

# Australian and New Zealand College of Anaesthetists

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## PRIMARY EXAMINATION

**WEDNESDAY, 20 MAY 2009**

**3:10 pm – 4:30 pm**

## PHYSIOLOGY

### **MULTIPLE CHOICE QUESTIONS**

#### NOTICE

- **ALL** questions must be answered
- Write the answer to each question on book provided.
- No queries regarding individual questions can be answered.
- There are 75 questions to answer in 75 minutes. You should answer each question in 1 minutes or less.
- All questions are worth equal marks.

**1. Which of the following statements are true of damping?**

- A. It helps to increase signal amplitude
- B. A damping factor of 0.8 provides optimal damping
- C. It is inversely proportional to the fifth power of the radius
- D. It is caused by the presence of air bubbles**
- E. Critical damping results in significant overestimation of pressure change

**2. Distribution of pulmonary ventilation & perfusion in the erect position:**

- A. Gradient of change in ventilation is greater than that for perfusion
- B. Ventilation increases as go up the lung
- C. Perfusion increases as go up the lung
- D. V:Q ratio at apex is greater than at base**
- E. None of the above

**3. Chronic vomiting leads to the following biochemical abnormalities:**

- A. hypotonic plasma due to the loss of hypotonic fluid in the vomit
- B. hypokalaemia from potassium loss in the vomit
- C. no change in plasma magnesium
- D. metabolic alkalosis**
- E. hypovolaemia and hyponatraemia so that aldosterone secretion decreases

**4. Coronary blood flow is:**

- A. Dominant in left coronary artery in 60% of people
- B. Better supply to subendocardium in systole
- C. Better supply to subendocardium in diastole**
- D. Better supply to left ventricle in systole
- E. Left ventricle > right ventricle during systole

**5. Gastric emptying is inhibited by:**

- A. acid in the duodenum**
- B. gastric distension
- C. gastrin
- D. protein
- E. parasympathetic activity

**6. Which is FALSE:**

- A. brain uses predominantly glucose
- B. 1 g of fat produces 9 cal
- C. brain cells cannot use ketone bodies for energy
- D. ketone bodies can be used by many peripheral tissues
- E. lactate is a commonly utilized energy source

**7. During voluntary movement, the Golgi tendon organ provides the central nervous system with information about**

- A. the length of the muscle being moved
- B. the velocity of the movement
- C. the blood flow to the muscle being moved
- D. the tension developed by the muscle being moved
- E. the change in joint angle produced by the movement

**8. Physiological dead space:**

- A. Is improved by pneumonia
- B. Will fall with hypovolaemia
- C. Can be reduced by pulmonary embolism
- D. Is increased by PEEP
- E. Is equipment independent

**9. Which of the following statements about the rotameter and its characteristics are true?**

- A. It is a variable pressure, variable orifice flowmeter
- B. The calibration of rotameters is gas specific
- C. The flow through the tube is laminar
- D. Viscosity of the gas determines the resulting flow at the top of the tube
- E. Readings of the flow rate are taken from the middle of the bobbin

**10. Which of the following is a normal characteristic of lung?**

- A. 3,000,000 alveoli
- B. Alveolar diameter 3 mm
- C. External surface area: 10 m<sup>2</sup>
- D. Alveolar surface area: 5 to 10 m<sup>2</sup>
- E. None of the above

**11. Which of the following statements are true?**

- A. A katharometer works on the principle of Joule–Thompson effect
- B. Graham's law states that the rate of diffusion of a gas is inversely proportional to the density
- C. The Ostwald solubility coefficient is the volume of gas dissolved in unit volume of liquid at standard temperature and pressure
- D. The blood–gas partition coefficient of a volatile anaesthetic agent is a measure of its potency
- E. Raoult's law states that the depression in vapour pressure of a solvent is directly proportional to the molality of the solute

**12. Which of the following statements are true?**

- A. Very compliant tubing in an arterial pressure monitoring system will overestimate systolic blood pressures
- B. Rate of rise of the upstroke in an arterial waveform reflects myocardial compliance
- C. Enlarged a waves in a central venous waveform are seen with tricuspid stenosis
- D. The P wave of the ECG occurs before the y descent of the central venous waveform
- E. In mitral stenosis, PCWP pulmonary capillary wedge pressure will be smaller than the LVEDP left ventricular end diastolic pressure

**13. Regarding the physiology of a cell:**

- A In muscle cells, the azurophilic granules are important for the storage of calcium ions
- B The process of DNA transcription is carried out by the enzyme RNA polymerase**
- C Oxidative phosphorylation takes place in the mitochondrial matrix
- D Regulation of gene expression occurs at the level of translation
- E In an RNA strand, introns are the sequences of nucleotides that have no useful information

**14. The following statements are true:**

- A Sensory nerves originating from the nuclear chain fibres show only dynamic responses
- B The vagus carries afferent nerves from the carotid body
- C Postganglionic sympathetic fibres are un-myelinated**
- D The postganglionic sympathetic fibres innervating sweat glands are adrenergic
- E The facial nerve supplies the parasympathetic secretory fibres to the parotid gland

**15. Highest O<sub>2</sub> saturation in the foetal circulation is in:**

- A. Thoracic IVC**
- B. Right atrium
- C. Ascending aorta
- D. Pulmonary vein
- E. Ductus arteriosus

**16. Regarding cerebral metabolic rate for oxygen (CMRO<sub>2</sub>), which is FALSE:**

- A. CMRO<sub>2</sub> under normal conditions is 15 ml/100 g/min**
- B. Hyperglycaemia is associated with an increase in cerebral metabolism
- C. The metabolic state of the brain can be assessed using jugular venous oxygen saturation
- D. At a brain temperature of 27°C, CMRO<sub>2</sub> is approximately halved
- E. Seizures are associated with an increase in CMRO<sub>2</sub>

**17. The following are associated with normal anion gap acidosis:**

- A. Diabetic ketoacidosis
- B. Lactic acidosis
- C. Salicylate poisoning
- D. Acetazolamide therapy**
- E. Pyroglutamic acidosis

**18. The following statements are FALSE:**

- A. CSF has a lower concentration of protein than plasma
- B. CSF is produced in the choroids plexus by ultra filtration of plasma
- C. Rate of CSF production is around 0.3 ml/min
- D. CSF flows from the lateral ventricle to the third ventricle through the foramen of Monro
- E. CSF is reabsorbed into the cerebral venous sinus exclusively by an active process**

**19. Which is INCORRECT regarding the physiological changes associated with aging:**

- A. Arm-brain circulation time is increased
- B. Closing capacity decreases with increasing age**
- C. Protein-binding of drugs is decreased
- D. Gastric-emptying is delayed
- E. The concentrating ability of the kidney is decreased

**20. Cardio-respiratory physiological changes during pregnancy:**

- A. Cardiac output increases by 20%
- B. Serum colloid osmotic pressure increases
- C. The risk of pulmonary oedema is maximum during the first stage of labour
- D. Pulmonary vascular resistance increases
- E. Central venous pressure remains unchanged**

**21. Regarding hormones that control blood glucose:**

- A. Growth hormone inhibits production of glycerol
- B. Somatostatin inhibits release of thyroid-stimulating hormone**
- C. C-peptide has no role in glucose homeostasis
- D. Cortisol decreases the effectiveness of glucagon
- E. Epinephrine inhibits gluconeogenesis in the kidney

**22. Human bile acids include all the following substances EXCEPT**

- A. cholic acid
- B. chenodeoxycholic acid
- C. deoxycholic acid
- D. lithocholic acid
- E. uric acid**

**23. Physiological changes that occur during starvation:**

- A. Triiodothyronine secretion increases
- B. Urinary nitrogen excretion decreases
- C. The brain can rely on ketone oxidation for its metabolic requirement**
- D. The body glycogen stores can last up to 1 week
- E. Gluconeogenesis is the final adaptive process

**24. The basic respiratory rhythm is generated by the**

- A. apneustic center
- B. nucleus parabrachialis
- C. dorsal medulla**
- D. pneumotaxic center
- E. cerebrum

**25. Which is FALSE regarding the Valsalva manoeuvre:**

- A. The Valsalva manoeuvre is forced expiratory effort against a closed glottis
- B. There is a brief fall in arterial blood pressure during phase 1**
- C. Baroreceptors are activated during phase 2 to elevate vascular resistance
- D. A reflex bradycardia occurs in phase 4
- E. The Valsalva ratio is the longest R-R interval during phase 4 divided by the shortest R-R interval during phase 2

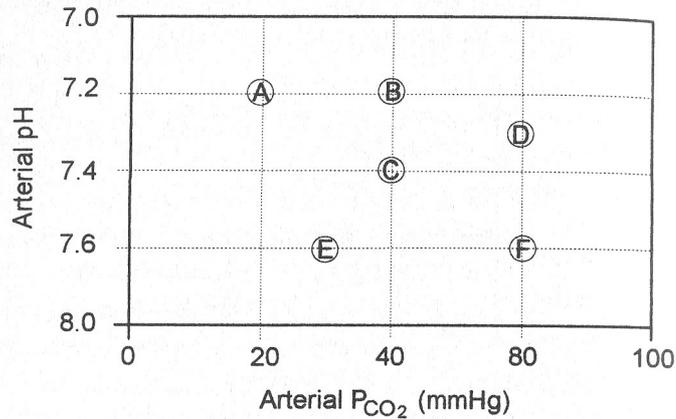
**26. Rapid infusion of 2 litres of normal saline causes:**

- A. Increased ECF, increased ICF, decreased [Na<sup>+</sup>]
- B. Increased ECF, unchanged ICF, increased [Na<sup>+</sup>]
- C. Unchanged ECF, increased ICF, increased [Na<sup>+</sup>]
- D. Increased ECF, unchanged ICF, unchanged [Na<sup>+</sup>]**
- E. Unchanged ECF, increased ICF, unchanged [Na<sup>+</sup>]

**27. Regarding various blood products available for replacement therapy, which is FALSE:**

- A Platelet concentrate requires ABO compatibility for transfusion**
- B Fresh frozen plasma contains fibrinogen
- C Factor VIII is commercially prepared as lyophilized powder from purified human plasma
- D Factor VIIa acts by activating factor X
- E Cryoprecipitate contains fibrinogen and von Willibrand factor

28-30. For each of the following conditions, select the point on the accompanying graph with which it is most likely to be associated.



28. Metabolic acidosis **A**

29. Respiratory acidosis **D**

30. Ascent to high altitude **E**

31. Respiratory physiology and the effects of ventilation:

- A. Vital capacity is the sum of inspiratory reserve volume and residual volume
- B. With increasing age the closing volume decreases with increasing age
- C. In a healthy individual bronchial resistance is greater during inspiration than expiration
- D. The ratio of dead-space volume and the volume of ventilation to perfused alveoli increases in COPD**
- E. In the west three zone model alveolar pressure is greater than pulmonary arterial pressure

**32. Regarding the factors affecting the flow of fluids:**

- A. The viscosity of a Newtonian fluid increases with an increase in temperature
- B. During laminar flow if the diameter of the tube is halved the flow is reduced by a factor of eight
- C. When considering the flow through an orifice, the flow rate is inversely proportional to the square root of the density of the fluid
- D. A mixture of helium 70% and oxygen 30% has a significantly lower viscosity compared with a mixture of nitrogen 70% and oxygen 30%
- E. The flows through a rotameter are unaffected at altitude

**33. The following statements regarding the cardiac cycle in a normal heart are true:**

- A. Immediately before ventricular systole each ventricle contains about 250 ml blood
- B. During ventricular systole, 85% of the blood is ejected from each ventricle
- C. During the first phase of ventricular diastole, both semilunar and AV valves are closed
- D. Atrial contraction accounts for about 35% of ventricular filling
- E. Atrial contraction becomes increasingly important for ventricular filling during bradycardia

**34. All of the following transport processes require energy EXCEPT the movement of**

- A. Sodium out of nerve cells
- B. calcium into the sarcoplasmic reticulum
- C. hydrogen into the lumen of the distal nephron
- D. glucose into adipose tissue
- E. potassium into striated muscle cells

**35. Regarding the Frank–Starling mechanism, which is FALSE:**

- A. States that the strength of myocardial contraction is a function of the initial length of the muscle fibres
- B. Could explain how stroke volume may be maintained when peripheral resistance rises
- C. Could explain the fall in cardiac output when a person changes from the supine to the standing position
- D. Could explain why the outputs of the left and right ventricles are equal in the long term
- E. Could explain the fall in cardiac output during severe sepsis**

**36. Concerning the ECG:**

- A. The T wave represents atrial repolarization
- B. The PR interval starts from the beginning of the P wave and ends at the end of the R deflection
- C. QRS complex greater than 0.12 seconds represents conduction delay**
- D. The T wave represents ventricular depolarization
- E. An abnormal ECG is always present when the circulation is grossly inadequate

**37. The resistance of the large and medium sized airways as a percentage of total airways resistance is approximately**

- A. 10%
- B. 20%
- C. 40%
- D. 60%
- E. 80%**

**38. The following substances are produced by the kidneys:**

- A Atrial natriuretic factor
- B 25-hydroxycholecalciferol
- C Aldosterone
- D Renin**
- E Antidiuretic hormone

**39. Beta receptors activate G proteins that activate**

- A. adeny cyclase**
- B. protein kinase A
- C. protein kinase C
- D. calmodulin
- E. phospholipase C

**40. Regarding the hepatic circulation, which is FALSE:**

- A. Normal portal venous pressure is about 10 mmHg
- B. a fall in hepatic artery flow results in increased portal vein flow**
- C. is mediated by cardiac output
- D. the hepatic artery usually supplies less than 50% of the blood supply
- E. is compromised by a reduction in splanchnic perfusion

**41. Excessive glutamate-mediated calcium entry into cells can lead to excitotoxicity and neuronal cell death. Which of the following statements are untrue?**

- A. Within a cell, calcium ions are vital for normal physiological processes
- B. homeostatic regulation of cytosolic Ca<sup>2+</sup> is tightly controlled
- C. Large internal Ca<sup>2+</sup> concentrations from excessive influx and release from intracellular stores overcome the regulatory mechanisms
- D. NMDA receptors are the sole source of excess Ca<sup>2+</sup> in ischaemia**
- E. NOS is activated by Ca<sup>2+</sup>

**42. Regarding the various principles governing the flow of fluids:**

- A. Laplace's law states that the pressure generated in a small sphere is less than the pressure in a large sphere
- B. Oxygen concentration delivered by a Venturi mask varies with the patient's minute volume
- C. Gay-Lussac's law states that the pressure is directly proportional to the absolute temperature at constant volume
- D. Movement of gases across the alveoli is governed by Graham's Law of Diffusion
- E. Work of breathing across the lung during inspiration increases as the flow rate decreases

**43. The following reflexes produce a tachycardia:**

- A. Bezold-Jarisch reflex
- B. Bainbridge reflex
- C. Cushing's reflex
- D. Head's paradoxical reflex
- E. Diving reflex

**44. Insulin deficiency results in all EXCEPT**

- A. loss of phosphate into the urine
- B. potassium moves out of cells
- C. magnesium moved intracellularly
- D. reduced plasma volume
- E. lipolysis

**45. If the QRS complex is positive in lead II and negative in lead III, the mean electrical axis (MEA) is between**

- A. -30 and +30
- B. +30 and +60
- C. +60 and +90
- D. +90 and +120
- E. +120 and +150

**46. A jugular venous pressure waveform:**

- A. Reflects the pressure changes in the left atrium
- B. Is normally visible when sitting at an angle of 45 degrees**
- C. The 'a' wave occurs just before right atrial contraction
- D. Giant 'a' waves are characteristic of tricuspid regurgitation
- E. The 'c' wave is caused by closing of the pulmonary valve

**47. Tissue oxygenation:**

- A. Acid/base status is a good indicator of ongoing shock and O2 debt**
- B. Clinical variables such as BP, HR and urine output are better indicators than SvO<sub>2</sub>, DO<sub>2</sub> and VO<sub>2</sub>
- C. Base deficit or lactate production indicates regional hypoperfusion
- D. Continuous use of PA catheterization is effective in improving the overall patient outcome
- E. pHi is a monitor of inadequate delivery of O<sub>2</sub> to the myocardium

**48. Dietary fat, after being processed, is extruded from the mucosal cells of the gastrointestinal tract into the lymphatic ducts in the form of**

- A. monoglycerides
- B. diglycerides
- C. triglycerides
- D. chylomicrons**
- E. Free fatty acids

**49. Regarding ventilation, which of the statements is correct:**

- A. CO<sub>2</sub> production is unchanged with a high temperature
- B. Shivering reduces temperature and reduces CO<sub>2</sub> production
- C. Glucose feeding tends to decrease CO<sub>2</sub> production
- D. Voluntary hyperventilation increases CO<sub>2</sub> production**
- E. Increased pulmonary artery perfusion decreases end tidal CO<sub>2</sub> values

**50. The following statements concerning arterial baroreceptors are true:**

- A. They are found in the carotid sinus**
- B. Their efferent fibres are carried by the glossopharyngeal nerve
- C. Stimulation of atrial baroreceptors leads to a fall in urine production via increased release of ADH
- D. Stimulation of carotid sinus baroreceptors results in inhibition of the vagus nerve activity
- E. Baroreceptors activity causes a rise in blood pressure

**51. The principle hormone secreted by the fetal adrenal cortex is**

- A. cortisol
- B. corticosterone
- C. dehydroepiandrosterone**
- D. progesterone
- E. pregnenolone

**52. Splitting of the second heart sound (S2) into two components is enhanced by**

- A. delayed closure of the aortic valve
- B. delayed closure of the mitral valve
- C. early closure of the pulmonary valve
- D. prolongation of atrial systole
- E. none of the above**

**53. If the extracellular K<sup>+</sup> concentration is increased from 4 meq/L to 10meq/L**

- A. the membrane potential will become more negative
- B. the sodium conductance will increase
- C. the potassium conductance will increase**
- D. the membrane will become more excitable
- E. the Na-K pump will become activated

**54. Temperature monitoring:**

- A. Can utilize expansion of air (aneroid gauge), liquid (alcohol or mercury) or metals (bimetallic strip)
- B. Constriction below the finebore tube prevents the liquid from retracting into the bulb reservoir until the thermometer is shaken
- C. Chemical thermometer use liquid crystals to measure skin temperature
- D. Thermocouples use the Seebeck effect whereby a small voltage is produced at the junction of 2 dissimilar metals.
- E. A thermistor is a semi-conductor from tiny beads of heavy metal oxides where electrical resistance increase with increasing temperature

**55. When breathing 100% oxygen, the mixed venous oxygen saturation is**

- A. 25%
- B. 50%
- C. 75%
- D. 85%
- E. 100%

**56. Normal pulmonary artery pressure**

- A. 10/0 mmHg
- B. 15/5 mmHg
- C. 25/10 mmHg
- D. 45/15 mmHg
- E. 120/80mmHg

**57. Liver synthesizes all but**

- A. vWF
- B. Prothrombin
- C. Antithrombin III
- D. Fibrinogen
- E. Albumin

**58. Diabetes insipidus untreated for 4 hours results in**

- A. Na 130, K 4.0, Osmol 280mosm/L
- B. Na 130, K 3.5, Osmol 300mosm/L
- C. Na 140, K 4.5, Osmol 320mosm/L
- D. Na 155, K 3.0, Osmol 320mosm/L**
- E. Na 155, K 3.5, Osmol 280mosm/L

**59. Regarding the management of poisoning. In what order would you perform the following:**

- \* 1. minimise absorption, increase excretion
- \* 2. ensure safety of health workers
- \* 3. manage airway, B, C
- \* 4. treat pharmacologic and toxicological effects

- A. 1,2,3,4
- B. 2,3,1,4
- C. 2,3,4,1**
- D. 4,3,2,1
- E. 4,2,3,1

**60. The alpha rhythm appearing on the electroencephalogram has which of the following characteristics?**

- A. It produces 20 to 30 waves per second
- B. It disappears when a patient's eyes open**
- C. It is replaced by slower, larger waves during REM sleep
- D. It represents activity that is most pronounced in the frontal region of the brain
- E. It is associated with deep sleep

**61. The constriction of a blood vessel to one half of its resting diameter would increase its resistance to blood flow by a factor of**

- A. 2
- B. 4
- C. 8
- D. 12
- E. 16**

**62. Hartmann's solution contains**

- A. Sodium 151 mmol/L
- B. Potassium 5 mmol/L**
- C. Calcium 3 mmol/L
- D. Magnesium 5 mmol/L
- E. Chloride 151 mmol/L

**63. The VO<sub>2</sub> max for a sedentary 40 year old male is about?**

- A. 3ml/kg/min
- B. 1 l/kg/min**
- C. 40ml/kg/min
- D. 90ml/kg/min
- E. 250ml/kg/min

**64. Which is true regarding the Clarke electrode?**

- A. Has a Ag/AgCl cathode and a platinum anode.
- B. Can measure pO<sub>2</sub> in both gas and blood sample.**
- C. Uses a 0.6 amp polarising current.
- D. Is accurate despite changing temperature.
- E. Is calibrated using a special electrical device.

**65. Regarding monitoring O<sub>2</sub> delivery, which is false:**

- A. Essential features are pulmonary function, Hb concentration and cardiac output
- B. At rest, O<sub>2</sub> delivered by alveolar ventilation is more than O<sub>2</sub> consumption (250 ml/min)
- C. The average PO<sub>2</sub> gradient across the alveolar capillary is 11mmHg
- D. If Hb is 97% saturated and Hb in 100 ml of blood carries 200 ml of O<sub>2</sub>**
- E. Conditions that facilitate O<sub>2</sub> unloading to the tissues include acidosis, hyperthermia and high 2, 3-DPG

**66. The monosynaptic stretch reflex uses the smallest number of neurons of any cord reflex. Stretch of a muscle spindle causes all of the following EXCEPT**

- A. Excitation of receptors
- B. excitation of motor nerves
- C. transmission of impulses to anterior motor neurons
- D. static as well as a dynamic reflex
- E. relaxation of the muscle containing the spindle**

**67. Person with these blood gas results: pH 7.33 CO<sub>2</sub> 58 HCO<sub>3</sub> 33**

- A. Acclimatization after several weeks at altitude
- B. Person with chronic pulmonary disease**
- C. Diabetic ketoacidosis
- D. Hyperventilation
- E. Prolonged vomiting

**68. Plasmin cleaves all the following except**

- A. II
- B. V
- C. VII**
- D. VIII
- E. XII

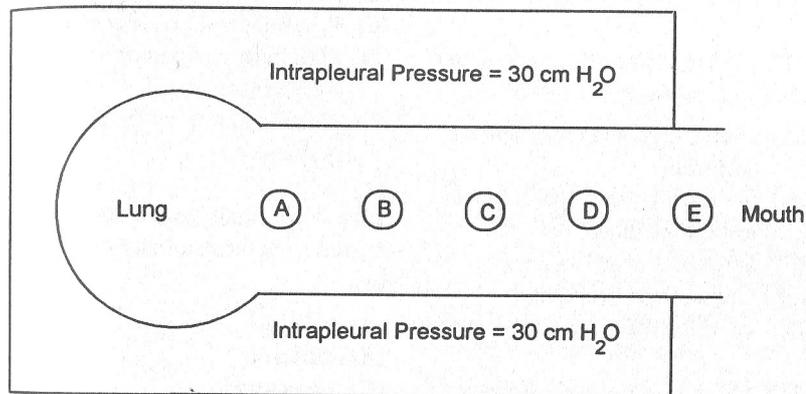
**69. Ammonia is an effective buffer and important urinary buffer for which of the following reasons?**

- A. Its production in the kidney decreases during chronic acidosis
- B. The walls of the renal tubules are impermeable to  $\text{NH}_3$
- C. The walls of the renal tubules are impermeable to  $\text{NH}_4^+$
- D. Its acid base reaction has a low pKa
- E. None of the above.

**70. Patient with following results: Na 122, K 6.7 Cl 80. Which is correct?**

- A. hyperaldosteronism
- B. adrenal insufficiency
- C. DKA
- D. Diabetes insipidus
- E. Water Toxicity

71-72. The diagram below illustrates the intrapleural pressure generated by a patient who exhales forcefully after a maximal inhalation.



71. If the intrapleural pressure at end of inspiration is  $-10\text{cm H}_2\text{O}$  and the intrapleural pressure during expiration is  $30\text{cmH}_2\text{O}$ , the equal pressure point will be closest to point

- A. A
- B. B**
- C. C
- D. D
- E. E

72. The equal pressure point would be most likely to move closer to the mouth with an increase in

- A. airways resistance
- B lung compliance
- C. lung volume**
- D. expiratory effort
- E. airway smooth muscle tone

**73. Phosphate buffer system is an effective buffer intracellularly and in renal tubules because:**

- A. Its pKa is close to the operating pH
- B. High concentration in distal tubule
- C. High concentration intracellularly
- D. All of the above**
- E. None of the above

**74. Post-translational modification occurs with:**

- A. Factor V
- B. Von Willebrand factor
- C. Factor XII
- D. Protein C**
- E. Factor VIII

**75. Diapedesis is a term related to**

- A. clotting
- B. platelet activation
- C. cardiac arrest
- D. migration of neutrophils**
- E. sickle cell anaemia