Place the following steps in order of how a muscle contracts

1. a) Neuron releases a neurotransmitter to stimulate the muscle
2. e) Sarcoplasmic reticulum releases calcium ions
3. b) Myosin heads attach to the actin filaments
4. d) Myosin heads pull the actin filament together
5. c) ATP is converted to ADP when the myosin head changes shape pulling the actin filament
47. List the 4 functions of the muscular system

- Produce movement of skeleton
- Maintain posture and body position
- Stabilize joints
- Maintain body temperature
1. Which muscle is non-striated and involuntary? smooth
2. Which is striated and voluntary? skeletal
3. Which is striated and involuntary? cardiac

4. shorten and thicken: contractility
ability to stretch: extensibility
ability to respond to a stimulus: excitability
ability to resume normal length after stretching: elasticity

5. What is the connective tissue covering around a single muscle cell? endomysium
   Around fascicles? perimysium
   Around the outside of a muscle belly? epimysium
   That binds muscles to underlying tissues or to a larger functional group: fascia
6. The thick filament is composed of **myosin**. The thin filament is made of **actin**.

7. The two other proteins, **tropomyosin** and **troponin** are associated with the thin filament.

8. What thin filament protein has the binding site for myosin? **actin**

9. Which protein normally blocks the myosin binding site? **tropomyosin**

   What event causes the blocking protein to move from the myosin binding site?

   **Calcium binds to troponin**
10. What process begins when the nerve impulse reaches the axon terminal of the motor neuron?

Voltage gates open and Ca2+ comes in.

Calcium activates the enzyme that moves the neurotransmitter vesicles to the membrane. Neurotransmitter = Acetylcholine (ACh).

It is released into the synaptic cleft.

ACh binds to receptors on the muscle sarcolemma.

Neurotransmitters connect, stimulating the sodium channel(s) to open Na+ flows in... Then, if THRESHOLD is reached...
11. What is the first event that happens once the muscle cell has been stimulated?

Sarcoplasmic Reticulum releases Ca\textsuperscript{2+}

Ca\textsuperscript{2+} binds to troponin on the thin filament.

This forces tropomyosin to change shape (rotate), leaving the binding sites on the actin exposed.

12. What is the purpose of the sarcoplasmic reticulum?

Calcium storage

13. What event puts the myosin head into its high energy configuration?

ATP bound to the head converts to ADP and P (a Phosphate)
14. What is released from the myosin head complex when the myosin head pulls the actin.

**ADP and a phosphate**

15. What causes the myosin head to disengage from the binding site?

**ATP attaches and releases the head**

The myosin pulls the actin toward the center of what functional unit of muscle contraction?

**the sarcomere**
16. What 2 events are necessary for muscles to relax from a contraction? 
   **Runs out of ATP, Runs out of Calcium**

17. The most effective form of energy production occurs when your cells have access to plenty of **oxygen**?

18. Muscle cells will first use **ATP**, as energy (which will last **4-6** seconds). Next, they will “recharge” ADP using **creatine phosphate**; or (CP) this energy source will last~**20 seconds**.

19. When cells have used up the stored energy, they will start to use **anaerobic respiration**, which produces 2 ATP but also **lactic acid**.
20. Label the diagram to the right with: **fascicle, tendon, muscle fiber, endomysium, epimysium, perimysium**

21. Place the following words in order from largest to smallest: **fascicle, myofilament, myofibril, myofiber (muscle cell), sarcomere**

myofibril = bundle of myofilaments
22. Label the following: 
*sarcomere, myosin, tropomyosin, troponin* and actin

on the figure to the right.

23. Thick filament fibers in myofibrils are ____________________

while thin filaments are called ____________.

24. ____acetylcholine (ACh)_______ is the neurotransmitter that is released to stimulate skeletal muscle.

25. What two ions are exchanged when the neurotransmitter opens the gates on the membrane of the muscle fiber? ____Na+ & ____K+____.
26. What ion is stored by the sarcoplasmic reticulum and starts muscle contraction? **Ca+2**

27. (**Aerobic**/ Anaerobic) exercise would create the most amount of energy for muscle contraction.

28. The depletion of **oxygen** causes muscles to fatigue.

29. Muscles produce different amounts of force because of different numbers of muscle fibers contracting. (**True** or False)
30. Be able to explain the steps from an action potential traveling down an axon to the stimulation of a muscle cell across the neuromuscular junction.

1) **Action potential** travels down pre-synaptic axon.
2) **Voltage gates** open and **Calcium** enters
3) **ACh** is released into synaptic cleft
4) ACh binds to a **sodium channel** on the **sarcolemma**
5) Channel opens and Na+ flows in; more channels open for more Na+
6) **IF threshold is reached**...
7) Sarcolemma (membrane) **depolarizes** and the muscle gets the action potential

**WATCH THE VIDEO BELOW TO REVIEW!**

http://highered.mheducation.com/sites/0072495855/student_view0/chapter10/animation__function_of_the_neuromuscular_junction__quiz_1_.html
31. Poisons such as botulism that prevent the release of acetylcholine would cause muscles to **stiffen/become paralyzed.**

32. What cell organelle provides the ATP needed for muscle activity? **mitochondria**

33. The junction where the motor neuron and the muscle fiber meet is called **neuromuscular junction**

34. During a muscle contraction, cross-bridges from between what two structures? **myosin head and actin (binding site)**
35. Under normal conditions, the primary energy source for muscle contraction is: **ATP**

36. Vesicles in the axon terminals of a motor neuron store **ACh**

37. Sustained contraction of individual fibers, even when muscle is at rest is known as: **tetanus**

38. The model that explains how muscles contract is also called the _____.

   **Sliding Filament Theory**
39. What is a motor unit?

Motor neuron and all of the muscle cells it stimulates

40. Myofibrils are composed of actin and myosin

41. Tendons connect muscle to bone

42. Bundles of muscular fibers are called fascicles

43. Place the following in the correct order

3. Actin and myosin form links
1. Acetylcholine crosses the gap at the neuromuscular junction
2. Calcium is released into the sarcoplasm
4. Myosin cross-bridges pull actin filaments inward.
Part IV - Sliding Filament Theory

Describe the sliding filament theory of muscle contraction.

A stimulus at the motor end plate which travels throughout the muscle, causing Calcium (Ca$^{2+}$) to be released from the Sarcoplasmic Reticulum.

ATP is broken into ADP and P to release the energy needed to attach the Myosin head to the Actin, forming a cross-bridge. Ca$^{2+}$ binds to Troponin, changing its shape, which moves the Tropomyosin from the active site of the Actin. This is repeated all along the myofibril. The Myosin detaches from the Actin and the cross-bridge is broken when another ATP molecule binds to the Myosin head.

This process of muscular contraction can last for as long as there is enough ATP and Ca$^{2+}$. Once the contraction stops, the Ca+ is pumped back to the Sarcoplasmic Reticulum.