PHYSIOLOGY EXAMINATION
Unit Exam #3
December 11, 2001
1:30 PM-4:30 PM

Directions: Select the one best answer and fill in the space below the corresponding letter on the answer sheet. Commonly used respiration, renal, and acid base information is located on the previous page.

Respiratory Physiology Questions

(Unless otherwise noted, assume an upright, healthy lung at sea level conditions)

1. Hypercapnia (increased PaCO₂)
   A) occurs during moderate exercise.
   B) causes an increase in arterial pH.
   C) stimulates both the carotid body and central chemoreceptors
   D) signifies hyperventilation.
   E) all of the above are correct

2. O₂ content in blood is
   A) normally higher than O₂ capacity in arterial blood.
   B) independent of O₂ saturation.
   C) increased in anemic patients.
   D) a function of O₂ capacity and O₂ saturation.
   E) higher in venous blood than in arterial blood.

3. The carotid body chemoreceptors
   A) increase their firing rate when PO₂ drops below 65 torr.
   B) are more responsive to reduced O₂ saturation than reduced PO₂.
   C) increase their firing rate in response to sustained hyperventilation.
   D) are stimulated by increased pH.
   E) play a minor role in mediating hyperventilation at high altitude.

4. The partial pressure of O₂
   A) is higher in alveoli at the top of the lung than at the bottom.
   B) decreases in arterial blood during hyperventilation.
   C) is near zero in venous blood.
   D) seldom equilibrates between the alveolus and the pulmonary capillary.
   E) decreases in upper airways during the last half of inspiration.

5. The recoil of the lung
   A) decreases during inspiration.
   B) increases in patients with severe emphysema.
   C) provides the energy for resting expiration.
   D) is unaffected by increased surface tension in the alveoli.
   E) All of these answers are correct.
6. Functional Residual Capacity (FRC)
   A) decreases during a prolonged asthma attack
   B) is measured at the end of a normal inspiration.
   C) is unaffected by a reduction in the recoil properties of lung.
   D) is measured with simple spirometry.
   E) is normally increased during severe emphysema.

7. A ventilation-perfusion ratio of < 1 (V_a/Q < 1)
   A) leads to an increase in arterial PO_2.
   B) occurs as a result of ventilation exceeding perfusion in the pulmonary system.
   C) causes an elevated alveolar PO_2 at the top of the lung.
   D) leads to a “shunt-like” condition.
   E) is normally found at the top of the lung.

8. During acclimatization to high altitude (>16,000 ft above sea level)
   A) the O_2 saturation curve shifts to the left because of acidification of arterial blood.
   B) arterial PCO_2 increases.
   C) there is a persistent hyperventilation that is mediated by the central chemoreceptors.
   D) the O_2 carrying capacity in the blood increases.
   E) 2,3-DPG levels in the RBC decrease.

9. Carbon monoxide (CO)
   A) transfer from alveoli to blood is perfusion-limited.
   B) exerts a high partial pressure even when breathing sub-lethal levels.
   C) shifts the O_2 saturation curve to the left.
   D) diffuses slowly between alveoli and pulmonary capillary blood.
   E) is released from hemoglobin at relatively low PO_2 (<100 torr).

10. Which one of the following statements is false?
    A) Sympathetic-like agents lead to dilation of airways.
    B) The carotid body senses changes in PO_2 and PCO_2 in arterial blood.
    C) The central chemoreceptors (located in brain) sense changes in PCO_2 (H^+).
    D) The pulmonary stretch receptors are stimulated by increased lung volume.
    E) Breathing supplemental O_2 at sea level greatly facilitates O_2 saturation.

11. Using the following information, calculate the partial pressure of alveolar PO_2
    \( P_B = 760 \text{ torr}; \quad \text{PaCO}_2 = 64 \text{ torr}; \quad R = 0.8 \)
    A) 25 torr
    B) 100 torr
    C) 115 torr
    D) 51 torr
    E) 69 torr

12. The data in question 11 indicate that the person most likely
    A) is undergoing the initial stages of acclimatization to altitude.
    B) is hypoventilating.
    C) has respiratory alkalosis.
    D) is performing moderate exercise.
    E) has an O_2 saturation less than 50%.
13. All of the following concerning intrapleural pressure are true, EXCEPT:
   A) is more subatmospheric at the top of the lung that at the bottom of lung.
   B) becomes less negative (less subatmospheric) during expiration.
   C) can become positive during a maximal forced expiration.
   D) decreases (becomes more subatmospheric) in diseases that reduce the recoil properties of lung.
   E) is determined by the opposite recoil forces of lung and chest wall.

14. The partial pressure of oxygen (PO\textsubscript{2})
   A) is higher in the conducting airways than in the alveoli at the end of inspiration.
   B) is higher in alveoli with V\textsubscript{A}/Q <1 than in alveoli with V\textsubscript{A}/Q > 1.
   C) has a linear relationship with hemoglobin O\textsubscript{2} saturation (i.e. the O\textsubscript{2} saturation curve)
   D) is reduced in alveoli by hyperventilation.
   E) is unchanged regardless of altitude.

15. An A-a (alveolar-arterial) gradient for PO\textsubscript{2}
   A) can occur as the direct result of a V\textsubscript{A}/Q mismatch that resembles a “shunt-like” effect.
   B) does not result from hypoventilation.
   C) can occur from a true anatomical shunt and is not fully corrected by breathing supplemental O\textsubscript{2}.
   D) is present at some level even in the healthy lung.
   E) all of the above are correct

16. During moderate exercise (prior to production of lactic acid)
   A) arterial PO\textsubscript{2} decreases.
   B) increased ventilation is dependent upon input from the carotid body chemoreceptors.
   C) the pH in arterial blood decreases.
   D) both the arterial PCO\textsubscript{2} and PO\textsubscript{2} remain unchanged.
   E) chemoreceptors in the venous circulation stimulate breathing.

17. Which one of the following statements is true?
   A) CO\textsubscript{2} is transported mostly in the dissolved form.
   B) The vital capacity cannot be measured by simple spirometry.
   C) The resistance to air flow is higher during expiration than inspiration.
   D) Alveolar pressure is higher than atmospheric pressure at the end of inspiration.
   E) Respiratory compensation for metabolic acidosis is hypoventilation.

18. The rate at which O\textsubscript{2} diffuses from the alveoli to blood is
   A) lower at high altitude than at sea level.
   B) unaltered in patients with diffusion impairments.
   C) faster than the rate of diffusion for CO (at same partial pressure gradient).
   D) normally too slow to reach equilibrium.
   E) unrelated to its solubility coefficient.

19. Alveolar ventilation
   A) is increased when breathing frequency doubles with no change in minute ventilation.
   B) is subtracted from dead space ventilation to determine minute ventilation.
   C) is the volume of the conducting airways multiplied by breathing frequency.
   D) is greatest at the top of the lung.
   E) and PaCO\textsubscript{2} are inversely related
20. Saturation of hemoglobin with O₂ is
   A) a function of the hemoglobin concentration.
   B) approximately 70% in mixed venous blood (in the pulmonary artery) of the healthy lung at sea level.
   C) inversely related to PaO₂.
   D) unaffected by carbon monoxide.
   E) lower in anemic patients.

21. All of the following statements are true EXCEPT:
   A) Pulmonary surfactant reduces surface tension in the alveoli.
   B) PAO₂ can exceed PIO₂ when breathing supplemental O₂.
   C) Most CO₂ is transported in the form of plasma HCO₃⁻.
   D) Functional residual capacity (FRC) normally increases during a sustained asthma attack.
   E) Venous blood is more acidic than arterial blood

Renal Physiology Questions

22. The glomerular filtration rate (GFR) in a healthy 70 kg individual will
   A) decrease if the afferent arteriole dilates.
   B) increase if the ultrafiltration coefficient (Kₒ) increases while in filtration pressure equilibrium.
   C) be approximately three times higher than the clearance of sodium on a high sodium diet (350 mEq/day).
   D) increase if tubular flow rate past the macula densa is reduced.
   E) increase more following a meal with little protein compared with a meal containing a large amount of protein.

23. Which one of the following statements concerning inulin is correct?
   A) With a fixed infusion rate of inulin, if the plasma concentration of inulin increases, the clearance of inulin must have increased.
   B) With a fixed infusion rate of inulin, if the plasma inulin concentration increases, the amount of inulin excreted must have increased.
   C) The clearance of inulin increases as the GFR decreases.
   D) With a fixed infusion rate of inulin, the plasma concentration of inulin increases as the GFR increases.
   E) None of the above is correct.

24. Which one of the following statements regarding renal blood flow (RBF) is correct? In a steady-state RBF
   A) can be calculated from only the clearance of inulin.
   B) increases as renal perfusion pressure decreases.
   C) is determined by the pressure gradient (arterial blood pressure minus renal venous blood pressure) and by renal vascular resistance.
   D) can be calculated from only the clearance of p-aminohippurate.
   E) minus the GFR is equal to renal blood flow in the renal vein.
25. Which one of the following equations best describes the dynamics of the glomerular filtration rate (GFR)? $K_f = \text{the ultrafiltration coefficient}$, $BP = \text{blood pressure}$, $HP = \text{hydrostatic pressure}$, $BS = \text{Bowman's space}$, $\text{cap} = \text{capillary}$, $COP = \text{colloid osmotic pressure}$, an * indicates that it is an average value along the glomerular capillary and $\Delta P = BP_{\text{cap}} - HP_{BS}$.

A) $\text{GFR} = K_f \left[ (BP_{\text{cap}}^{*} + HP_{BS}^{*}) - (COP_{\text{cap}}^{*} + COP_{BS}^{*}) \right]$

B) $\text{GFR} = K_f \left[ (BP_{\text{cap}}^{*} + COP_{\text{cap}}^{*}) - (HP_{BS}^{*} + COP_{BS}^{*}) \right]$

C) $\text{GFR} = K_f \left[ (BP_{\text{cap}}^{*} - HP_{BS}^{*}) + (COP_{\text{cap}}^{*} - COP_{BS}^{*}) \right]$

D) $\text{GFR} = K_f \left[ (\Delta P^{*} + COP_{\text{cap}}^{*}) \right]$

E) $\text{GFR} = K_f \left[ BP_{\text{cap}}^{*} - HP_{BS}^{*} - COP_{\text{cap}}^{*} + COP_{BS}^{*} \right]$

Use the following steady-state data obtained from 2 male patients at age 20 and then again at age 70 to answer questions #26-27 (assume the clearance of creatinine and inulin are equal):

<table>
<thead>
<tr>
<th></th>
<th>$U_{\text{inulin}}$</th>
<th>$V$</th>
<th>$P_{\text{inulin}}$</th>
<th>$P_{\text{Creatinine}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Age 20)</td>
<td>100</td>
<td>1.0</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>(Age 70)</td>
<td>140</td>
<td>1.4</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td><strong>Patient 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Age 20)</td>
<td>180</td>
<td>1.2</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>(Age 70)</td>
<td>51</td>
<td>1.7</td>
<td>1.3</td>
<td></td>
</tr>
</tbody>
</table>

26. With regard to patient #1

A) his production rate of creatinine was higher at 70 than at 20 years of age.
B) his GFR was lower at 70 compared to 20 years of age.
C) the amount of creatinine he excreted was 0.7 mg/min at age 70.
D) his GFR cannot be calculated at either age.
E) the amount of creatinine he produced was 0.13 mg/min at age 20.

27. Patient #2 has a

A) higher creatinine production rate at 70 compared to 20 years of age.
B) higher filtered Na load at 70 compared to 20 years of age if his plasma Na concentration is the same at both ages.
C) a higher GFR at 70 compared to 20 years of age.
D) a higher GFR at 70 compared with that of patient #1 at 70 years of age.
E) a $U/P$ inulin ratio of 150/1 at 20 years of age if his urine flow rate is 1 ml/min.

28. A male diabetic patient has a tubular maximum ($T_M$) for glucose of 360 mg/min. He has not taken his insulin resulting in a plasma glucose concentration of 250 mg%. If his GFR is 100 ml/min, based on these data and on your knowledge of the renal handling of glucose, which of the following statements is correct?

A) The amount of glucose filtered by this patient is 360 mg/min.
B) The amount of glucose reabsorbed by this patient is 360 mg/min.
C) This patient would likely have glucose in his urine.
D) The calculated renal glucose threshold in this patient is 250 mg%.
E) The renal extraction of glucose in this patient would be about 1.0.
To answer question 29, use the following data obtained from a 20 year old man and from the same man at 80 years of age.

<table>
<thead>
<tr>
<th></th>
<th>20 years</th>
<th>80 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>V (liters/day)</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Plasma creatinine (mg%)</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td>Creatinine production rate (g/day)</td>
<td>1.728</td>
<td>1.152</td>
</tr>
</tbody>
</table>

29. Based on these data, his

A) GFR was higher at 80 than at 20 years of age.
B) urine to plasma creatinine concentration ratio was higher at 80 than at 20 years of age.
C) creatinine excretion rate was higher at 80 than at 20 years of age.
D) his GFR at 80 was 120 ml/min.
E) fractional volume excretion (V/GFR) was higher at 80 than at 20 years of age

Use the following illustration of a renal tubular cell to answer question #30; the luminal concentration is 1, the intracellular concentration is 2 and the blood concentration is 3; A and B represent luminal (apical) and basolateral (serosal) membranes, respectively.

30. Which one of the following statements regarding a specific nephron segment is correct?

A) In the distal convoluted tubule, the concentration of sodium at 1 is the same as the concentration at 3.
B) In the thick ascending limb, sodium is cotransported with amino acids at membrane B.
C) In a patient treated with penicillin, towards the end of the proximal tubule, the concentration of the drug at 2 would be greater than at 1.
D) In the thick ascending limb, antidiuretic hormone stimulates both water and solute transport across membrane A.
E) In the cortical collecting duct, aldosterone increases the insertion of an epithelial sodium channel into membrane B.

31. Which one of the following statements regarding the concentrations of various solutes in proximal tubular fluid (TF) and plasma (P) is correct?

A) The TF/P osmolar concentration ratio increases in the transition from the S1 to the S2 segment.
B) The fractional reabsorption of sodium in the S1 segment can be calculated from the TF/P chloride ratio.
C) The fractional reabsorption of water in the proximal tubule can be calculated from the TF/P sodium ratio.
D) The TF/P sodium ratio and the TF/P inulin ratio will provide information concerning both water and sodium reabsorption.
E) In a patient with untreated diabetes mellitus, the TF/P glucose ratio along the proximal tubule would be the same as in healthy individual.
Use the following data sets, A – E, as answers for questions 32 - 36 (answers may be used once, more than once or not at all). If none of the answers apply, or if it cannot be calculated use answer F. PAH = p-aminomethylphosphonate.

<table>
<thead>
<tr>
<th>Renal plasma flow (ml/min)</th>
<th>A) 600</th>
<th>B) 600</th>
<th>C) 600</th>
<th>D) 600</th>
<th>E) 600</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFR (ml/min)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Plasma PAH (mg/ml)</td>
<td>0.1</td>
<td>0.3</td>
<td>0.6</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Amount of PAH excreted (mg/min)</td>
<td>60</td>
<td>90</td>
<td>120</td>
<td>160</td>
<td>260</td>
</tr>
</tbody>
</table>

32. The amount of PAH filtered is greatest in A, B, C, D, E, or F (cannot be calculated).

33. The clearance of PAH is greatest in A, B, C, D, E, or F (cannot be calculated).

34. The renal extraction of PAH is greatest in A, B, C, D, E, or F (cannot be calculated).

35. The renal extraction of PAH is 50% in A, B, C, D, E, or F (cannot be calculated).

36. The Tm (transport maximum) for PAH in the above questions (32-35) was

   A) 10 mg/min
   B) 20 mg/min
   C) 30 mg/min
   D) 60 mg/min
   E) cannot be calculated

37. Which one of the following data sets is consistent with normal physiological function in a nephron with a long loop of Henle?

<table>
<thead>
<tr>
<th>End Proximal Tubular Fluid</th>
<th>Tubular Fluid at Tip of Loop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osmolarity (mOs/L)</td>
<td>Na Concentration (mEq/L)</td>
</tr>
<tr>
<td>A) 300</td>
<td>100</td>
</tr>
<tr>
<td>B) 1200</td>
<td>140</td>
</tr>
<tr>
<td>C) 300</td>
<td>140</td>
</tr>
<tr>
<td>D) 300</td>
<td>140</td>
</tr>
<tr>
<td>E) 300</td>
<td>140</td>
</tr>
</tbody>
</table>

38. The osmolar concentration of tubular fluid at the macula densa is:

   A) higher than that of the final urine when plasma ADH concentrations are zero.
   B) unaffected by furosemide.
   C) higher than that of plasma when ADH concentrations are high.
   D) increased by aldosterone.
   E) normally isosmotic to plasma.

39. A low plasma concentration of aldosterone can be the result of:

   A) hyperkalemia (high plasma K concentration).
   B) hypotension.
   C) a deficiency of 11-β hydroxysteroid dehydrogenase
   D) hyponatremia (low plasma Na concentration).
   E) none of the above results in a low plasma aldosterone concentration.
Use the following data sets in conditions I, II and III to answer question 40

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine osmolarity (mOs/L)</td>
<td>60</td>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>Plasma osmolarity (mOs/L)</td>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Free water clearance (ml/min)</td>
<td>10.0</td>
<td>0</td>
<td>-2.0</td>
</tr>
</tbody>
</table>

40. Based on these data, which one of the following statements is correct?

A) The urine flow rate in condition I is 12.5 ml/min.
B) The urine flow rate in condition III is 5 ml/min.
C) The urine to plasma osmolar ratio is 0.5 in condition II.
D) The osmolar clearance in condition III cannot be calculated from the data.
E) The free water clearance in condition II is erroneous for it must be a positive value rather than zero.

41. The osmolar gradient in the medulla

A) will decreases if an antagonist of antidiuretic hormone is administered
B) increases during a water diuresis
C) decreases during dehydration
D) decreases if an inhibitor of phosphodiesterase is administered
E) increases during treatment with furosemide

42. Both pressure natriuresis and pressure diuresis

A) would be enhanced if the renal capsule was removed.
B) are caused by a decrease in ADH release from the posterior pituitary.
C) are aldosterone-mediated phenomena.
D) are related to increases in renal interstitial fluid pressure.
E) reflect the negative correlation between sodium excretion and arterial blood pressure.

43. Which one of the following statements regarding the renal handling of K is correct?

A) K excretion increases during treatment with agents that inhibit sodium reabsorption in the proximal tubule or in the loop of Henle.
B) Increases in plasma K concentration cause a decrease in aldosterone release from the adrenals.
C) As the transtubular potential in the distal tubule decreases (becomes more negative), K secretion decreases.
D) Drugs such as amiloride or spironolactone enhance K secretion.
E) “Aldosterone escape” refers to the fact that K secretion returns to the normal baseline during hyperaldosteronism.

44. Bicarbonate reabsorption in the proximal tubule:

A) increases when the extracellular fluid volume is expanded.
B) increases in the presence of acetozolamide.
C) decreases as protein intake increases.
D) is a K-dependent process.
E) does not result in net acid excretion.
45. Which one of the following statements regarding the renal ammonia/ammonium system is correct? On a typical western diet that leads to about 100 mEq/day of fixed acid

A) ammonium excretion represents a small portion of the total acid excreted.
B) ammonium production by the kidney is at a maximum.
C) ammonium production by the kidney would reach a maximum one or two hours following the onset of respiratory acidosis.
D) the total concentration of ammonium + ammonia will be lower in the tubular lumen compared with plasma because the pH in the tubular lumen is lower than plasma.
E) ammonium excretion results in the formation of “new” bicarbonate.

46. Chronic excess secretion of ADH (syndrome of inappropriate antidiuretic hormone; SIADH) is characterized by:

A) an isotonic expansion of the extracellular and intracellular fluid space.
B) an increase in the volume of the extracellular and intracellular fluid space but a decrease in osmolar concentration in both spaces.
C) an increased volume of the intracellular fluid space but a decreased volume of the extracellular fluid space.
D) hypernatremia (increased plasma concentration of sodium).
E) a persistent water diuresis.

47. Which one of the following conditions would you expect to find the most alkaline urine?

A) Acute respiratory acidosis
B) Treatment with a thiazide diuretic
C) Inhibition of 11-β hydroxysteroid dehydrogenase
D) Hyperaldosteronism
E) Primary hyperkalemia

48. Which one of the following statements concerning free water clearance is correct?

A) Free water clearance is zero when the urine to plasma (U/P) osmolar ratio is greater than 1.0.
B) The maximum negative free water clearance is reduced by the loop diuretic, furosemide.
C) During a water diuresis, administration of antidiuretic hormone would increase the urine flow rate.
D) Negative free water is formed primarily in the ascending loop.
E) When the U/P osmolar ratio is less than 1.0, antidiuretic hormone concentration is highest.

49. The transport maximum for glucose (T_{MG})

A) increases in diabetes mellitus.
B) can be calculated from the renal threshold and the GFR.
C) decreases following unilateral nephrectomy (removal of one kidney).
D) decreases in diabetes mellitus.
E) is regulated by insulin.

50. Which one of the statements regarding urea is correct?

A) The excretion of urea increases when ADH concentrations decrease.
B) The clearance of urea is equal to the GFR.
C) The blood urea nitrogen (BUN) decreases when the GFR decreases.
D) An increase in the BUN to creatinine ratio indicates overhydration.
E) Approximately 50% of the gradient in the outer medulla is composed of urea.
Acid Base Questions

All of the acid base questions assume these values under normal conditions:

\[ \text{pH 7.40; } [\text{H}^+] \text{ 40 nM; PaCO}_2 \text{ 40 torr (mmHg); measured plasma } [\text{HCO}_3]\text{ 24 mEq/L} \]

51. The following blood chemistries are consistent with which disorder(s)

\[ \text{pH 7.28; } [\text{H}^+] \text{ 52 nM; PaCO}_2 \text{ 55 torr; measured plasma } [\text{HCO}_3]\text{ 25.5 mEq/L} \]

A) No diagnosis is possible because the data are not internally consistent
B) Mixed respiratory and metabolic acidosis
C) Acute respiratory alkalosis
D) Chronic respiratory acidosis
E) None of the above are consistent with the data

52. The following blood chemistries are consistent with which chronic disorder(s):

\[ \text{pH 7.20; } [\text{H}^+] \text{ 63 nM; PaCO}_2 \text{ 90 torr; measured plasma } [\text{HCO}_3]\text{ 34 mEq/L} \]

A) Mixed chronic respiratory acidosis and metabolic acidosis
B) Mixed chronic respiratory acidosis and metabolic alkalosis
C) Mixed chronic respiratory alkalosis and metabolic acidosis
D) Chronic respiratory acidosis
E) No diagnosis is possible because the data are not internally consistent

53. The following blood chemistries are consistent with which disorder(s):

\[ \text{pH 7.50; } [\text{H}^+] \text{ 31 nM; PaCO}_2 \text{ 35 torr; measured plasma } [\text{HCO}_3]\text{ 40 mEq/L} \]

A) Metabolic alkalosis
B) Acute respiratory alkalosis
C) Mixed metabolic alkalosis and respiratory acidosis
D) Chronic respiratory acidosis
E) No diagnosis is possible because the data are not internally consistent

54. The following blood chemistries are consistent with which disorder(s):

\[ \text{pH 7.47; } [\text{H}^+] \text{ 37 nM; PaCO}_2 \text{ 25 torr; measured plasma } [\text{HCO}_3]\text{ 16 mEq/L} \]

A) Chronic respiratory alkalosis
B) Metabolic acidosis
C) Acute respiratory alkalosis
D) Metabolic alkalosis
E) No diagnosis is possible because the data are not internally consistent
55. The following blood chemistries are consistent with which acid base disorder(s)?

\[ \text{pH 7.27; } [\text{H}^+] \text{ 54 nM; PaCO}_2 \text{ 71 torr; measured plasma } \text{[HCO}_3^-] \text{ 31 mEq/L} \]

A) A single disorder of acute respiratory acidosis  
B) A single disorder of metabolic acidosis  
C) A chronic respiratory acidosis and a metabolic alkalosis  
D) An acute respiratory acidosis and a metabolic acidosis  
E) None of the above is correct

Use the following figure illustrating the plasma bicarbonate concentration as a function of the arterial PCO\(_2\) to answer question #56 (the data represent the approximate 95% confidence limits for four acid-base disorders).

56. Which one of the following statements regarding the transition among curves 1, 2, 3 and 4 in the above figure is correct?

A) Curve 1 to curve 2 reflects a transition from a pathophysiological state of an acute to a chronic respiratory acidosis.  
B) Curve 4 to curve 3 reflects a transition from a pathophysiological state of an acute to a chronic respiratory alkalosis.  
C) Curve 4 to curve 3 reflects a transition from a pathophysiological state of an acute to a chronic respiratory acidosis.  
D) Curve 2 to curve 1 reflects a transition from a pathophysiological state of an acute to a chronic respiratory acidosis.  
E) Curve 4 to curve 3 reflects a transition from a pathophysiological state of an acute to a chronic metabolic acidosis.
Use the following figure to answer questions #57-58. Plotted are PCO₂ isobars X, Y and Z (the Z line represent a PCO₂ = 40 mmHg), buffer lines 1 and 2, and points H to O; acid-base disorder paths are indicated by lines 3, 4, 5, and 6.

57. Which one of the following statements regarding this figure is correct?

A) Line 5 would represent the path for a respiratory acidosis combined with a metabolic alkalosis.
B) Point L represents a multiple acid base disorder.
C) If line 1 represents the patients buffer line, point O reflects a single disorder of acute respiratory alkalosis.
D) If line 2 represents the patients buffer line, Point H represents a single disorder of chronic respiratory acidosis.
E) Line 1 reflects a higher non-bicarbonate buffer base compared with Line 2.

58. Which one of the following statements regarding this figure is correct?

A) If line 1 represents the patients buffer line, Point O would be expected during a combined disorder of metabolic acidosis and acute respiratory acidosis.
B) If line 1 represents the patients buffer line, at Point J the patient would have a positive Base Excess.
C) If line 1 represents the patients buffer line, at Point H the patient would have a no change in Base Excess.
D) Line 6 is the path followed by a mixed disorder of respiratory acidosis and metabolic acidosis.
E) None of the above is correct

59. In a chronic respiratory acidosis,

A) a person has an elevated alveolar ventilation.
B) more chloride ions will be found in RBCs.
C) the plasma HCO₃ will be considerably lower than normal.
D) hemoglobin will carry less CO₂ as carbamino than normal.
E) arterial pH is corrected to 7.40.
60. You have determined that your patient has a single disorder of metabolic alkalosis; the measured plasma HCO$_3^-$ is 44 mEq/L. The arterial [H$^+$], in nM, is:

A) 9  
B) 19  
C) 29  
D) 39  
E) 49

61. You have determined that your patient has a single disorder of acute respiratory acidosis; the measured PaCO$_2$ is 80 torr. The arterial [H$^+$], in nM, is:

A) 32  
B) 40  
C) 52  
D) 69  
E) 75

62. Which one of the following statements regarding acid-base regulation is correct?

A) The pK of the bicarbonate system is within one pH unit of 7.4.  
B) An increase in the strong ion difference results in an acidosis.  
C) The pK of hemoglobin is higher in oxygenated blood compared with deoxygenated blood.  
D) Base excess decreases in an acute respiratory acidosis.  
E) None of the above is correct.

63. Which one of the following statements regarding acid-base balance is false?

A) If a patient has a pH of 7.40, a PCO$_2$ of 80 torr, and a HCO$_3^-$ of 48 mEq/L, the patient must have a mixed acid-base disorder.  
B) The expected compensation for a metabolic acidosis requires appropriate chemoreceptor function.  
C) A reduced inspired oxygen tension to 80 torr will result in a respiratory alkalosis.  
D) A healthy individual will have an elevated PCO$_2$ during treatment with an inhibitor of carbonic anhydrase such as acetozolamide.  
E) If none of the above answers is false use answer E).

64. What is the ratio of [ A$^-$ ] / [ HA ] if the weak acid has a PK$_a$ of 6.3 and the pH is 7.3?

A) $1/1$  
B) $5/1$  
C) $10/1$  
D) $50/1$  
E) $100/1$

65. If the total energy utilized while performing light work was 400 units, which of the following would most closely approximate the units of external work performed?

A) 800  
B) 400  
C) 25  
D) 250  
E) 90
66. Using the technique of direct calorimetry, if a person lost 11.60 kcal of heat per unit time, how many grams of water were vaporized during this time?

A) 20  
B) 200  
C) 16  
D) 48  
E) 510

67. In terms of the greatest amount of heat produced when one liter of oxygen is used to oxidize each of the major foodstuffs, which of the following is arranged in the correct sequence?

A) protein > fat > carbohydrate  
B) fat > protein > carbohydrate  
C) carbohydrate > fat > protein  
D) protein > carbohydrate > fat  
E) fat > carbohydrate > protein

68. The basal metabolic rate (BMR) of a healthy individual is:

A) greater at age 20 than age 10 in both males and females.  
B) less in males than in females at all ages.  
C) about 30% less in females at age 25 than in females at age 10.  
D) directly proportional to body surface area but does not vary with age.  
E) less in a pregnant female at age 25 than in a non-pregnant female of the same age.

69. The normal diurnal variation in core body temperature is

A) characterized by a minimum value that is reached in mid-afternoon.  
B) independent of modest physical activity.  
C) not synchronized with external signals such as the light cycle.  
D) not evident during the postovulatory period of the menstrual cycle.  
E) about +/- 3°C from the mean body temperature for the day.

70. In an unclothed person at a comfortable room temperature, which of the following areas have the lowest resting mean skin temperature?

A) head  
B) hands  
C) feet  
D) both A and B  
E) both B and C

71. Sweat

A) is a hypertonic solution  
B) glands in the hands and feet are innervated by sympathetic cholinergic fibers.  
C) production in warm, humid conditions is an effective heat loss mechanism.  
D) glands, other than those located in the hands and feet, are innervated predominantly by the parasympathetic cholinergic division of the ANS.  
E) production is initiated by heating of the preoptic area of the anterior hypothalamus.

72. Fever

A) is always due to a defect in the effector portion of the temperature regulatory mechanism.  
B) represents an inability to regulate core body temperature.  
C) is associated with sweating in the early stages and shivering in the late stages.  
D) and hyperthermia are examples of failure to acclimatize to excessive ambient heat.  
E) none of the above

73. Which one of the following statements regarding temperature regulation is false?
A) Cold and warm receptors are not uniformly distributed over the body surface.
B) A physiological adjustment that enhances performance in hot or cold environments is termed acclimatization or acclimation.
C) Warm fibers carrying sensory information typically decrease their firing rate as the skin is warmed from 30 °C to 40 °C.
D) During fever, circulating cytokines are monitored by neurons in or near the organum vasculosum.
E) If none of the above answers is false use answer E).

Answers
1c2d3a4a5c6e7d8d9e10e11e12b13d14a15e16d17c18a19e20b21b22d23e24c25e26c27e28c29b30c31d32e33a34a35b36d37d38a39c40a41a42d43a44e45e46b47e48b49c50a51e52a53e54a55e56d57b58c59b60c61d62e63d64c65e66a67c68e69b70e71e72e73c