerve innervates the outer membrane only
- Shwan cells covering the axon of these nerve fibers have *varicosities*
- Some contains norepinephrin and some having acetyle choline, secrete accordingly

NM junctions in smooth muscle

- **Contact junctions** are formed just like a synaptic cleft in NM junction of skeletal muscle
- The vesicular membrane is 20-30 micrometer away from the muscle cell membrane

Excitatory and inhibitory substances

- Acetyle choline
- Norepinephrine
- Receptors difference

  (Beta 1&2 Alpha 1&2)

Mechanism of contraction

- Action potential
- Excitation by ***Stretch reflex*** (peristaltic waves)
- Depolarization by neurotransmitters directly without proper action potential (junctional potential)

Hormonal efects on contraction of smooth muscle

- **Local tissue chemical factors**
  i.e local blood flow control, pre-capillary sphincter *(vasomotion)*
- Effects of hormones on smooth muscle
  epi, norepi, acetyle ch, serot, vasopressin,, oxytocin, histamine etc

Effect of hormones

In excitation Na and Ca channels are opened just like electric action potential and in inhibition these channels are closed.

Excitatory chemical mediators

- Adenylate cyclase
- cAMP
- Cyclic guanocine monophosphate (cGMP)

Source of Ca to cause contraction

- From sarcoplasmic reticulum (caveolae)
- Extra cellular Ca level
- Ca pump is required to open in smooth muscle membrane, to move intracellular Ca then the muscle will be relaxed.

Mechanics of skeletal muscle contraction

- Multiple fibers (motor unit) summation, when contraction of all motor units taking place at one time
- Frequency summation and tetanization

Mechanics of skeletal muscle contraction

Muscle tone

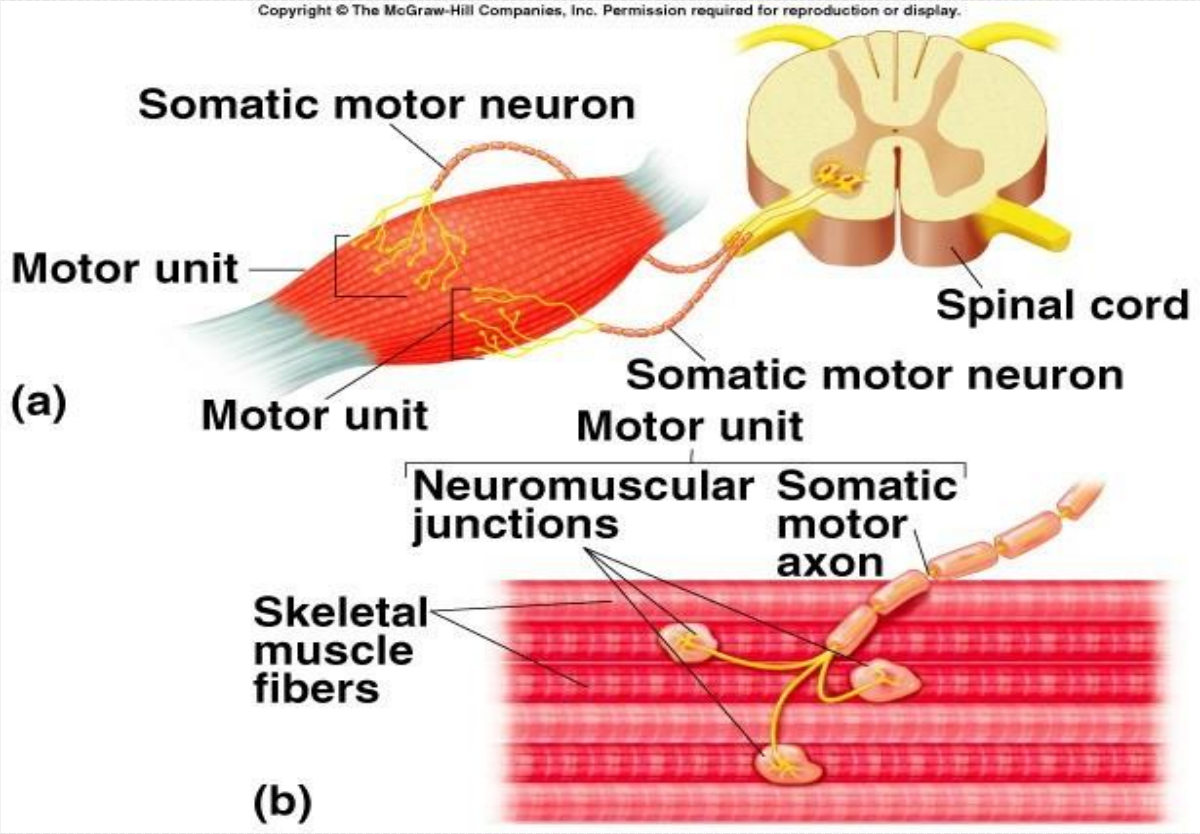
a. spinal card

b. locally from muscle spindle

(Lever system , agonist and antagonist) anatomy

Mechanics of skeletal muscle contraction

- Motor unit, structure



Adaptations of Muscles to Exercise Training (continued)

- All fibers adapt to endurance training:
  - Increase # of mitochondria.
- Endurance training produces an increase in type IIA fibers

- Muscle enlargement produced by:
  - Frequent periods of high-intensity exercise in which muscles work against high-resistance.
    - Type II fibers become thicker.
      - May split into 2 myofibrils.

MUSCLE CONTRACTION

- Work output during muscle contraction

$$W = L \times D$$

W- work output
L - load
D- distance

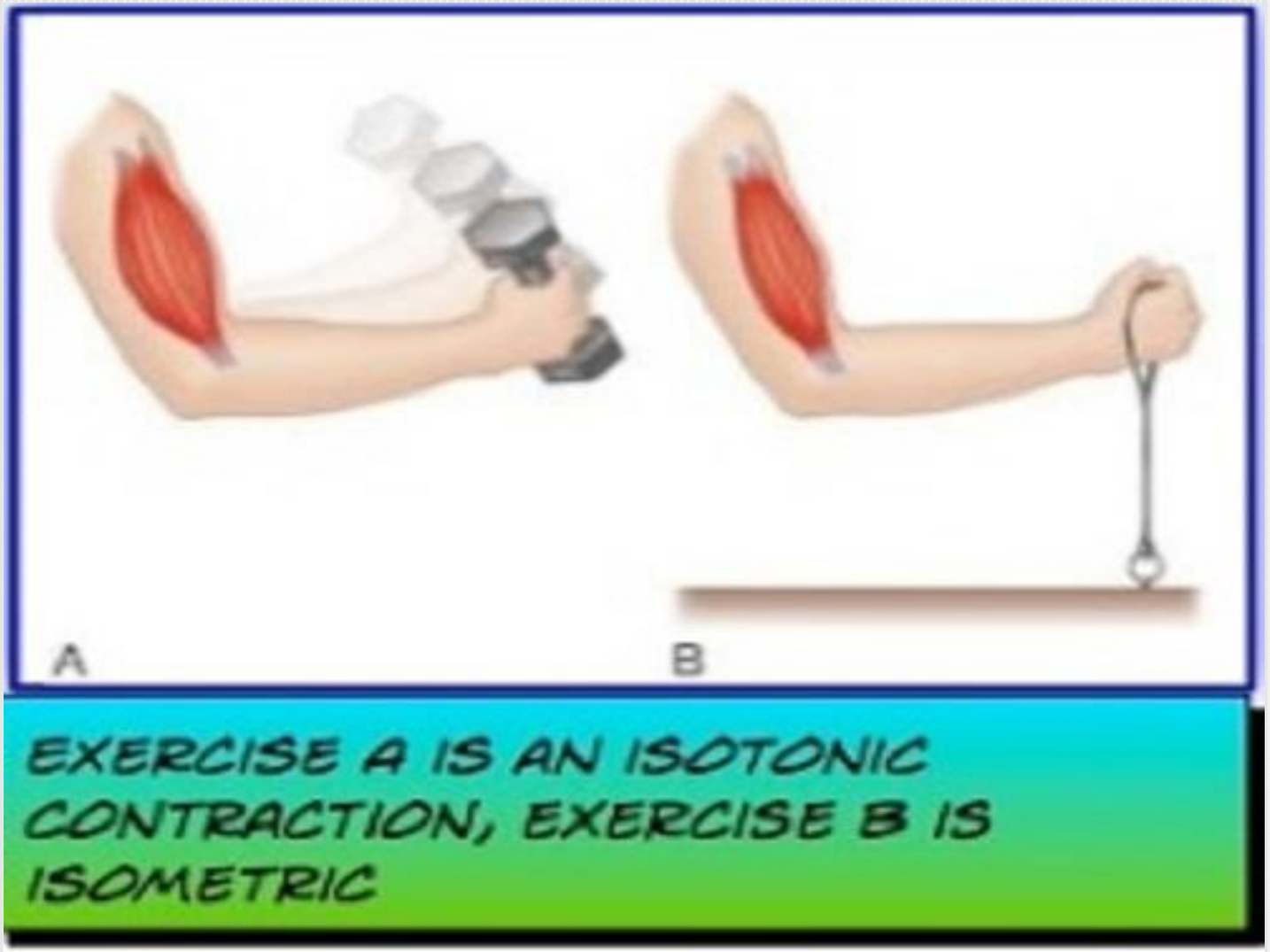
Characteristics of whole muscle contraction

- Isometric contraction
- Isotonic contraction

Isotonic, Isometric, and Eccentric Contractions

In an **isotonic contraction**, the muscles maintain the same **tension** as it shortens while in an **isometric contraction**, the muscle remains the same **length** as the tension changes

Isotonic and Isometric



Energy for the muscle contraction

ATP is required for

1. Actin myosin sliding
2. Ca++ from sarcoplasmic reticulum
3. Na+ and K+ pump in action potential

Sources of muscle energy

- ATP--dephophrylation-ADP—re-phosphorylation—ATP

- Sources of ATP

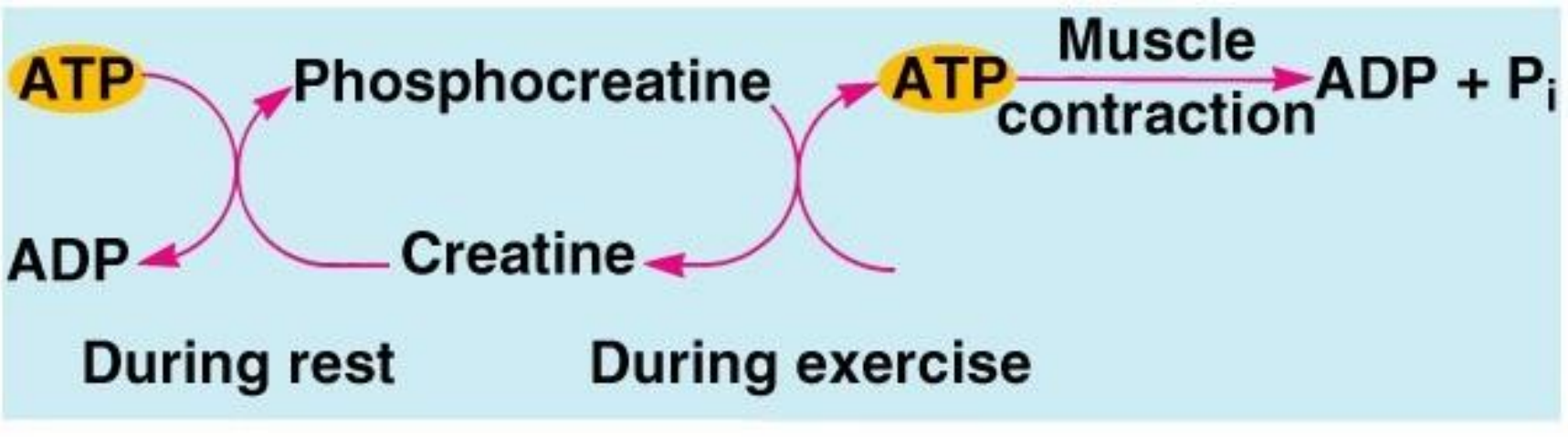
  a. From phopho-creatine in muscle 8 sec

  b. From glycolysis of glycogen 60 sec

  c. From Oxidative metabolism (C.A.C)

Metabolism of Skeletal Muscles (continued)

- Phosphocreatine (creatine phosphate):
  - Rapid source of renewal of ATP.
  - ADP combines with creatine phosphate.
- [Phosphocreatine] is 3 times [ATP].
  - Ready source of high-energy phosphate.



THANK YOU