

# Cardiovascular

## Section 1

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- 1 Regarding ECG changes, which is CORRECT?
  - a) hypernatraemia is associated with low voltage complexes
  - b) the first change in hyperkalaemia is prolongation of QRS
  - c) with hypokalaemia, the resting membrane potential decreases
  - d) in hyperkalaemia, the heart stops in systole
  - e) in hypercalcaemia, myocardial contractility is enhanced
  
- 2 Regarding jugular pressure waves:
  - a) the 'v' wave denotes the increased atrial pressure due to the bulging of the tricuspid valve during isovolumetric ventricular contraction
  - b) in tricuspid insufficiency, there is a giant 'A' wave with each ventricular systole
  - c) atrial premature beats produce an 'A' wave
  - d) the 'v' wave occurs during systole
  - e) a giant 'C' wave ('cannon wave') may be seen in complete heart block
  
- 3 What factor does not alter cardiac output?
  - a) standing up
  - b) sleeping
  - c) eating
  - d) exercising
  - e) pregnancy
  
- 4 What is the O<sub>2</sub> consumption of a beating heart at rest?
  - a) 2ml/100g/min
  - b) 9ml/g/min
  - c) 2ml/g/min
  - d) 2L/100g/min
  - e) 9ml/100g/min
  
- 5 Regarding percentages of blood volume in the body:
  - a) the heart has 5%
  - b) the pulmonary circulation has the greatest percentage
  - c) the venous circulation has 35%
  - d) the aorta has 2%
  - e) capillaries have 20%

- 6 What is a biological action of endothelin?
- a) dilates vascular smooth muscle
  - b) produces bronchodilation
  - c) increase GFR and renal blood flow
  - d) evokes positive inotropic and chronotropic effects on myocardium
  - e) inhibits gluconeogenesis
- 7 What inhibits gene transcription for endothelin-1 secretion:
- a) nitric oxide
  - b) angiotensin II
  - c) insulin
  - d) growth factors
  - e) catecholamines
- 8 Regarding NO synthase:
- a) it synthesises nitrous oxide from arginine
  - b) there are 2 isoforms
  - c) it is inactivated by haemoglobin
  - d) NOS-1 is activated by cytokines
  - e) NOS-2 is in endothelial cells
- 9 What factor dilates the arterioles?
- a) decreased local temperature
  - b) myogenic theory of autoregulation
  - c) angiotensin II
  - d) increased discharge of noradrenergic vasomotor nerve
  - e) histamine
- 10 Which is NOT a baroreceptor site?
- a) right atria at the entrance of SVC and IVC
  - b) aortic arch
  - c) left atria at the entrance of the pulmonary veins
  - d) pulmonary circulation
  - e) carotid body
- 11 Regarding cerebrospinal fluid:
- a) the total volume of CSF is 300mL
  - b) CSF is absorbed through the choroid plexus
  - c) the average CSF pressure is 220m-CSF
  - d) CSF has a higher pH than plasma
  - e) it contains very low levels of cholesterol relative to plasma

- 12 Which substance has equal concentrations in CSF and plasma?
- $\text{Ca}^{2+}$
  - $\text{K}^{+}$
  - $\text{Na}^{+}$
  - $\text{PCO}_2$
  - glucose
- 13 Which vessel has the lowest  $\text{PO}_2$ ?
- maternal artery
  - maternal vein
  - uterine vein
  - umbilical vein
  - umbilical artery
- 14 During exercise:
- diastolic BP increases more than systolic BP
  - regional blood flow to the brain doubles
  - cardiac output may increase 15-fold
  - after exercise, BP takes longer to return to normal than heart rate
  - $\text{O}_2$  consumption of skeletal muscle may increase 100-fold
- 15 Atrial systole:
- causes a decrease in atrial pressure
  - causes the 'A' wave of the jugular pulse
  - causes the 'C' wave of the jugular pulse
  - causes the 'V' wave of the jugular pulse
  - causes the dicrotic notch of the aortic pulse
- 16 The depolarisation of cardiac muscle cells is characterised by:
- a slow depolarisation, a plateau then a rapid repolarisation
  - initial depolarisation due to a slow  $\text{Na}^{+}$  influx
  - repolarisation due to  $\text{K}^{+}$  efflux through two types of  $\text{K}^{+}$  channels
  - a plateau phase due to slowly opening  $\text{Na}^{+}$  channels
  - calcium efflux during the plateau phase
- 17 Regarding cardiac electrical properties:
- all cardiac cells have the same resting membrane potential
  - cholinergic fibres act predominantly by blocking tonic sympathetic input
  - discharge rates of pacemaker tissue does not change significantly with temperature
  - the bundle of HIS is not the most rapidly conducting part of the conducting system
  - the last parts of myocardium to depolarise normally do not include the septum

- 18 Abnormalities causing ECG changes in myocardial infarction include:
- delayed repolarisation early on
  - delayed depolarisation
  - increased resting membrane potential
  - TQ segment elevation
  - current flow away from the infarct
- 19 Features of the venous system include all of the following EXCEPT:
- total volume is approximately 55% of the total vascular volume
  - compliance approximately 25 times the arterial side
  - total volume of venules is twice the total capillary volume
  - valves in the cerebral circulation
  - substantial venoconstriction in response to noradrenaline
- 20 Arteriolar constriction is caused by:
- serotonin
  - ANP
  - NO
  - $K^+$
  - histamine
- 21 Regarding the inputs into the vasomotor centre:
- baroreceptors causes stimulation
  - chemoreceptors cause inhibition
  - baroreceptors provide significant input below 70mmhg mean arterial pressure
  - atrial stretch receptors inhibit the vasomotor centre
  - direct inputs include  $pO_2$
- 22 CSF:
- volume is about 600ml
  - normal pressure is 5-10cm CSF
  - has a higher concentration of creatinine than plasma
  - has a higher concentration of urea than plasma
  - is formed solely in the choroid plexus

- 23 Regarding arrhythmias, which is TRUE?
- the PR interval is shortened but the QRS normal in length in Lown Ganong Levine syndrome
  - with respect to the long QT syndrome, the genetic defect can occur in both  $\text{Ca}^{2+}$  and  $\text{Na}^+$  channels
  - with respect to the long QT syndrome, the genetic defect can occur in both  $\text{Ca}^{2+}$  and  $\text{K}^+$  channels
  - in atrial fibrillation, the atria beat at 200-300bpm, with the ventricles varying from 80-160/minute (irregular) depending on variable AV conduction
  - ventricular premature beats are never benign
- 24 With regards to CSF and the blood brain barrier, which is NOT true?
- the concentration of  $\text{K}^+$  in CSF is 2.9  $\text{mEq/L}$   $\text{H}_2\text{O}$
  - the concentration of creatinine is approximately equal to that of plasma
  - the kety method utilises inhaled  $\text{N}_2\text{O}$  to determine cerebral blood flow
  - injection of hypotonic fluids can disrupt the blood brain barrier
  - the chemoreceptor trigger zone for vomiting is in the area postrema
- 25 Foetal circulation, which is TRUE?
- HbF has a higher affinity for  $\text{O}_2$  than HbA as it binds 2,3DPG more effectively than HbA
  - the sucking action of the first breath in the newborn, plus constriction of the umbilical veins, squeezes as much as 250ml blood from placenta
  - bradykinin dilates umbilical veins and the ductus arteriosus, while constricting the pulmonary bed
  - blood in the umbilical veins is believed to be about 80% saturated with  $\text{O}_2$
  - the placenta is a more efficient gas exchange organ than the adult lungs
- 26 Regarding the conduction system of the heart:
- the right bundle branch (of HIS) divides into anterior and posterior fascicles
  - the AV node contains P cells
  - myocardial fibres have a resting membrane potential of -60mV
  - action potential in the SA and AV nodes are largely due to  $\text{Na}^+$  influx
  - there are two types of  $\text{K}^+$  channels in pacemaker tissue – transient and long acting
- 27 During systole:
- the peak left ventricular pressure is 160mmHg
  - contraction of the atria propels 70% of the ventricular filling
  - the period of isovolumetric ventricular contraction is 0.5sec????
  - the end systolic ventricular volume is about 50mL
  - coronary blood flow to subendocardial portions of the left ventricle occur only in systole

- 28 Regarding cardiac output:
- "energy of contraction is proportional to the initial length of the cardiac muscle fibre" is Fick's Law of the heart
  - cardiac index is the correlation between resting cardiac output and height
  - sleep decreases cardiac output
  - basal  $O_2$  consumption by the myocardium is 2ml/g/min
  - standing normally decreases the length of ventricular cardiac muscle fibres
- 29 Effects of electrolyte changes:
- PR interval increases in hyperkalaemia
  - in hyperkalaemia, the heart stops in systole
  - hypercalcaemia causes prolongation of the ST segments
  - hyponatraemia is associated with low voltage electrocardiographic complexes
  - magnesium counteracts digitalis toxicity
- 30 Which statement is TRUE regarding cardiac muscle?
- cardiac muscle fibres are multinucleated
  - they are smaller than skeletal muscle fibres
  - $Ca^{2+}$  release is triggered by membrane repolarisation
  - the elastic 'Titin' protein component is greater than in skeletal muscle, adding stiffness
  - the amount of  $Ca^{2+}$  in the sarcoplasmic reticulum is decreased by catecholamine stimulation
- 31 Which statement regarding cardiac "work" is FALSE?
- the energy applied to the blood stream is defined as kinetic plus potential
  - potential energy involves consideration of energy stored in elastic arterial walls and gravity
  - there is an exchange between kinetic and potential energy
  - the largest drop in energy occurs at the level of the precapillary sphincters
  - the higher resistance in smaller calibre vessels corresponds to greater energy losses
- 32 Which statement about blood flow is FALSE?
- cardiac output = stroke volume x heart rate
  - the volume of blood pumped through the lungs equals the volume entering the heart
  - Poiseuille's Law predicts the effects of pressure and resistance on cardiac output
  - the resistance of the systemic circulation is 5 to 10 times the pulmonary vascular resistance
  - with constant pressure, a vessel with radius '2X' has 16 times the flow of vessel with radius 'X'

- 33 Regarding haemodynamic principles, which statement is FALSE?
- a) viscosity of blood with haematocrit of 40 is three times that of water
  - b) 'arterial' blood volume is 10-15% total volume
  - c) 'elastance' measures a vessel's stiffness or recoil
  - d) aging causes increased elastance and therefore decrease in resting (unstressed) arterial volume
  - e) an increase in total peripheral resistance leads to increased arterial volume and BP
- 34 Considering conduction rates in myocardial cells, which statement is TRUE?
- a) Perkinje fibres are subepicardial and are the largest fibres, 4-7 times the width of other fibres
  - b) Perkinje fibres are 'fast fibres', and can conduct a wave of depolarisation at a speed of 4m/sec
  - c) the duration of the action potential and refractory period in fast fibres is shorter than slow fibres
  - d) initial depolarisation occurs in fast fibres with a rapid influx of  $Ca^{2+}$  ions from the sarcoplasmic reticulum
  - e) none of the above statements are true
- 35 With respect to splanchnic circulation:
- a) the liver is approximately 50% blood by volume
  - b) zone 3 of the hepatic acinus is well oxygenated
  - c) abdominal viscera receive at 30% cardiac output
  - d) liver receives blood from hepatic artery (1000ml/min) and hepatic vein (500ml/min)
  - e) muscular layer of intestinal wall has higher flow of mucosal layer
- 36 Blood pressure:
- a) the sounds of Korotkoff when taking blood pressure are caused by laminar flow
  - b) the diastolic pressure in resting adults correlates to the muffling of Korotkoff sound
  - c) pressures obtained by palpation of auscultation methods are usually 2-5mmHg higher
  - d) if cuff is inflated for some time, it can give falsely low BP readings
  - e) sounds of Korotkoff occur when velocity of flow through constriction exceeds critical velocity
- 37 Coronary circulation:
- a) left coronary artery has greater flow in 50% of people
  - b) thebesian veins connect arterioles to the heart chambers
  - c) cusps of the aortic valve occlude orifices of coronary arteries during LV ejection
  - d) coronary flow at rest is 250ml/min
  - e) at rest, heart extracts 50%  $O_2$  / unit of blood delivered

- 38 Regarding blood vessels:
- the large diameter arteries are the major site of resistance to blood flow
  - true capillaries are about 5µm in diameter at the arterial end and 9µm in diameter at the venous end
  - the aorta wall is 1mm thick
  - lymphatic endothelium contains fenestrations
  - angiogenin inhibits angiogenesis
- 39 Regarding blood flow:
- turbulence is always present when ??? is more than 2,000
  - flow is displacement per unit time (cm/s)
  - velocity is proportionate to flow multiplied by the area of the conduit
  - the Poiseuille-Hagen formula gives the relation between the flow in a long narrow tube, the viscosity of the fluid and the radius of the tube
  - whole blood is 7 times as viscous as water
  - turbulence is more frequent in polycythaemia because the viscosity of the blood is higher
- 40 Regarding venous circulation:
- pressure is higher in the veins compared with the venules
  - central venous pressure averages 6.4mmHg and fluctuates with respiration and heart action
  - the drop in venous pressure during expiration aids venous return
  - peripheral venous pressure is not affected by gravity
  - venous flow may be pulsatile
- 41 Which does not cause vasodilation?
- decreased O<sub>2</sub> tension
  - increased temperature
  - decreased K<sup>+</sup>
  - increased osmolality
  - adenosine
  - decreased pH
- 42 Regarding vasoactive substances:
- endothelial cells produce new cyclooxygen over four days
  - nitrous oxide synthase in immune cells is induced by increased intracellular calcium concentration
  - no synthase inhibition leads to a prompt rise in blood pressure
  - endothelin-1 is a potent vasodilator
  - angiotensin II inhibits secretion of endothelin-1

- 43 Heart rate is slowed by:
- a) decreased activity of baroreceptors
  - b) inspiration
  - c) Bainbridge reflex
  - d) stimulation of pain fibres in trigeminal nerve
  - e) increased activity of atrial stretch receptors
- 44 In myocardial infarction:
- a) rapid depolarisation by  $\text{Ca}^{2+}$  channels is shown by ST segment elevation
  - b) resting membrane potential is increased
  - c) arrhythmias in the first 30 minutes are due to re-entry whereas after 12 hours, the arrhythmias are due to increased automaticity
  - d) after three days arrhythmias are usually due to increased automaticity
  - e) failure to progression of the R wave occurs in infarction of the posterior left ventricle
- 45 Regarding the jugular pulse:
- a) the 'A' wave occurs prior to atrial systole
  - b) the 'C' wave is the rise in atrial pressure produced by the bulging of the mitral valve into the atria during isovolumetric ventricular contraction
  - c) the 'V' wave occurs during systole
  - d) venous pressure falls in expiration
  - e) cannon waves are giant 'A' waves seen in complete heart block
- 46 Which does NOT stimulate angiogenesis?
- a) platelet factor IV
  - b) angiogenin
  - c) tissue factor
  - d) IL-8
  - e) tumour necrosis factor  $\alpha$

# Cardiovascular

## Section 1 – Answers

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1	E	24	no answer
2	C	25	no answer
3	B	26	B
4	E	27	D
5	D	28	E
6	D	29	E
7	A	30	B
8	C	31	D
9	E	32	B
10	E	33	D
11	E	34	B
12	C	35	C
13	E	36	E
14	E	37	D
15	B	38	no answer
16	D	39	no answer
17	D	40	no answer
18	B	41	no answer
19	D	42	no answer
20	A	43	no answer
21	D	44	no answer
22	C	45	no answer
23	no answer	46	no answer

## Section 2

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- 1 Which statement is FALSE regarding CVS?
  - a) the primary function of the CVS uses convection
  - b) secondary function involves heat control
  - c) the heart is two pumps operating in parallel
  - d) the same volume of blood passes through each semilunar valve over time
  - e) the Frank Starling mechanism is used in balancing the output of both ventricles
  
- 2 Regarding the heart, which is TRUE?
  - a) the right and left ventricles perform the same amount of work, because the same volume of blood is pumped by each
  - b) the cross sectional shape of both ventricles is approximately cylindrical
  - c) the right ventricle pumps by a bellows type mechanism
  - d) the left ventricle pump action is via reducing cross-sectional area, as a function of radius cubed
  - e) in pulmonary disease the right ventricle hypertrophies and assumes a crescented shape in cross section
  
- 3 Which is FALSE? Stroke Volume varies with changes in:
  - a) ventricular contractility
  - b) arterial pressure
  - c) end diastolic volume of ventricle
  - d) blood viscosity
  - e) right ventricle compared to left
  
- 4 Regarding pressure in circulation, which is FALSE?
  - a) kinetic energy =  $\frac{M.V^2}{2}$  (mass x velocity<sup>2</sup>)
  - b) hydrostatic (gravitational) pressure = potential energy
  - c) the pressure in a foot vein may be 150 cm??? greater than at aortic root (in upright posture)
  - d) the same pressure differential applies in arterial system, (in upright posture)
  - e) the greatest pressure drop occurs in the capillaries
  
- 5 Regarding volumes in each compartment, which is FALSE?
  - a) 3% in LV and aorta
  - b) 15% in arterial system
  - c) 7% in capillaries
  - d) 50% in venous system (systemic)
  - e) 40% in pulmonary circulation

- 6 Regarding pressures, which is FALSE?
- lateral (static) pressure is reduced but prolonged by elastic arteries
  - static pressure increases with gravitation (hydrostatic) pressure increases
  - static pressure does not include kinetic energy
  - greater resistance to flow through a segment of circulation leads to greater loss of energy through that segment
  - kinetic energy becomes more significant in a narrowed segment and converts back to potential energy when the tube widens
- 7 Regarding flow, which is FALSE?
- flow is proportional to pressure gradient
  - flow is inversely proportional to resistance
  - Poiseuille's Law relates flow to pressure gradient and factors that influence resistance
  - Poiseuille' Law demonstrates that resistance to flow is largely determined by viscosity and length of tube and radius x 4
  - if radius of a vessel is halved, the flow may be reduced to 1/16<sup>th</sup> of previous flow
- 8 Concerning flow, which is TRUE in the circulatory system?
- the volume of flow is predicted by velocity ????
  - the widest cross sectional area in the circulation has a flow rate equal to the narrowest
  - increased viscosity (haematocrit) of blood does not influence the workload of the heart
  - the greatest cross-sectional area in the blood circulation is in the capillary beds
  - all of the above are true
- 9 Which statement about factors affecting blood pressure is FALSE? Factors that increase blood pressure are:
- increased heart rate
  - increased blood volume
  - pressure rises in increased cardiac output until the amount entering the arterial system equals the amount leaving
  - increased total peripheral resistance
  - increased end systolic volume
- 10 Regarding blood pressure, which is TRUE?
- M.A.P. = pulse pressure / 2 + diastolic pressure
  - elastance increases progressively with age
  - increase in arterial blood pressure causes a subsequent increase in stroke volume
  - increased sympathetic stimulation may sometimes lead to decreased cardiac output
  - pulse pressure increases with age because of decreased arterial elastance

- 11 Regarding red blood cells, all are true EXCEPT:
- erythropoiesis is stimulated by anaemia and hypoxia
  - after splenectomy, malaria has a higher mortality
  - normal adult haemoglobin is designated  $\alpha_2 \beta_2$
  - about 5% of adult haemoglobin is haemoglobin A<sub>2</sub> ( $\alpha_2 \delta_2$ )
  - G6PD deficiency increases red cell susceptibility to lysis by drugs and infection
- 12 Regarding the function of the heart:
- at increased heart rates, diastole is shortened more than systole
  - the pericardial sac normally contains about 50ml of fluid
  - during the cardiac cycle, left ventricular ejection begins before right ventricular ejection
  - during expiration, the aortic valve closes before the pulmonary valve
  - the end—diastolic ventricular volume is about 170ml
- 13 Regarding flow in vessels:
- velocity is greatest closest to blood vessel walls
  - turbulence is almost always present at a Reynold's number greater than 2,000
  - probability of turbulence in a vessel is directly related to twice the radius
  - flow in vessels is directly related to the fourth power of the ?????
  - turbulence is related to increasing radius
- 14 Which of the following does not increase the length of ventricular cardiac muscle fibres?
- increased total blood volume
  - increased venous tone
  - increased pumping action of skeletal muscle
  - increased negative intrathoracic pressure
  - increased intrapericardial pressure
- 15 Which of the following does not cause a systolic murmur?
- aortic stenosis
  - anaemia
  - mitral insufficiency
  - tricuspid stenosis
  - normal flow in children
- 16 Timing of events in the cardiac cycle:
- right atrial systole begins after left atrial systole
  - the pulmonary closes after the aortic in inspiration
  - right ventricular ejection starts after left ventricular ejection
  - right ventricular systole starts after left ventricular systole
  - right and left atrial systole are synchronous

- 17 Starling's Law of the heart:
- a) is an example of heteromeric regulation
  - b) is an example of homomeric regulation
  - c) is explained by troponin / tropomyosin overlap
  - d) relates stroke volume to cardiac output
  - e) bears little relation to in vivo regulation of the heart
- 18 The least frequent "ABO" gene is:
- a) A
  - b) B
  - c) O
  - d) AB
  - e) ABO
- 19 Stimulation of the right vagus:
- a) increases calcium inflow to the SA node
  - b) decreases calcium inflow to the AV node
  - c) increases potassium outflow in the SA node
  - d) increases potassium outflow in the AV node
  - e) decreases potassium outflow in the SA node
- 20 Starling's Law:
- a) defines a linear relationship between wall tension and force of contraction of cardiac muscle
  - b) is approximated by representing wall tension as preload and force of contraction as afterload
  - c) predicts greater force of contraction when filling pressure is decreased (eg during shock)
  - d) is explained by an increased availability of intracellular  $\text{Ca}^{2+}$
  - e) describes heterometric autoregulation
- 21 Pacemaker cells of the SA nodes:
- a) have an unstable membrane potential due to lack of sodium channels
  - b) display a 'prepotential' prior to depolarisation due to opening of slow calcium channels
  - c) do not 'overshoot' to the same degree as ordinary cardiac myocytes during depolarisation
  - d) control heart rate by virtue of the relatively large numbers of contractile fibres they contain
  - e) are primarily innervated by the left vagus nerve

22 Capillaries:

- a) contain approximately 20% of the blood volume at rest
- b) are often collapsed
- c) exchange fluids between the vascular compartment and ISF primarily by filtration
- d) are well innervated
- e) respond to metabolites such as  $K^+$ ,  $H^+$  and heat by (vaso)dilating

## Section 2 – Answers

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1	C
2	C
3	E
4	E
5	E
6	B
7	D
8	B, D
9	E
10	B
11	D
12	A
13	C
14	E
15	D
16	B
17	A
18	B
19	C
20	E
21	no answer
22	no answer

## ***Viva questions on vascular distensibility and function of the arterial and venous system***

- 1 Draw and describe the volume-pressure curve in the left ventricle
- 2 Describe the effects of systolic and diastolic dysfunction on the curve
- 3 Name the aides to venous flow
- 4 Describe the three venous waves
- 5 What are pulse pressure and mean pressure
- 6 Explain oedema and give causes for it
- 7 Explain La Places Law and give examples of its clinical relevance
- 8 Explain Starling forces and fluid ?????? and the capillary