Case 1

A 61 year-old woman presents with complaint of shortness of breath and cough. She started experiencing dyspnea on exertion about 4 years ago. She was otherwise asymptomatic until 8 months ago when she developed a non-productive cough. She was treated with antibiotic and inhaled bronchodilators without improvement. Since then, her shortness of breath has worsened and now she has trouble climbing one flight of stairs. She denies arthralgias, myalgias, night sweat or any other constitutional symptoms. Her past medical history is unremarkable.

Physical examination is significant for crackles heard over the lower third of the posterior lung fields. Laboratory evaluations are normal including a negative rheumatoid factor.

Chest x-ray shows small lung volumes and reticular densities that are most prominent in the lower lung zones. Pulmonary function tests reveal the following:

\[
\begin{align*}
\text{TLC} & = 3.03 \text{ L (70\% of predicted)} \\
\text{FRC} & = 1.68 \text{ L (66\% of predicted)} \\
\text{RV} & = 0.95 \text{ L (62\% of predicted)} \\
\text{DLCO} & = 14.29 \text{ ml/min/torr (58\% of predicted)} \\
\text{FVC} & = 1.68 \text{ L (58\% of predicted)} \\
\text{FEV1} & = 1.36 \text{ L (56\% of predicted)} \\
\text{FEV1/FVC} & = 81\%
\end{align*}
\]
(1) Which one of the following interpretations of the PFT is INCORRECT? (1 point)
   a) The lung volumes indicate a restrictive dysfunction  
   b) The reduction in TLC is most likely due to a change in the pressure volume relationship of the respiratory system  
   c) The spirometry is consistent with a combined obstructive and restrictive pattern  
   d) The dysfunction is most likely due to a process intrinsic to the lung

The patient undergoes a thoracoscopic lung biopsy which shows heterogeneous early and late histopathologic changes.

(2) Based on the clinical and pathologic findings, you could tell the patient that: (1 point)
   a) she is likely to respond to corticosteroids, and her prognosis is good
   b) she is likely to respond to corticosteroids, but her prognosis is poor
   c) there is no good therapy to offer her, but her prognosis is good
   d) there is no good therapy to offer her, and her prognosis is poor

(3) Changes in lung physiology as a result of the underlying pathology in this disorder include all the following EXCEPT (1 point)
   a) Impaired diffusion
   b) Abnormal small airway function
   c) Loss of elastic recoil of the lung
   d) Gas exchange abnormality
   e) Pulmonary hypertension

(4) Compared to a patient with emphysema, this patient has (1 point)
   a) Increased respiratory system compliance
   b) Decreased respiratory system compliance
   c) Normal respiratory system compliance
   d) No consistent findings regarding pulmonary compliance distinguish this patient's pulmonary disorder from those with emphysema
Case 2

A 55 year-old male presents for evaluation of snoring at the urging of his wife. He has such severe snoring that his wife now sleeps in another room. He feels tired all the time and falls asleep frequently during the day. He is mildly obese with a wide neck. You are concerned that he may have obstructive sleep apnea.

(5) Which of the following statements about obstructive sleep apnea is CORRECT (1 point)

a) The apnea is caused by lower airway obstruction
b) The apnea is caused by the absence of respiratory muscle effort
c) There is increased activity of upper airway muscles during sleep leading to obstruction
d) It is less common than central sleep apnea
e) Pulmonary hypertension may develop as a result of hypoxia-induced vasoconstriction

(6) Obstructive sleep apnea may be associated with all of the following EXCEPT (1 point)

a) Systemic vasoconstriction
b) Pulmonary vascular dilatation
c) Respiratory Disturbance Index (RDI) greater than 5 events per hour
d) Bradycardia
e) Alveolar hypoxia
Case 3

A 64 year-old male with history of coronary artery disease just had an echocardiogram which showed normal left ventricular function. There was moderate tricuspid regurgitation but the rest of the valves were normal. The estimated systolic pulmonary artery pressure was 55 mmHg. He smoked 2 packs of cigarettes a day and had been smoking since he was 16. He had Pulmonary Function Test done last year for shortness of breath and it showed the following:

\[
\begin{align*}
\text{TLC} &= 7.80 \text{ L (131\% of predicted)} \\
\text{FRC} &= 4.80 \text{ L (143\% of predicted)} \\
\text{RV} &= 4.05 \text{ L (277\% of predicted)} \\
\text{DLCO} &= 11.95 \text{ ml/min/torr (42\% of predicted)} \\
\text{FVC} &= 2.23 \text{ L (48\% of predicted)} \\
\text{FEV1} &= 1.03 \text{ L (26\% of predicted)} \\
\text{FEV1/FVC} &= 46\%
\end{align*}
\]

During his office visit a week ago, his hemoglobin was found to be elevated at 19 g/dL and his arterial blood gas showed pH = 7.38, PCO2 = 37 mmHg, PO2 = 51 mmHg, O2 saturation = 86%.

(7) Which of the following statements about the pulmonary circulation is CORRECT (1 point)

a) Blood viscosity is not one of the normal determinants of pulmonary arterial pressure  
b) Pulmonary circulation is a high pressure/low flow system  
c) There is abundance of medial vascular smooth muscles in pulmonary arteries 
d) Chronic hypoxia can lead to vessel wall remodeling  
e) Acute hypoxia leads to vasodilation

(8) The causes of this patient’s pulmonary hypertension may include all the following EXCEPT (1 point)

a) Increased pulmonary venous pressure 
b) Loss of blood vessels from destruction of lung parenchyma  
c) Increased blood viscosity from polycythemia  
d) Lung hyperinflation causing mechanical constriction of arteries 
e) Chronic hypoxia causing medial hypertrophy
(9) Treatment for this patient's pulmonary hypertension should include all of the following EXCEPT (1 point)

a) Supplemental oxygen  
b) Bronchodilator therapy  
c) Vasodilator therapy  
d) Phlebotomy  
e) Smoking cessation

A recent chest x-ray revealed a left upper lung lesion. A CT scan showed a 2.5 cm diameter left upper lung cavitated lesion without any evidence of hilar or mediastinal adenopathy. Cytologic examination of a transbronchial needle aspirate of the mass is shown in Figure 1.

(10) The cells identified with the solid arrows in Figure 1 are clearly malignant, based on: (1 point)

a) the irregular contours of the nuclei  
b) the waxy, orange-staining, irregularly shaped cytoplasm  
c) the anisonucleosis, comparing one cell to another  
d) the intense staining of the nuclei  
e) all of the above

(11) The cells identified with the open arrows in Figure 1 are most likely: (1 point)

a) Alveolar type II cells  
b) Inflammatory cells  
c) Red blood cells  
d) Clara cells  
e) Bronchiolar epithelial cells

The patient subsequently underwent a left upper lobectomy. Pathologic examination showed a single 2 cm diameter cavitated mass arising from a major left upper lobe segmental bronchus. A photomicrograph of the lesion is shown in Figure 2. The margins of resection were free of disease. Disease was found in only one lymph node from the ipsilateral hilum of the numerous hilar and mediastinal lymph nodes sampled at the time of surgery. During surgery, the pleural surfaces were evaluated and the liver and spleen were palpated, and no other sites of involvement by disease were found. Answer the following questions.
(12) Based on your examination of Figure 2 and the history, which one of the following heterotopic hormone products would you be most likely to find in this patient? (1 point)

a) Anti-diuretic hormone (ADH)
b) Testosterone
c) Serotonin
d) Parathyroid-related peptide
e) None of the above

(13) Based on your examination of Figure 2 and the history, what is the stage of this patient’s disease? (1 point)

a) Limited disease
b) Disseminated disease
c) Stage IIA (T1N1M0)
d) Stage IIIB (T4N3M0)
e) Stage IV (T1N2M1)

(14) Based on your examination of Figure 2 and the history, the patient’s chances for long-term survival are in the range of: (1 point)

a) Greater than 90%
b) 50-90%
c) 10-50%
d) Less than 10%
Case 4

A 46 year-old woman was admitted to the hospital with community-acquired pneumonia. She was intubated in the emergency room for respiratory distress and hypotension. Her arterial blood gas on FiO2 of 40% shows pH = 7.46, PCO2 = 34 mmHg, PO2 = 63 mmHg. Her chest x-ray was significant for left upper lobe consolidation. She was admitted to the intensive care unit and started on antibiotic therapy. She received approximate 8 liters of normal saline and her blood pressure stabilized.

The day after her admission, her oxygenation started to deteriorate. An arterial blood gas performed on 80% FiO2 showed pH = 7.43, PCO2 = 36 mmHg, PO2 = 56 mmHg. Chest x-ray was repeated and it showed bilateral infiltrates. Her sputum and blood cultures were positive for *Streptococcus pneumoniae*. A pulmonary artery catheter was placed. The pulmonary capillary wedge pressure was 14 mmHg.

(15) Which one of the following statements about this patient’s condition is INCORRECT: (1 point)

a) This patient’s clinical presentation met all the criteria for the diagnosis of acute respiratory distress syndrome
b) The bilateral infiltrates were results of pulmonary edema from increased capillary hydrostatic pressure
c) The lung injury was heterogeneous with damaged areas interspersed with normal lung parenchyma
d) Both endothelial and epithelial cells were injured leading to edema in the alveolar spaces
e) Loss of surfactant can lead to areas of atelectasis

(16) The pathophysiologic abnormalities associated with this clinical condition include all the following EXCEPT (1 point)

a) Intra-alveolar water accumulation causing right-to-left shunt
b) Bronchoconstriction leading to V/Q mismatch
c) Abnormal surfactant leading to decreased lung compliance
d) The edema fluid in the alveolar space leading to increased lung volumes
e) Increased work of breathing
Positive end-expiratory pressure (PEEP) was added to the patient's mechanical ventilator setting in order to improve oxygenation. On PEEP of 10 cm H2O and FiO2 of 60%, patient's arterial blood gas showed pH = 7.38, PCO2 = 46 mmHg, PO2 = 62 mmHg and O2 saturation was 91%. Her hemoglobin was 10.1 g/dL. With this ventilator setting, the pulmonary capillary wedge pressure was 16 with the cardiac output of 7.0 liters/min.

(17) Which of the following statements about PEEP is CORRECT: (1 point)

a) It prevents pneumothorax from barotrauma  
b) It decreases functional residual capacity (FRC)  
c) It increases lung compliance  
d) It increases cardiac output  
e) It potentiates oxygen toxicity

Different levels of PEEP were tried with the corresponding changes in hemodynamic parameters:

<table>
<thead>
<tr>
<th>PEEP (cmH2O)</th>
<th>PaO2 (mmHg)</th>
<th>O2 saturation (%)</th>
<th>Cardiac Output (L/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>62</td>
<td>91</td>
<td>7.0</td>
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<tr>
<td>15</td>
<td>76</td>
<td>95</td>
<td>6.8</td>
</tr>
<tr>
<td>20</td>
<td>84</td>
<td>98</td>
<td>6.2</td>
</tr>
</tbody>
</table>

(18) Which of the following intervention will give this patient best oxygen delivery?  
(1 point)

a) Keep PEEP at 10 cmH2O  
b) Increase PEEP to 15 cm H2O  
c) Increase PEEP to 20 cm H2O
Case 5

A 33 year-old Hispanic male is found to have a positive tuberculin skin test during a pre-employment screening. Patient was born in Dominican Republic and moved to United States when he was 17 years old. He denies any history of tuberculosis and does not remember ever been exposed to anyone with active TB. He denies any fatigue, weight loss, fever, night sweat, cough or hemoptysis. His chest X-ray is normal.

(19) Which one of the following statements is CORRECT (1 point)

a) This patient has tuberculous infection
b) Since the patient is asymptomatic and has a negative chest x-ray, it indicates that the tubercle bacilli have been completely eliminated from this host
c) The patient most likely had the exposure to the tubercle bacilli within the past week
d) The positive tuberculin skin test is the manifestation of the host’s humoral immune response to the exposure
e) This patient is not at risk for developing active tuberculosis in the future

Case 6

A young man was brought in to the emergency department by the ambulance after his roommate found him unresponsive at home. The rescue personnel noted some empty medication bottles next to the patient and some vomitus on his shirt when they arrived at the scene. They were concerned that patient might have vomited and aspirated. He was only responsive to deep pain on arrival to the emergency department and had shallow breathing on exam. An arterial blood gas was obtained which showed pH = 7.15, PCO2 = 72 mmHg, PO2 = 54 mmHg on room air.

(20) What is the acid-base disorder (1 point)

a) Acute metabolic acidosis
b) Acute respiratory acidosis
c) Acute respiratory alkalosis
d) Chronic respiratory acidosis
e) Acute on chronic respiratory acidosis

(21) What is the most likely mechanism of this patient’s hypoxemia (1 point)

a) Hypoventilation
b) Diffusion abnormality
c) V/Q mismatch
d) Shunt
e) Increased dead space
Case 7

A 73-year-old man presents to the emergency room with complaint of severe dyspnea. He is cyanotic and in acute respiratory distress. His wife states that he has had increasing dyspnea and productive cough since he had a cold two days ago. He was seen by a pulmonologist 1 month ago and had a pulmonary function test done at that time which showed:

- TLC = 5.92 L (141% predicted)
- FRC = 4.06 L (165% predicted)
- RV = 3.58 L (242% predicted)
- DLCO = 13.19 ml/min/torr (54% predicted)
- FVC = 1.78 L (61% of predicted)
- FEV1 = 0.74 L (31% of predicted)
- FEV1/FVC = 35%

(22) Which of the following best described the pulmonary dysfunction (1 point)

a) Restriction with diffusion abnormality
b) Obstruction with diffusion abnormality
c) Combined restriction and obstruction with diffusion abnormality
d) Obstruction without diffusion abnormality
e) Restriction without diffusion abnormality

An arterial blood gas at rest was obtained in the office after the pulmonary function test which showed pH = 7.35, PCO2 = 52 mmHg, PO2 = 54 mmHg on room air. A CXR showed no infiltrates or effusions.

(23) This patient’s Alveolar-arterial oxygen difference (A-a gradient) was (1 point)

a) 10 mmHg
b) 16 mmHg
c) 23 mmHg
d) 31 mmHg
e) 47 mmHg

(24) Patient’s hypoxemia at rest was most likely due to which of the following mechanisms (1 point)

a) Hypoventilation
b) V/Q mismatch
c) Shunt
d) Diffusion abnormality
e) Increased dead space
(25) Which of the following best described the acid-base disorder (1 point)
   a) Respiratory alkalosis with metabolic compensation
   b) Respiratory acidosis with metabolic compensation
   c) Metabolic acidosis with respiratory compensation
   d) Metabolic alkalosis with respiratory compensation

   In the emergency room, a CXR is obtained which shows hyperinflated lungs without infiltrates. The arterial blood gas is repeated and it shows pH = 7.22, PCO2 = 72 mmHg, PO2 = 48 mmHg on room air.

(26) Which of the following best describes the type of respiratory failure (1 point)
   a) Acute hypoxemic and hypercapnic respiratory failure
   b) Chronic hypoxemic and hypercapnic respiratory failure
   c) Acute on chronic hypoxemic and hypercapnic respiratory failure

(27) Which of the following interventions will be LEAST helpful for this patient's current condition (1 point)
   a) Nebulized beta2- adrenergic agonists
   b) Nebulized anticholinergic agents
   c) Mucolytic agents
   d) Systemic corticosteroid
   e) Non-invasive positive pressure ventilation (NPPV)

   Upon further questioning, you are not surprised to learn that this patient has been a life-long cigarette smoker.

(28) Based on this information and the rest of the history, the most likely pathologic diagnosis of this patient's most serious disease process is: (1 point)
   a) Usual interstitial pneumonia
   b) Desquamative interstitial pneumonia
   c) Centriacinar emphysema
   d) Panacinar emphysema
   e) Hamman-Rich syndrome
Despite your therapy, the patient dies. You attend the autopsy and are able to grossly examine the lungs. You observe that the patient’s disease is much more severe in the upper lobes compared to the lower lobes.

(29) A likely explanation for this observation is: (1 point)

a) the underlying genetic deficiency in α1-antitrypsin
b) the different organization of the acinus in the upper versus lower lung
c) the differential inflammatory response in the upper versus lower lung
d) the differential blood flow in the upper versus lower lung
e) the higher oxygen concentration in the upper versus lower lung

(30) Cigarette smoke contributes to the pathogenesis of this disease by all of the following mechanisms EXCEPT: (1 point)

a) Attracting neutrophils into the lung
b) Stimulating release of neutrophil elastase
c) Inhibiting the ability of pulmonary leukocytes to clear bacteria
d) Directly inhibiting α1-antitrypsin
e) Stimulating macrophage elastase activity

(31) Cigarette smoking is causally related to all of the following pulmonary diseases EXCEPT: (1 point)

a) Chronic bronchitis
b) Centrilobular emphysema
c) Asthma
d) Small airway disease (bronchiolitis)
e) Bronchogenic carcinoma
Case 8

A 58-year old male was hospitalized with 1-week history of weakness in his legs that is progressively getting worse. Patient also complained of progressive dyspnea over the past 4 days prior to his admission. Pulmonary function testing on admission revealed the following:

- \( \text{TLC} = 3.32 \text{ L (64\% predicted)} \)
- \( \text{FRC} = 1.61 \text{ L (60\% predicted)} \)
- \( \text{RV} = 1.04 \text{ L (58\% predicted)} \)
- \( \text{DLCO} = 25.89 \text{ ml/min/torr (91\% predicted)} \)

- \( \text{FVC} = 2.18 \text{ L (62\% of predicted)} \)
- \( \text{FEV1} = 1.77 \text{ L (61\% of predicted)} \)
- \( \text{FEV1/FVC} = 81\% \)

(32) Which of the following best described the pulmonary dysfunction (1 point)

a) Restriction with diffusion abnormality  
b) Obstruction with diffusion abnormality  
c) Combined restriction and obstruction with diffusion abnormality  
d) Obstruction without diffusion abnormality  
e) Restriction without diffusion abnormality

(33) The pulmonary dysfunction is most consistent with which of the following pulmonary disease (1 point)

a) Neuromuscular disease  
b) COPD  
c) Pulmonary embolism  
d) Pulmonary fibrosis  
e) Pulmonary edema
Case 9

A 38-year old female presented with complaint of progressive shortness of breath and fatigue. Her lungs were clear to auscultation but she was noted to have a holosystolic murmur over the right sternal border on physical exam. An echocardiogram was obtained which showed right ventricular enlargement with severe tricuspid regurgitation. Her estimated mean pulmonary artery pressure was 60 mmHg. Her chest X-ray revealed enlarged pulmonary arteries with clear lung fields. Her pulmonary function tests did not reveal any obstructive or restrictive defects. Subsequent work up pointed to the diagnosis of primary pulmonary hypertension.

(34) All of the following hemodynamic features are seen in primary pulmonary hypertension EXCEPT (1 point)

a) Low cardiac output
b) Elevated pulmonary capillary wedge pressure (PCWP)
c) Elevated pulmonary artery pressure
d) Elevated right atrial pressure
e) Increased pulmonary vascular resistance (PVR)

(35) The treatment of primary pulmonary hypertension include all of the following EXCEPT (1 point)

a) Diuretic for right heart failure
b) Vasodilator therapy
c) Bronchodilator therapy
d) Supplemental Oxygen for hypoxemia
e) Anticoagulation
Case 10

A 20 year-old college student presented to the infirmary with complaint of shortness of breath with physical activity 3 weeks ago. He also reported the experiences of waking up at night with wheezing many times over the past 3 months. He had no history of medical illness except for seasonal allergies which seemed to make his shortness of breath worse. He smoked half a pack of cigarettes a day since age 16. He was referred to the local pulmonary function laboratory and the following pulmonary function tests were obtained:

- TLC = 6.54 L (112% of predicted)
- FRC = 2.72 L (101% of predicted)
- RV = 1.91 L (105% of predicted)

- FVC = 4.67 L (118% of predicted)
- FEV1 = 3.28 L (98% of predicted)
- FEV1/FVC = 70%

(36) To confirm the clinical diagnosis of asthma, bronchial hyperresponsiveness could be demonstrated by exposing the patient to the following EXCEPT (1 point)

- a) Methacholine
- b) Histamine
- c) Inhaled corticosteroids
- d) Antigens
- e) Cold air hyperventilation

Patient underwent a methacholine challenge and had 35% reduction in FEV1 after 16 cumulative units of methacholine. However, he did not show up for his appointment with a pulmonologist as instructed. Today he was brought in by rescue to the emergency room for acute respiratory distress. He had headache and running nose for the past 4 days and experienced an acute episode of shortness of breath while running to one of his classes this morning. He was tachypneic on arrival to the emergency room and had diffuse wheezing noted on examination. A bedside spirometry was performed which showed FVC = 2.57 L (65% of predicted), FEV1 = 1.41 L (42% of predicted), FEV1/FVC = 55%.

(37) The change in patient’s PFT from his baseline could be due to all the following EXCEPT (1 point)

- a) Inflammatory cell infiltration
- b) Obliteration of airspace walls
- c) Acute bronchoconstriction
- d) Bronchial wall edema
- e) Mucus plugging of airways
(38) Which of the following statements about asthma is **INCORRECT** (1 point)

a) Airway inflammation is a critical component of pathogenesis in asthma  
b) Mediators released from inflammatory cells can increase the responsiveness of bronchial smooth muscles to bronchoconstrictive stimuli  
c) During an asthmatic attack, patients usually have greater difficulty with airflow on inspiration than on expiration  
d) During an asthmatic attack, pulmonary function studies will show decreases in forced expiratory flow rates and evidence of air trapping  
e) The most common pattern of arterial blood gas during an asthmatic attack is respiratory alkalosis

(39) The mechanism of hypoxemia during an asthmatic attack is (1 point)

a) Hypoventilation  
b) V/Q mismatch  
c) Shunt  
d) Diffusion abnormality  
e) Increased dead space

He was treated for this acute exacerbation of asthma and his PFT returned to baseline after 2 weeks of therapy.

(40) Appropriate management of his asthma should include the following maintenance medications **EXCEPT** (1 point)

a) A long-acting beta2-adrenergic agonist for his nocturnal symptoms  
b) A regularly scheduled short-acting beta2-adrenergic agent to prevent episodic wheezing  
c) An inhaled corticosteroid to reduce airway inflammation  
d) A leukotriene-modifying agent for better control of the allergen and exercise-induced component of his asthma
(41)-(45) For each of the following statements about bronchial asthma, answer either:

a) TRUE
or
b) FALSE

(41) Most bronchial asthma is mediated by an immune response producing immunoglobulin E (0.5 point)

(42) In most patients with asthma, the airways are hyperreactive to bronchoconstrictor agents (0.5 point)

(43) Asteroid bodies are characteristic, but not pathognomonic, of asthma (0.5 point)

(44) Increased mast cells are found in the bronchial smooth muscle of asthmatics compared to controls (0.5 point)

(45) Mucous plugs in the major airways are a common gross finding in patients dying in status asthmaticus (0.5 point)

(46) Indicate which of the drugs below would be the most appropriate to administer to this student upon his arrival at the emergency room suffering from acute respiratory distress. (1 point)

a) Cromolyn Sodium
b) Salmeterol
c) Beclomethasone
d) Montelukast
e) Albuterol

(47) Indicate which of the drugs below would be the most appropriate for this student to take before bedtime for preventing asthmatic symptoms during sleep. (1 point)

a) Epinephrine
b) Albuterol
c) Ephedrine
d) Salmeterol
e) Isoproterenol
(48) – (51) For chronic maintenance therapy for this student several therapeutic drugs could be considered. A list of lettered asthma-relevant drugs below is followed by a set of numbered descriptions. For each numbered entry, match the one lettered option that is most closely associated with it. Each lettered option may be used once, more than once, or not at all. (1 point each)

a) Oral zileuton
b) Inhaled cromolyn
c) Inhaled beclomethasone
d) Oral montelukast
e) Inhaled ipratropium

(48) A drug given for long-term inhibition of histamine release from mast cells. ____

(49) A drug whose anti-asthmatic action involves muscarinic receptor blockade. ____

(50) A drug which is a leukotriene receptor antagonist. ____

(51) A drug which inhibits leukotriene synthesis. ____

(52) Of the various drugs below which might be considered as treatment for this student, all of them are considered to be bronchodilators EXCEPT: (1 point)

a) Theophylline
b) Terbutaline
c) Cromolyn Sodium
d) Ephedrine
e) Ipratropium

(53) If this student were to receive treatment with terbutaline which one of the following effects would be least likely to occur? (1 point)

a) Smooth muscle relaxation
b) Diuretic effect
c) Positive inotropic effect
d) Skeletal muscle tremor
e) Tachycardia
(54) Suppose this student had to return again to the emergency room with acute respiratory distress and it was decided to treat him with a loading dose of theophylline. Given the information below about theophylline, what is the appropriate loading dose of theophylline to give? (1 point)

Half-life: 9 hours
Volume of distribution: 0.65 Liters/kg
Desired plasma therapeutic concentration: 5 µg/ml

a) 0.361 mg/kg
b) 0.722 mg/kg
c) 1.63 mg/kg
d) 3.25 mg/kg
e) 7.22 mg/kg

(55) Using the information in the question above about theophylline, choose the time below which is the shortest time that it would take for theophylline to achieve at least 90% of its steady state concentration in the plasma if it were being given via constant intravenous infusion. (1 point)

a) 9 hours
b) 18 hours
c) 36 hours
d) 45 hours
e) 72 hours
Case 11

A 59 year-old immigrant from Southeast Asia presented for the first time to a neighborhood clinic with complaint of cough. He had been feeling ill for about a month. He felt fatigued and had experienced night sweats. His cough started about 3 weeks ago with white sputum production. On exam, he had a temperature of 38.5° C and the lung was clear to auscultation. His chest X-ray showed bilateral infiltrates in the apices with possible cavitation on the right side. There was also evidence of scarring and contraction in the right lung. His pulse oximetry showed O2 saturation of 96% on room air. His sputum smear was positive for acid-fast bacilli.

(56) Which one of the following statements is **CORRECT** *(1 point)*

a) This patient most likely had primary tuberculosis  
b) Non-caseating granulomas are typically seen in active TB  
c) Reactivation tuberculosis is more common in the apices of the lung because these regions receive better blood perfusions than the rest of the lung  
d) This patient’s oxygenation is relatively preserved because ventilation and perfusion are destroyed simultaneously in the affected lung regions  
e) *Mycobacterium tuberculosis* is a fast growing organism so the identification and drug sensitivity are usually available within 48 hours
Case 12

A 72 year-old male with history of coronary artery disease and congestive heart failure presented with 2-week history of dyspnea and fatigue. On physical exam he was noted to have rales at the left base and diminished breath sounds at the right base. Chest x-ray showed mild vascular congestion and bilateral pleural effusions. The pleural effusion was slightly larger on the right. There was a rounded density in the right lower lung field and widened mediastinum. A chest CT showed a mass in the right lower lobe with enlarged hilar lymph nodes and bilateral pleural effusions. There were also several lesions noted in the liver. Bronchoscopy revealed an endobronchial lesion in the right lower lobe bronchus; a high power photomicroscopic image of the biopsy is shown in Figure 3.

(57) Based on your examination of Figure 3 and the history, which one of the following heterotopic hormone products would you be most likely to find in this patient? (1 point)

a) Anti-diuretic hormone (ADH)
b) Testosterone
c) Serotonin
d) Parathyroid-related peptide
e) None of the above

(58) Based on your examination of Figure 3 and the history, what is the stage of this patient’s disease? (1 point)

a) Limited disease
b) Disseminated disease
c) Stage IIA (T1N1M0)
d) Stage IIB (T4N3M0)
e) Stage IV (T1N2M1)

(59) Based on your examination of Figure 3 and the history, the patient’s chances for long-term survival are in the range of: (1 point)

a) Greater than 90%
b) 50-90%
c) 10-50%
d) Less than 10%
A thoracentesis was performed for the right pleural effusion with the following results: (The upper limit of normal serum LDH is 280 U/L)

Pleural fluid protein = 2.8 g/dL  
Serum protein = 6.1 g/dL
Pleural fluid LDH = 93 U/L  
Serum LDH = 172 U/L

(60) The pleural fluid results are consistent with (1 point)

a) Transudative effusion
b) Exudative effusion

(61) What is the mechanism of pleural effusion in this patient? (1 point)

a) Altered permeability from his lung cancer  
b) Altered permeability from his congestive heart failure  
c) Increased hydrostatic pressure from his lung cancer  
d) Increased hydrostatic pressure from his congestive heart failure

Patient was started on therapy for his lung cancer. Two months after he presented with fever, cough and worsened dyspnea. On physical exam, he was acutely ill with a fever of 38.8°C and his Chest x-ray showed right lower lobe consolidation consistent with pneumonia.

(62) Which one of the following statements about defense of the lung is INCORRECT (1 point)

a) There is migration of polymorphonuclear leukocytes into the alveoli in bacterial pneumonia  
b) T-lymphocytes with the ability to produce antibodies are responsible for the humoral immune responses  
c) Alveolar macrophages are capable of phagocytosis  
d) Viral infection can lead to impaired mucociliary clearance  
e) Smoking can decrease macrophage function
Case 13

An 82-year old female was sent to the Pulmonary Function Laboratory for testing because of complaint of dyspnea associated with exertion during pre-op evaluation for an elective hysterectomy for fibroid uterus.

(63) Which one of the following changes in her pulmonary function will be expected given her advanced age (1 point)

a) Decreased lung compliance due to increased elastic recoil of the lung  
b) Decreased TLC because of reductions in FVC and RV  
c) Increased DLCO because of decreased collagen content in the alveolar walls  
d) Decreased airway resistance because of increased airway size  
e) Increased FRC with early closure of small airways

Her pulmonary function tests were significant for a positive methacholine bronchoprovocation.

(64) Which of the following statement is CORRECT about asthma in the elderly (1 point)

a) Most elderly asthmatics have long-standing asthma; new onset of asthma in this group is rare  
b) Prevalence of asthma in the elderly approaches the prevalence in childhood  
c) The prevalence of allergic asthma is higher in elderly than in the younger population  
d) Asthma is an uncommon cause of chronic cough in elderly  
e) Adverse drug effects is less common in this group because of increased elimination of medication in elderly
Case 14

A 71-year old male was sent to the hospital for fever and hypotension from the nursing home. On arrival to the emergency department patient was found to be febrile with temperature of 39.1°C, hypotensive with BP = 70/42 and tachypneic with respiratory rate of 32. His chest X-ray showed bilateral infiltrates. His arterial blood gas showed pH = 7.21, PCO2 = 25 mmHg, PO2 = 51 mmHg on room air. His blood chemistry was significant for HCO3 of 10mEq/L and an elevated anion gap. Because of the low PCO2, you concluded that this patient had increased minute ventilation.

(65) All the following mechanisms may be responsible for this patient’s increased minute ventilation **EXCEPT** (1 point)

   a) Stimulation of the carotid body by the decreased arterial pH
   b) Stimulation of the central receptor in the medulla by the increased in [H+]
   c) Stimulation of carotid body by the decreased PO2
   d) Stimulation of the central receptor in the medulla by the decreased PCO2

Patient was intubated and placed on mechanical ventilation. However, his condition continued to deteriorate and he required 80% FiO2 on the ventilator to maintain a PO2 of 62 mmHg. His urine and blood cultures were positive for *Klebsiella pneumoniae*. A pulmonary artery catheter was placed and the pulmonary capillary wedge pressure was 16 mmHg.

(66) The pathogenesis of this patient’s pulmonary dysfunction include all of the following **EXCEPT** (1 point)

   a) Leukocyte-induced endothelial cell injury
   b) Macrophage and monocyte activation by endotoxin
   c) Increased hydrostatic pressure leading to fluid influx into alveolar space
   d) Leukocyte activation by cytokines
   e) Epithelial cell injury leading to loss of surfactant
Case 15

A 56 year-old female presented with complaint of acute onset of pleuritic chest pain and dyspnea. One week ago she underwent an uneventful hysterecctomy for fibroid uterus. She had right calf tenderness for the past 3 days. On physical exam, her temperature was 37.2°C, pulse 110/min, respiratory rate 28/min and blood pressure was 130/84 mmHg. Her breath sounds were normal and there was no murmur or gallop on heart exam. Her right calf was swollen but no cords were palpable. An arterial blood gas on room air showed pH = 7.44, PCO2 = 33 mmHg, PO2 = 58 mmHg, O2 saturation of 89%. The rest of her laboratory evaluation was normal. Her chest X-ray did not show any abnormality. Lower leg Doppler ultrasound was positive for right leg deep venous thrombosis and a ventilation-perfusion scan (V/Q scan) showed multiple unmatched perfusion defects.

(67) What are the potential mechanisms of hypoxemia in this patient (1 point)

a) Hypoventilation and V/Q mismatch
b) V/Q mismatch and shunt
c) Shunt and hypoventilation
d) Shunt and increased dead space
e) Increased dead space and V/Q mismatch

(68) Potential consequences of this condition may include all of the following EXCEPT (1 point)

a) Bronchoconstriction of the small airways
b) Increased right ventricular output
c) Increased dead space
d) Increased pulmonary vascular resistance
e) Atelectasis
Case 16

A term male infant (2523 gm) born following an uncomplicated pregnancy and delivery was transferred to your hospital on the third day of life. Soon after birth, the infant showed respiratory distress and was placed on a ventilator. A chest x-ray showed bilateral lung opacities without other chest abnormalities. After transfer he was given 100% oxygen and arterial blood gases showed a pO2 of 63 mm Hg with O2 saturation of 99%. On day 5, the PaO2 fell to <30 mm Hg despite maximal ventilatory support. Extracorporeal membrane oxygenation (ECMO) was begun, but it could not be discontinued, so on day 23 after birth the baby was removed from support and died. A photomicrograph of the infant’s lung obtained at autopsy is shown in Figure 4. Answer the following questions.

(69) The differential diagnosis of respiratory distress in the full term newborn includes all of the following EXCEPT: (1 point)

a) Transient tachypnea of the newborn
b) Meconium aspiration syndrome
c) Respiratory distress syndrome (hyaline membrane disease)
d) Lung hypoplasia due to diaphragmatic hernia
e) Alveolar capillary dysplasia

(70) In Figure 4, the asterisks identify: (0.5 point)

a) Bronchioles
b) Alveoli
c) Arterioles
d) Lymphatics
e) Venules

(71) In Figure 4, the solid arrows identify: (0.5 point)

a) Bronchioles
b) Alveoli
c) Arterioles
d) Lymphatics
e) Venules

26
(72) In Figure 4, the open arrows identify: (0.5 point)

a) Bronchioles
b) Alveoli
c) Arterioles
d) Lymphatics
e) Venules

(73) Based on the clinical history and Figure 4, the most likely diagnosis in this case is: (1 point)

a) Transient tachypnea of the newborn
b) Meconium aspiration syndrome
c) Respiratory distress syndrome (hyaline membrane disease)
d) Lung hypoplasia due to diaphragmatic hernia
e) Alveolar capillary dysplasia
(74) All of the following statements concerning drug metabolism are correct EXCEPT: (1 point)

a) The liver is a major drug metabolizing organ
b) Phase I reactions add glucuronyl groups via conjugation
c) Some cytochrome P450 enzymes can be induced by barbiturates
d) If a drug is made more polar via metabolism it will be less likely to be reabsorbed back into the plasma via the kidney
e) Catecholamines are substrates for metabolism by monoamine oxidase

(75) Indicate which of the following statements concerning the Ames test are CORRECT: (1 point)

a) A negative result (no bacterial growth) indicates that the drug does not produce mutations
b) It tests drugs to determine if they can produce a back mutation in histidine-dependent bacteria
c) Many of the drugs found to be mutagenic by this test also turn out to be carcinogenic
d) A and B
e) B and C

(76) Patient P.R. is taking a 10 mg tablet orally of Drug A every 12 hours. P.R. now also starts taking Drug B (10 mg) orally every 12 hours. Three days after starting Drug B, P.R. develops side effects similar to those associated with too high a dosage of Drug A. The most likely explanation for this observation: (1 point)

a) Drug B is inhibiting the metabolism of Drug A
b) Drug B is increasing the binding of Drug A to plasma proteins
c) Drug B is competing with Drug A for reabsorption in the kidney
d) Drug B is decreasing the half-life of Drug A
e) Drug B is causing receptor down-regulation

(77) Indicate after which phase of drug testing, approval from the Food and Drug Administration is usually sought for general drug marketing. (1 point)

a) Phase I
b) Phase II
c) Phase III
d) Phase IV
e) Phase V
(78) Drug D is infused at a rate of 4 mg/min and produces a steady state concentration of 12 mg/L in the plasma. What is the clearance rate of Drug D? (1 point)

a) 48 ml/min  
b) 96 ml/min  
c) 144 ml/min  
d) 333 ml/min  
e) 480 ml/min

(79) Below is a graph depicting blood concentration of Drug A at various times following Drug A administration. Based on this graph, what is the half-life of Drug A? (1 point)

a) 0.5 hour  
b) 1 hour  
c) 2 hours  
d) 3 hours  
e) 4 hours

(80) Drug X is a carboxylic acid (like aspirin) with a pKa of 5.9. This means that: (1 point)

a) At a pH of 6.9, Drug X is 90% in a charged form  
b) At a pH of 4.9, Drug X is 90% in an uncharged form  
c) Drug X would be readily absorbed by diffusion across the stomach membranes  
d) A and B  
e) A, B and C
(81) For drug X, what would be its half-life if its volume of distribution is 5 liters/kg and its clearance is 34.7 ml/min per kg? (1 point)

- a) 6.9 min
- b) 69 min
- c) 100 min
- d) 174 min
- e) 690 min

(82) It is dangerous to combine heavy chronic ethyl alcohol consumption with acetaminophen (Tylenol) because: (1 point)

- a) Acetaminophen inhibits the metabolism of ethyl alcohol
- b) Ethyl alcohol inhibits the metabolism of ethyl alcohol
- c) Ethyl alcohol inhibits the absorption of acetaminophen
- d) Acetaminophen increases the absorption of ethyl alcohol
- e) Ethyl alcohol will increase phase 1 metabolism of acetaminophen

(83) Indicate which of the following statements concerning drug half-life are CORRECT: (1 point)

- a) If drug X has a half-life of 12 hours when a 10 mg pill is taken every 12 hours, it will now have a half-life of 6 hours if that 10 mg pill is taken once every 24 hours
- b) If renal disease produces a decrease in CL_{total} (total clearance) of drug Y, the half-life of drug Y will increase
- c) After 3 half-lives, the drug concentration in the plasma will decline by greater than 95%
- d) A and B
- e) B and C

(84) Indicate which of the following statements concerning asthma are CORRECT: (1 point)

- a) If both routes work, glucocorticoid administration via inhalation is preferred over oral administration
- b) Antihistamines are one of the main types of drugs used to treat asthma
- c) Theophylline stimulates both β_1 and β_2 receptors
- d) A and B
- e) B and C
(85) The antisense approach to gene therapy is used to: (1 point)

a) Increase gene expression for the gene that you are trying to insert
b) Inhibit DNA replication
c) Block formation of specific proteins
d) A and B
e) A, B and C

(86) – (90) For each numbered compound below, indicate the single most appropriate lettered antidote to be used if toxic amounts of the numbered compound were to be in the body. (1 point each)

Each lettered option may be used once, more than once, or not at all.

a) Ethanol
b) Naloxone
c) N-acetylcysteine
d) Sodium nitrite
e) Calcium disodium edetate (EDTA)

(86) Lead _____
(87) Acetaminophen _____
(88) Cyanide _____
(89) Heroin _____
(90) Ethylene glycol _____
(91) When 75 mg of drug A is administered, the plasma concentration is 15 μg/ml (with the plasma concentration determined by extrapolation back to zero time from the elimination curve for the drug). What is the volume of distribution (Vd) of drug A? (1 point)

   a) 0.2 Liters
   b) 5 Liters
   c) 15 Liters
   d) 75 Liters
   e) 1125 Liters

(92) Indicate which of the following statements regarding the ability of drugs to enter the brain from the peripheral circulation are CORRECT: (1 point)

   a) L-DOPA can enter the brain because it is very lipophilic
   b) Epinephrine can enter the brain because of specific transport proteins
   c) Amphetamine can enter the brain because it is very lipophilic
   d) A and B
   e) B and C

(93) All of the following statements concerning drug administration and distribution are correct EXCEPT: (1 point)

   a) Bioavailability is always 100% for intravenous drug administration
   b) Liver first-pass metabolism is avoided with sublingual drug administration
   c) A charged form of the drug will pass through cell membranes via passive diffusion easier than the uncharged form of the drug
   d) Drug absorption is defined as the passage of a drug from its site of administration to the blood stream
   e) The distribution phase of a drug is ignored when the half-life of the drug is calculated from a graph of plasma drug concentration vs. time
(94) Refer to Figure 2 and the previous history in this case. Briefly describe the histopathologic features which are important to your specific diagnosis of this patient's disease process. Be sure to explicitly describe the features of the cells in the box and the process highlighted by the asterisk. What is your pathologic diagnosis? (3 points)

(95) Refer to Figure 3 and the previous history in this case. Briefly describe the histopathologic features which are important to your specific diagnosis of this patient's disease process. What is your pathologic diagnosis? (3 points)
2003 Pulmonary Exam Answers

1. C
2. D
3. C
4. B
5. E
6. B
7. D
8. A
9. C
10. E
11. B
12. D
13. C
14. C
15. B
16. D
17. C
18. B
19. A
20. B
21. A
22. B
23. D
24. B
25. B
26. C
27. C
28. C
29. D
30. C
31. C
32. E
33. A
34. B
35. C
36. C
37. B
38. C
39. B
40. B
41. A
42. A
43. B
44. A
45. A
46. E
47. D