Chapter 1a

Physiology Questions

Question 1

Regarding cardiac muscle structure, which of the following statements are correct?:

a. The volume of the left ventricle is maximal at the atrial end systolic pause
b. The right coronary artery usually supplies both the right atrium and ventricle, and part of the left atrium
c. Cardiac muscle cells have one nucleus, but many mitochondria
d. Striated cardiac muscle fibres are more structured than skeletal muscle fibres
e. The sarcoplasmic reticulum sequesters calcium via a Na^+/K^+-ATPase pump

Question 2

Regarding conduction through the heart:

a. Conduction through the cardiac septum is usually uni-directional from left to right
b. Left bundle branch block usually produces left axis deviation on the 12-lead ECG
c. Right bundle branch block usually produces right axis deviation on the 12-lead ECG
d. Stimulation of the tenth cranial nerve induces slowing of AV conduction
e. Wolff–Parkinson–White syndrome is always associated with an accessory conducting bundle

Question 3

With regard to the cardiac action potential:

a. Sodium influx via fast sodium channels occurs during phase 0 of the nodal cardiac action potential
b. The absolute refractory period extends into phase 3 of the action potential
c. The plateau phase is due to a decrease in cell membrane permeability of calcium
d. The Na^+/K^+ pump is involved in the restoration of ionic gradients in phase 4 of the nodal action potential
e. Slow L-type Ca^{2+} channels are involved in both nodal and conduction system action potentials

Question 4

Regarding automaticity with the sinoatrial (SA) node and the atrioventricular (AV) node:

a. The SA node is principally responsible for the heart's automaticity
b. The threshold potential for the nodal action potential is –90 mV

c. Parasympathetic stimulation of the SA node causes a slowing of heart rate via an increase in membrane Ca^{2+} permeability
d. The SA node does not have an absolute refractory period
e. The AV node has a longer phase 4 than the SA node

Question 5

With regard to the cardiac cycle:

a. The first heart sound represents the closure of the aortic valve
b. The second heart sound occurs at the beginning of the T wave on the ECG
c. The peak of left ventricular pressure occurs with the QRS complex on the ECG
d. Ventricular volume begins to increase when the atrioventricular valves open
e. The peak of aortic pressure corresponds with the T wave

Question 6

This question concerns the cardiac cycle – diastole, perfusion, lusitropy:

a. The myocardium is entirely dependent on perfusion occurring during diastole
b. Lusitropy refers to the myocardial relaxation
c. At rest diastole accounts for 0.5 seconds of a cardiac cycle lasting 0.8 seconds
d. Ventricular filling is rapid during early diastole
e. Atrial contraction during late diastole accounts for the majority of end diastolic ventricular volume

Question 7

With respect to the CVP waveform:

a. Irregular cannon 'a waves' are due to complete heart block
b. The 'v wave' is smaller in tricuspid incompetence
c. Normal CVP is 0–8 mmHg
d. The 'y descent' is demonstrating passive ventricular filling
e. The 'c wave' is the tallest wave

Question 8

This question concerns the P-V relationship, and the Frank–Starling curve:

a. The Frank–Starling law states that the force of contraction is related to the initial fibre length
b. The force of myocardial contraction is proportional to the initial fibre length, until an upper limit is reached
c. Before the mitral valve opens there is a decrease in pressure in the ventricle, but no change in volume
d. Before aortic valve closure there is an increase in volume with no associated change in pressure
e. The aortic valve opens when the pressure in the ventricle is lower than that in the aorta

Question 9

With respect to cardiac output formulae:

a. CO = HR × (ESV – EDV)
b. The Fick principle cannot be used to calculate blood flow through the liver
c. Only calculated values are used in the Fick equation
d. The oxygen uptake forms the denominator in the Fick equation
e. Shunts do not affect the accuracy of the calculation of cardiac output via the Fick principle

Question 10

Regarding preload, afterload and contractility:

a. Afterload is increased by peripheral vasoconstriction
b. Increased afterload causes an increased stroke volume
c. Preload can be likened to end systolic volume
d. Preload can be estimated by measurement of CVP
e. Preload and afterload are the only factors affecting contractility

Question 11

Regarding heart rate and coronary blood flow:

a. The sympathetic outflow controlling heart rate is via T1–T8
b. The right coronary artery is the dominant vessel in half the population
c. The right coronary artery arises from the posterior aortic sinus
d. Atrial natriuretic peptide (ANP) is a vasodilator
e. The nucleus ambiguus is involved in integration of the afferent inputs affecting heart rate from baroreceptors, chemoreceptors and higher centres

Question 12

With regard to the Valsalva manoeuvre:

a. A square wave response is seen in autonomic neuropathy
b. A diminished chemoreceptor reflex causes the abnormal response in autonomic neuropathy
c. It can be used to terminate supraventricular tachycardia
d. The fall in blood pressure is exaggerated in patients under spinal anaesthesia
e. It decreases the intensity of most heart murmurs on auscultation

Question 13

With regard to the physiological control of blood pressure:

a. Baroreceptors in the carotid sinus are innervated by the vagus nerve
b. The vasomotor centres are found in the hypothalamus and medulla
c. Higher centres have no influence on the vasomotor centres
d. Low pressure baroreceptors are found in the atria, ventricles and pulmonary vessels
e. The Bainbridge reflex causes a reflex bradycardia

Question 14

With regard to the left ventricular end diastolic volume:

a. In a normal heart it is approximately 30 ml
b. It is a measure of preload
c. It is reduced in exercise
d. It is independent of ventricular compliance
e. It is increased in diastolic heart failure

Question 15

The following will cause arterioles to constrict:

a. Direct injury to the vessel
b. Decreased tissue pH
c. Decreased tissue oxygen tension
d. Thromboxane A2
e. Bradykinin

Question 16

The following mediators cause vasoconstriction in vascular smooth muscle:

a. Epinephrine
b. $PGF_2\alpha$
c. Serotonin
d. PGI_2
e. Adenosine

Question 17

The following factors may predispose to turbulent flow within a tube:

a. Small diameter
b. Large diameter
c. High viscosity
d. Low velocity
e. High density

Question 18

The following statements are true regarding the lymphatic system:

a. Lymph contains clotting factors
b. Protein content of lymph is generally more than that of plasma
c. The lymphatic system contains valves
d. Skeletal muscle contraction aids lymphatic flow
e. The thoracic duct is the largest lymphatic vessel

Question 19

Regarding blood flow in arterioles and capillaries:

a. Arterioles are the main site of resistance to blood flow
b. Blood flow in capillaries is pulsatile
c. Capillaries have no smooth muscle
d. Changes in temperature can affect flow
e. Precapillary sphincters have rich sympathetic innervation

Question 20

In a rigid tube:

a. Flow is directly proportional to the fourth power of the radius
b. Flow is inversely proportional to the pressure difference
c. Resistance is directly proportional to the length
d. Resistance is directly proportional to the square of the radius
e. If the radius is doubled, the resistance is increased by 16 times

Question 21

The following lung volumes or capacities can be measured by spirometry:

a. Functional residual capacity
b. Vital capacity
c. Total lung capacity
d. Inspiratory reserve volume
e. Expiratory reserve volume

Question 22

Regarding lung compliance:

a. The normal total lung compliance is 200 $cmH_2O.ml^{-1}$
b. Static compliance is greater than dynamic compliance
c. Compliance is increased when a patient is supine
d. It is determined by the gradient of the pressure–volume curve
e. It is greatly reduced in acute respiratory distress syndrome (ARDS)

Question 23

Regarding respiratory dead space:

a. In dead space, the V/Q ratio is zero
b. As dead space increases, p_aCO_2 falls
c. It is increased by general anaesthesia
d. Total dead space is determined using the Bohr equation
e. It is greater in the apices of the lungs than the bases

Question 24

When referring to work of breathing:

a. It is determined by the area inside a pressure–volume curve
b. Inspiratory work is that which overcomes the elastic recoil of the thoracic wall
c. Expiratory work is that which overcomes airway resistance
d. Work to overcome non-elastic forces is lost as heat
e. Respiratory work increases in a ventilated patient

Question 25

Regarding the functional residual capacity (FRC):

a. It is approximately 30 $ml.kg^{-1}$
b. Pulmonary vascular resistance is highest at FRC
c. It may be less than the closing capacity
d. It is increased under anaesthesia
e. It is decreased in pregnancy

Question 26

Concerning respiratory mechanics:

a. The diaphragm is responsible for 50% of the air that enters the lungs during spontaneous respiration
b. A third of the diaphragmatic fibres are slow twitch fibres
c. The transpulmonary pressure is equal to the difference between the pressure within the lungs and the intrapleural pressure
d. The accessory muscles of respiration serve to stabilize the upper rib cage and to prevent in-drawing in normal respiration
e. Compliance of the lung is defined as the change in pressure per unit change in volume

Question 27

Concerning surfactant:

a. Before 32–34 weeks' gestation, its production is inadequate and this predisposes to respiratory distress syndrome
b. Type II alveolar epithelial cells are responsible for its production
c. Less fluid is drawn from capillaries into alveoli as a result of its action
d. The hysteresis area of the pressure–volume loop is increased as a result of its action in reducing surface tension
e. Larger alveoli are seen to collapse more readily as a result of its action

Question 28

Regarding ventilation and perfusion matching in the upright lung:

a. From apex to base, ventilation increases; blood flow also increases, but less rapidly
b. The ventilation/perfusion ratio is higher at the apex of the lung and decreases progressively towards the base of the lung

c. The difference in partial pressures between the apex and base of the lung is greater for carbon dioxide compared with that for oxygen
d. Hypoxaemia that results from ventilation/perfusion inequality can be corrected by an increase in ventilation
e. Pulmonary emboli result in an increase in the ventilation/perfusion ratio

Question 29

Concerning alveolar ventilation and the alveolar gas equation:

a. At rest, the level of alveolar ventilation is the main determinant of the pO_2 of alveolar gas
b. Hypoventilation always results in an increased arterial pressure of carbon dioxide in the blood stream
c. The respiratory quotient is calculated by the oxygen consumption divided by the carbon dioxide production
d. Faced with hyperventilation, it takes longer for pCO_2 to reach equilibrium as compared with pO_2
e. Shunt refers to areas of the lungs where ventilation is adequate, but perfusion is deficient

Question 30

Concerning the distribution of blood flow in the lung described by West:

a. Zone 1 does not exist under normal conditions
b. In zone 2, the difference between alveolar and arterial pressures determines blood flow
c. In zone 3: Pa > PA > Pv
where Pv = venous pressure, Pa = arterial pressure and PA = alveolar pressure
d. From apex to base, the pressure responsible for driving blood flow increases
e. In zone 2, the arteriovenous pressure difference determines blood flow

Question 31

With reference to intermittent positive pressure ventilation (IPPV):

a. The addition of positive end-expiratory pressure (PEEP) increases the dead space
b. It increases the functional residual capacity (FRC)
c. It reduces V/Q mismatch
d. It results in an increase in antidiuretic hormone (ADH) secretion
e. High airway pressures cause a decrease in pulmonary vascular resistance

Question 32

At high altitude (2500 m above sea level):

a. The FiO_2 is 20.9%
b. The oxygen–haemoglobin dissociation curve (OHDC) is moved to the right initially
c. Hypoxic pulmonary vasoconstriction is beneficial

d. There is increased 2,3-DPG production
e. Polycythaemia is the most effective feature of acclimatization

Question 33

The non-respiratory functions of the lungs include:

a. Immune function mediated by pulmonary alveolar macrophages
b. Epinephrine breakdown
c. Angiotensin I production
d. Fibrinolysis of blood clots in the pulmonary circulation
e. Drug metabolism by the cytochrome p450 system

Question 34

Increased oxygen binding to haemoglobin occurs with:

a. 2,3-DPG
b. HbF
c. Methaemoglobin
d. Bohr effect
e. Haldane effect

Question 35

Central chemoreceptors directly increase minute ventilation in response to:

a. Hypercarbia
b. Hypoxia
c. Acidosis
d. Hyperthermia
e. Anaemia

Question 36

Regarding the haemoglobin buffering system:

a. Haemoglobin is a weak acid
b. It increases plasma bicarbonate
c. It increases plasma chloride
d. It has a pKa of 8.1 when deoxygenated
e. It is facilitated by plasma carbonic anhydrase

Question 37

Prolonged oxygen therapy at atmospheric pressure can cause:

a. Cough
b. Retrolental fibroplasia
c. Pulmonary oedema
d. Renal failure
e. Tremors

Question 38

Acute respiratory failure can be a feature of:

a. Aspirin overdose
b. Tetanus
c. Hypersensitivity pneumonitis
d. Poliomyelitis
e. Guillain–Barré syndrome

Question 39

Diagnostic criteria for acute lung injury include:

a. Acute onset
b. Air bronchograms on chest radiograph
c. Pulmonary artery wedge pressure (PAWP) <20 mmHg
d. Hypoxaemia with p_aO_2 /F_iO_2 <27
e. Bilateral infiltrates on chest radiograph

Question 40

In chronic respiratory failure, the following are commonly seen on an arterial blood gas (ABG):

a. p_aO_2 under 8 kPa
b. Bicarbonate greater than 30 $mEq.l^{-1}$
c. p_aCO_2 greater than 6 kPa
d. Base excess greater than +2
e. COHb >15%

Question 41

The rate of diffusion of a gas through a tissue membrane is:

a. Directly proportional to the surface area of the membrane
b. Inversely proportional to the square root of the thickness of the membrane
c. Directly proportional to the difference in gas partial pressures either side of the membrane
d. Directly proportional to the solubility of the gas in the tissue
e. Inversely proportional to the square root of the molecular weight of the gas

Question 42

The alveolar–arterial (A–a) oxygen gradient in hypoxaemia:

a. Is normal in alveolar hypoventilation
b. Is elevated at high altitude
c. Is decreased in diffusion defects
d. Is increased in right-to-left shunt
e. Is decreased in V/Q mismatch

Question 43

Regarding the oxyhaemoglobin dissociation curve:

a. The curve is shifted to the right with an increase in pH
b. The curve is shifted to the left in stored blood
c. P50 is shifted to the right in chronic anaemia
d. P50 is shifted to the left in HbS (sickle cell)
e. P50 is shifted to the left in HbF

Question 44

Regarding carbon dioxide transport in blood:

a. CO_2 is 20 times more soluble in blood than oxygen
b. The majority of CO_2 is transported as bicarbonate
c. About 10% of CO_2 is dissolved unchanged in blood
d. CO_2 combines with water to form carbonic acid catalyzed by carbonic anhydrase in plasma
e. Binding of oxygen to haemoglobin reduces its affinity for CO_2

Question 45

Regarding peripheral and central chemoreceptors:

a. Central chemoreceptors respond to changes in pO_2, pCO_2 and $[H^+]$
b. Peripheral chemoreceptors respond to changes in oxygen content
c. Central chemoreceptor sensitivity to CO_2 may be lost in chronic lung disease
d. Aortic body chemoreceptors respond to changes in pH, pO_2 and pCO_2
e. Carotid body response to low pO_2 is potentiated by low pH

Question 46

The membrane potential of a neurone at rest:

a. Is more negative on the outside of the cell than the inside
b. Is maintained by the active transport of potassium ions out of the cell and sodium ions into the cell
c. Is more permeable to potassium ions than sodium ions
d. Is impermeable to anions
e. Is –50 mV

Question 47

The Nernst equation:

a. Calculates the potential difference that any ion would produce if the membrane was permeable to it
b. Calculates the value of the overall membrane potential
c. Requires knowledge of the absolute temperature
d. Calculates similar potentials to the real potential for all ions
e. Takes into account the electrostatic attraction of impermeable ions