1. What is the name of the lung volume or capacity which remains in the lungs at the end of a maximal expiration?

The residual volume

2. Explain the mechanism which is responsible for the flow of gas out of the lungs during expiration.

When the inspiratory muscles collapse the elastic recoil of the lungs compresses the gas in the alveoli which raises intra-alveolar pressure above atmospheric pressure and produces the pressure gradient which causes gas to flow out of the lungs.

3. What type of gas, fresh air or alveolar gas, first enters the alveoli during inspiration?

Alveolar gas

4. Write the equation which defines alveolar ventilation and define each of the terms in the equation.

Definition of alveolar ventilation

\[ V_A = (V_T - V_D)f \]

Term #1

\( V_T \) is the tidal volume, the volume of gas exhaled per breath

Term #2

\( V_D \) is the dead space volume, the volume of gas contained by the airways

Term #3

\( F \) = frequency of ventilation
5. Why does the FEV 1 sec decrease during an asthmatic attack?

**Because during an asthmatic attack the patient has a very high airway resistance which impedes the flow of gas**

6. Define partial pressure.

**The pressure exerted by one gas contained within a mixture of gases**

7. What are the normal values for the following?

   A. The partial pressure of oxygen in the alveoli (P\textsubscript{A\textsubscript{O}2})
      \[ \_105 \_ \text{mm Hg} \]

   B. The partial pressure of carbon dioxide in the alveoli (P\textsubscript{A\textsubscript{CO}2})
      \[ \_40 \_ \text{mm Hg} \]

   C. The partial pressure of oxygen in venous blood (P\textsubscript{V\textsubscript{O}2})
      \[ \_40 \_ \text{mm Hg} \]

   D. The partial pressure of carbon dioxide in venous blood (P\textsubscript{V\textsubscript{CO}2})
      \[ \_46 \_ \text{mm Hg} \]

8. Define the term, hypoventilation.

   \[ P\textsubscript{A\textsubscript{CO}2} > 40 \text{ mm Hg} \]

9. Sketch an oxyhemoglobin dissociation curve in the space provided and place a point on the curve which shows the point at which the red cells would be operating as they leave the pulmonary capillaries.
10. Explain the effect of a pulmonary shunt on the partial pressures of oxygen and carbon dioxide of arterial blood.

The shunt blood is venous type blood so when it mixes with pulmonary end-capillary blood it decreases the PO$_2$ from 105 to 100 mm Hg. Usually there is no change in PCO$_2$.

11. How must a patient who has emphysema exhale?

They must perform forced expiration.

12. Compare the tidal volumes and respiratory frequencies of a person who has restrictive lung disease with a normal person.

The person will have a smaller tidal volume and a higher ventilatory frequency than do normal people.

13. If 100 mg of glucose are dissolved in 1 liter of water, what is the concentration of glucose in the mixture?

\[ \frac{100}{1} \text{ Mg/Liter} \]

14. What are the two determinants of mean blood pressure?

Cardiac output
Total peripheral resistance
15. What are the positions, open or closed, of the aortic and mitral valves during ventricular filling?

   Aortic Valve Closed

   Mitral Valve Open

16. In what structure do the action potentials which activate the heart originate?

   SA node

17. What ion binds to troponin and initiates cross bridge cycling?

   Ca^{++}

18. Define isometric contraction.

   Muscle contraction with no shortening

19. Draw a pressure-volume loop which shows the effect of a decrease in contractility.

   ![Pressure-volume loop](image)

20. Why is the resistance of the capillaries as a group, less than the resistance of the large arteries, as a group?

   The total crosssectional area of the capillaries is greater than the total crosssectional area of the large arteries.

21. What reflex mechanism is used to increase cardiac output back toward normal during hemorrhage?

   The baroreceptor reflex initiated by the fall in mean blood pressure produces a reflex increase in heart rate and contractility.
22. What mechanism is responsible for the decrease in total peripheral resistance which occurs during aerobic exercise?

The accumulation of metabolic waste products, such as lactate, which causes vasodilation.
23. A normal person is given 1 liter of isotonic NaCl (290 mOsm) intravenously. Indicate how each of these variables will change (increase, decrease, or no change) as a result of receiving the intravenous salt solution. Assume that any osmotic movement of water across the cell membrane has already occurred, but that the kidneys have not yet excreted anything.

A. total body water content increase
B. osmolarity of the extracellular fluid (ECF) no change
C. osmolarity of the intracellular fluid (ICF) no change
D. volume of the extracellular fluid (ECF) increase
E. volume of the intracellular fluid (ICF) no change

24. Membrane Potential.

A. Is the normal resting potential of a nerve cell closer to \( E_K \) (the Nernst equilibrium potential for K\(^+\)) or \( E_{Na} \) (the Nernst equilibrium potential for Na\(^+\)) ? Circle one.

**Closer to \( E_K \) \hspace{1cm} \text{Closer to } E_{Na}**

B. If the transference of Na\(^+\) increases and the transference of K\(^+\) decreases, in which direction will the membrane potential, \( E_m \), change? Circle one.

\( E_m \) will move towards \( E_K \) \hspace{1cm} \( E_m \) will move towards \( E_{Na} \)

25. In a nerve action potential,

A. What causes the gates on the Na\(^+\) channels to open and cause an action potential?

*Depolarization opens the activation gates.*

B. Once the Na\(^+\) channels open, why don’t they stay open?

*Depolarization closes the inactivation gates, after a slight delay. The channel is only open when both gates are open.*
26. Answer the following questions about the neuromuscular junction by indicating whether the event takes place on the nerve terminal or on the muscle cell. Circle one.

A. opening of Ca\textsuperscript{2+} channels \hspace{1cm} nerve \hspace{1cm} muscle

B. release of acetylcholine by exocytosis \hspace{1cm} nerve \hspace{1cm} muscle

C. binding of acetylcholine to its receptor \hspace{1cm} nerve \hspace{1cm} muscle

D. opening of a channel permeable to Na\textsuperscript{+} and K\textsuperscript{+} \hspace{1cm} nerve \hspace{1cm} muscle

E. synthesis of acetylcholine \hspace{1cm} nerve \hspace{1cm} muscle

27.

28. (This is question 27 and 28 combined. It counts 10 points.) Which component of the nephron is responsible for each of these functions? Choose from the list below. Each component can be used more than once. (2 pts. each)

- proximal tubule
- thick ascending limb of the loop of Henle
- collecting ducts

A. reabsorption of glucose \hspace{1cm} proximal tubule

B. reabsorption of NaCl without reabsorption of water \hspace{1cm} thick ascending limb

C. reabsorption of isotonic NaCl \hspace{1cm} proximal tubule

D. reabsorption of water, controlled by ADH \hspace{1cm} collecting ducts

E. reabsorption of Na+, controlled by aldosterone and ANF \hspace{1cm} collecting ducts

29. If a normal red blood cell has a volume of 20 µ\textsuperscript{3} in a 290 mOsm NaCl solution, what will its steady-state volume be after it is placed in a large volume of 250 mOsm NaCl solution? Show all your work.

\[ \pi_1 V_1 = \pi_2 V_2 \]

23.2 µ\textsuperscript{3}
30. Starling forces explain the fact that water is filtered out of the glomerular capillaries while the peritubular capillaries reabsorb water.

A. Which is greater, the hydrostatic pressure (P) in the glomerular capillaries or the hydrostatic pressure in the peritubular capillaries?

Hydrostatic pressure is greater in the glomerular capillaries.

B. Which is greater, the oncotic pressure (π) in the glomerular capillaries or the oncotic pressure in the peritubular capillaries?

Oncotic pressure is greater in the peritubular capillaries.

31. If the plasma Na+ concentration is 142 mM and the plasma glucose concentration is 1 mg/ml, what will be composition of the fluid filtered into the tubules (Bowman’s space)?

A. The fluid filtered into the tubules will have a Na+ concentration of about _______142____ mM.

B. The fluid filtered into the tubules will have a glucose concentration of about _______1____ mg/ml.

32. If a woman has a glomerular filtration rate (GFR) of 125 ml/min and her plasma glucose concentration is 4 mg/ml,

A. What is her filtered load of glucose?  
500 mg/min

B. If her maximum glucose reabsorption rate is 375 mg/min, will glucose be present in her urine?  Circle one.

Yes
No

33. True or False: The kidneys can regulate the osmolarity of the extracellular fluid faster than they can regulate the volume of the extracellular fluid.

True False

34. If a person with uncontrolled diabetes mellitus has glucose in his urine, would you expect him to produce a large volume of urine (high urine flow rate) or a normal volume of urine (normal urine flow rate)?

high urine flow rate normal urine flow rate
Explain your answer:

Unreabsorbed glucose acts as an osmotic diuretic, holding water in the tubular fluid. Therefore, less water reabsorbed.

35. True or False: In the kidneys of a normal person, the osmolarity of the tubular fluid leaving the proximal tubule and entering the descending limb of the loop of Henle is about the same as that of the initial glomerular filtrate.

   True  False

36. In central diabetes insipidus, the plasma ADH concentration is lower than it should be. What effects does this have on the urine produced? (Circle your answers.)

   A. The volume of urine produced will be: high  low  normal

   B. The osmolarity of the urine produced will be: high  low  normal

37. Circle the correct choice (increased or decreased):

   Low extracellular fluid volume will lead to increased decreased secretion of the hormone aldosterone.

38. If a person takes a medicine known as an angiotensin converting enzyme inhibitor, what effect will this have on the secretion of aldosterone?

   More aldosterone will be secreted.  Less aldosterone will be secreted.
39. Fill in the blanks using “relax” or “contract”.

When the bladder fills to the point that there is a sensation of fullness, the micturition reflex causes the smooth muscle in the walls of the bladder to ______ contract _______ and causes the smooth muscle in the internal urethral sphincter to ______ relax _______.

40. What organ secretes ANF into the blood, what effect does ANF have on Na+ reabsorption, and what is the stimulus for ANF secretion?

A. ANF is secreted by ______ the heart _______.

B. ANF increases decreases Na+ reabsorption.

The stimulus for ANF secretion is increased stretch on the atria because of increased blood volume.