Part I. Multiple choice. 2 points each (18 points total). Only one option is correct for each question.

1. Tetanus (maximum summation) occurs in a muscle when
   A  rate of muscle stimulation is so fast that the Ca++ pump on the SR can’t keep up
   B  lactic acid accumulates
   C  creature phosphate is used up
   D  ATP is depleted

2. The most likely cause of muscle fatigue is:
   A  depletion of ATP
   B  acidic conditions from buildup of lactic acid
   C  loss of Ca++ from muscle cell
   D  buildup of Ca++ in cytosol

3. Which of these muscle fiber types is most likely to be found in the muscles used for standing and walking?
   A  slow oxidative
   B  fast glycolytic
   C  fast oxidative
   D  slow glycolytic

4. The sympathetic nervous system can regulate cardiac output by
   A  Increasing the rate of depolarization of the SA node and therefore increasing heart rate
   B  Increasing the contractile capacity of the heart and therefore increasing stroke volume
   C  increasing the length of heart muscle fibers (Starring’s law)
   D  Both A and B

5. The major mechanism for exchange of material between blood and tissues at capillaries is
   A  Bulk flow
   B  Diffusion
   C  Vesicular Transport
   D  Active Transport
6. Which ONE of the following is FALSE regarding bulk flow?

A  It is the mechanism of fluid exchange and fluid balance between blood and interstitial fluid.
B  Slightly more fluid is filtered than is reabsorbed; the remainder is reabsorbed by lymph vessels.
C  Osmotic pressure makes fluid want to move from the capillary to the interstitial fluid.
D  At the beginning of the capillary, hydraulic pressure makes fluid want to move from the capillary to the interstitial fluid.

7. Which one of the following is false regarding gas exchange?

A  A partial pressure gradient of O₂ at the alveoli makes O₂ diffuse from alveoli to pulmonary capillaries.
B  A partial pressure gradient of CO₂ in the tissues makes CO₂ diffuse from systemic capillaries to tissues.
C  The partial pressure of O₂ in the alveoli is approximately 100mmHg.
D  The partial pressure of CO₂ in tissues is approximately 46mmHg.

8. Which one of the following is FALSE regarding control of airway resistance and pulmonary blood flow?

A  Sympathetic stimulation causes bronchoconstriction.
B  If blood flow > airflow, lack of O₂ will cause vasoconstriction.
C  If airflow > blood flow, such as at the “top” of the lungs where capillaries are collapsed, lack of CO₂ will cause bronchoconstriction.
D  “Uneven” matching of airflow to blood flow throughout the lungs may be the cause of high altitude pulmonary edema (HAPE).

9. Central chemoreceptors in the medulla monitor blood gases in the following manner (which one is TRUE):

A  P₃O₂ is sensed directly by central chemoreceptors.
B  P₃CO₂ is not monitored except in “emergencies” – normally only P₃O₂ is monitored.
C  CO₂ crosses the blood brain barrier, is converted into H⁺ and HCO₃⁻, and H⁺ is sensed by the chemoreceptors.
D  If blood P₃CO₂ is too low, chemoreceptors tell the respiratory center to increase ventilation.
Part II. Short answer/fill in the blank. 3 points each, except where indicated (79 points total).

10. (6 points) Fill in the missing steps describing excitation-contraction coupling in skeletal muscle (see diagram below).

1. ACh binding generates an end plate potential (EPP) - this always causes an AP.
2. 
3. Ca++ channel on SR opens and releases Ca++ into cytosol
4. 
5. Myosin cross bridges bind to actin and stroke forward
6. When there is no longer an AP, 

11. In the absence of ATP (but presence of Ca++), cross bridge cycling comes to a halt. This is known as _____________

12. The two factors that contribute to tension of whole muscle are A. # of motor units that are active (recruitment) and B. the tension of each muscle fiber. The tension of each muscle fiber is a function of 1) summation, 2) fiber diameter, 3) ________________ and 4) _______________

13., 14., and 15. Fill in the missing parts of the table comparing skeletal vs. smooth vs. cardiac muscle (as promised!).

<table>
<thead>
<tr>
<th>APPEARANCE IN MICROSCOPE</th>
<th>SKELETAL</th>
<th>SMOOTH</th>
<th>CARDIAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXCITATION/CONTRACTION COUPLING</td>
<td>Ca++ dependent via troponin</td>
<td>Ca++ -dependent via calmodulin</td>
<td></td>
</tr>
<tr>
<td>NERVOUS CONTROL</td>
<td>somatic motor neurons</td>
<td></td>
<td>autonomic neurons</td>
</tr>
<tr>
<td>INITIATION OF CONTRACTION</td>
<td>input from motor neuron</td>
<td></td>
<td>initiated by autorhythmic cells</td>
</tr>
</tbody>
</table>
16. Fill in the missing step involved in a cardiac action potential in contractile myocardial cells (see diagram below).

1. Influx of Na+ through Na+ channels depolarizes the cell.
2. K+ channels open; K+ leaving repolarizes cell.

![Diagram of membrane voltage over time with steps labeled 1, 2, 3.]

17. (4 points) Fill in the missing steps involved in a cardiac action potential in a pacemaker cell (see diagram below).

1. Slow leak of Na+ allows membrane potential to drift toward threshold (funny channels are important for this step).
2. At threshold, L-type Ca++ channels open; Ca++ rushes in and depolarizes cell.
3. K+ channels open; K+ leaving repolarizes cell.
4. 

![Diagram of membrane voltage over time with steps labeled 1, 2, 3, 4.]

18. Fill in the following in the diagram of the cardiac cycle (on the following page):
   - Ventricular systole (write out systole in the space provided)
   - Ventricular diastole (write out diastole in the space provided)

19. Label the P wave, the QRS complex, and the T wave.

20. What electrical event in the heart does the P wave represent? 
What electrical event in the heart does the T wave represent? 

21. Indicate where heart sounds occur, using the space provided (use “lub” and “dup”).
What is the Stroke Volume (in ml)?
22. Cardiac Output (L/min) is a function of Stroke Volume (L/beat) X Blood Pressure = Cardiac Output X

23. Blood flow through a tissue is function of pressure gradient and resistance. Resistance is a function of vessel length, ________________, and ________________.

24. \( \frac{1}{r^4} = R \), where \( r \) = radius of arteriole and \( R \) = resistance. What does this equation mean?

25. In local control of blood flow to tissues, the accumulation of factors such as K+, acid (lactic acid), and CO², as a result of high metabolic activity, causes release of the paracrine hormone ________________ from endothelial cells, which results in ________________ (vasodilation or vasoconstriction).

26. The sympathetic nervous system influences which tissues get high vs. low blood flow. In tissues with primarily alpha receptors, NE causes ________________ (vasodilation or vasoconstriction), to increase mean arterial blood pressure. In tissues with primarily beta-2 receptors, such as heart and ________________, the adrenal hormone ________________ causes vasodilation to increase flow to these tissues.

27. The hormone erythropoietin is released by the kidneys in response to _____, and causes ________________
28. What is the function of pulmonary surfactant?

29. In the drawing below, is inspiration or expiration about to occur? What is the approximate pressure (mmHg) of the pleural space?

Atmos. P = 760mmHg

761mmHg

Use the Hb saturation curve below to answer the following questions.

30. Does a P_{o2} of 100mmHg (such as at alveoli) favor loading or unloading of Hb? If the P_{o2} drops to 85mmHg (such as in alveoli at moderately high altitude), will % saturation of Hb change a little or a lot?

31. Consider metabolically active skeletal muscle with a P_{o2} of 35mmHg. Will Hb be loaded or unloaded? In this skeletal muscle, a considerable amount of acid (H+ from lactic acid) is being generated. This will right-shift the curve (Bohr effect) to facilitate (loading or unloading).

32. Carbon dioxide is transported in the blood in three forms: 1) dissolved in plasma, 2) bound to Hb, and 3)

The following questions are based on this chemical equation:

\[ \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 \rightarrow \text{H}^+ + \text{HCO}_3^- \]

33. This reaction is catalyzed by the enzyme in red blood cells.
HCO₃⁻ leaves the red blood cells, and the ion ________ enters so there is no change in membrane potential.

34. What happens to the H⁺ remaining in the red blood cells? ____________________________

Part III. Describe and/or illustrate. Points as indicated (13 points total).

35. (Sorry, no choices here; 7 points). Using illustrations, describe cross-bridge cycling in skeletal muscle. Assume that both ATP and Ca++ are present. Begin with cleavage of ATP by the myosin head.

36. (6 points) Choose one of the following. Please indicate your choice.
A  Draw the baroreceptor reflex as a negative feedback loop.
B  Describe the pathway (all the nodes and so forth) of the action potential as it spreads through the heart.

Extra Credit: The latest fad in Hollywood is the “oxygen bar” -a restaurant that serves pure oxygen at $13.00 for 20 min. of breathing; proponents of the fad claim it to be “revitalizing”. Do you think this is reasonable or ridiculous? Explain your answer based on your understanding of oxygen diffusion and transport.