**Muscle Review**

- Why is tension in tetanus > tension generated in a single twitch?

- SEC = all components “between” contractile component and load (e.g. tendon, Z disc, cross bridges, etc.)

- Takes time and energy to stretch SEC

- Calcium is so quickly re-sequestered into SR, that “active state” is decaying before a single twitch reaches its peak

**Energetics of muscle contraction**

- ATP needed for
  - Power stroke
  - Break cross bridge
  - Resequester calcium into SR

- Source of energy (Fig 10.13)
  - Phosphogens (stored ATP and creatine phosphate)
  - Anaerobic metabolism
  - Aerobic metabolism

**Anaerobic vs. aerobic path**

- Aerobic
  - Relies on oxygen delivery systems (lungs and cardiovascular)
  - High ATP yield/substrate
  - But slow max rate of ATP supply

- Anaerobic
  - No oxygen required
  - Lactic acid build up, use substrate fast
  - But high max rate of ATP supply
• Use aerobic pathways exclusively where need high endurance, sustainable, non-fatiguing, slow contraction (slow myosin-ATPase)
• Use anaerobic pathway for bursts of intense power output, easily fatigue, substrate used high and produce lactic acid.
• Recovery, oxygen debt
• What must be “recovered”?

Muscle fiber type
• Stain for 3 types
  – Fast glycolytic (IIa or IIx)
  – Fast oxidative (type IIa)
  – Slow oxidative (type I)
• One motor unit usually all of one type

Summary (see Table 10.1 in text)
• Fast glycolytic: anaerobic, short bursts, high intensity, high power output at infrequent intervals
• Slow oxidative: fatigue resistant, low power, sustained ability & postural.
• Fast oxidative-glycolytic: intermediate

FG vs. SO
• Speed: fast (~10 msec twitch) vs slow (100 msec)
• Power: high 100 g/cm² vs low 10 g/cm²
• Size: large (myofibril packed) vs small
• Myoglobin sparse (white) vs abundant (red)
• Capillaries: sparse vs dense
• Fuel: glycogen vs fat/glycogen
• Recruitment: late vs early

• Oxygen debt varies with exercise
Skeletal, cardiac and smooth muscle

- Why are cardiac and smooth so “slow”

Smooth Muscle

- Like skeletal: actin/myosin, cross bridges, calcium control
- Differ: small cells, no sarcomere, no T-tubule
- Excitation-contraction coupling: autonomic (+ or -), autorhythmic, hormonal (+ or -), stretch
- Time course: very slow and efficient

Smooth muscle (see Fig 10.19)

- Much “looser” structure than skeletal
- Thick and thin filaments
- Intermediate filaments
- Dense bodies
- Length/tension relationship
- Stretch --> realign (stress-relaxation response)
- Importance: line many distensible organs

Smooth muscle tone

- Skeletal tone= asynchronous firing of motor units
- Smooth muscle tone = graded contraction depends on level of calcium and # of cross bridges formed