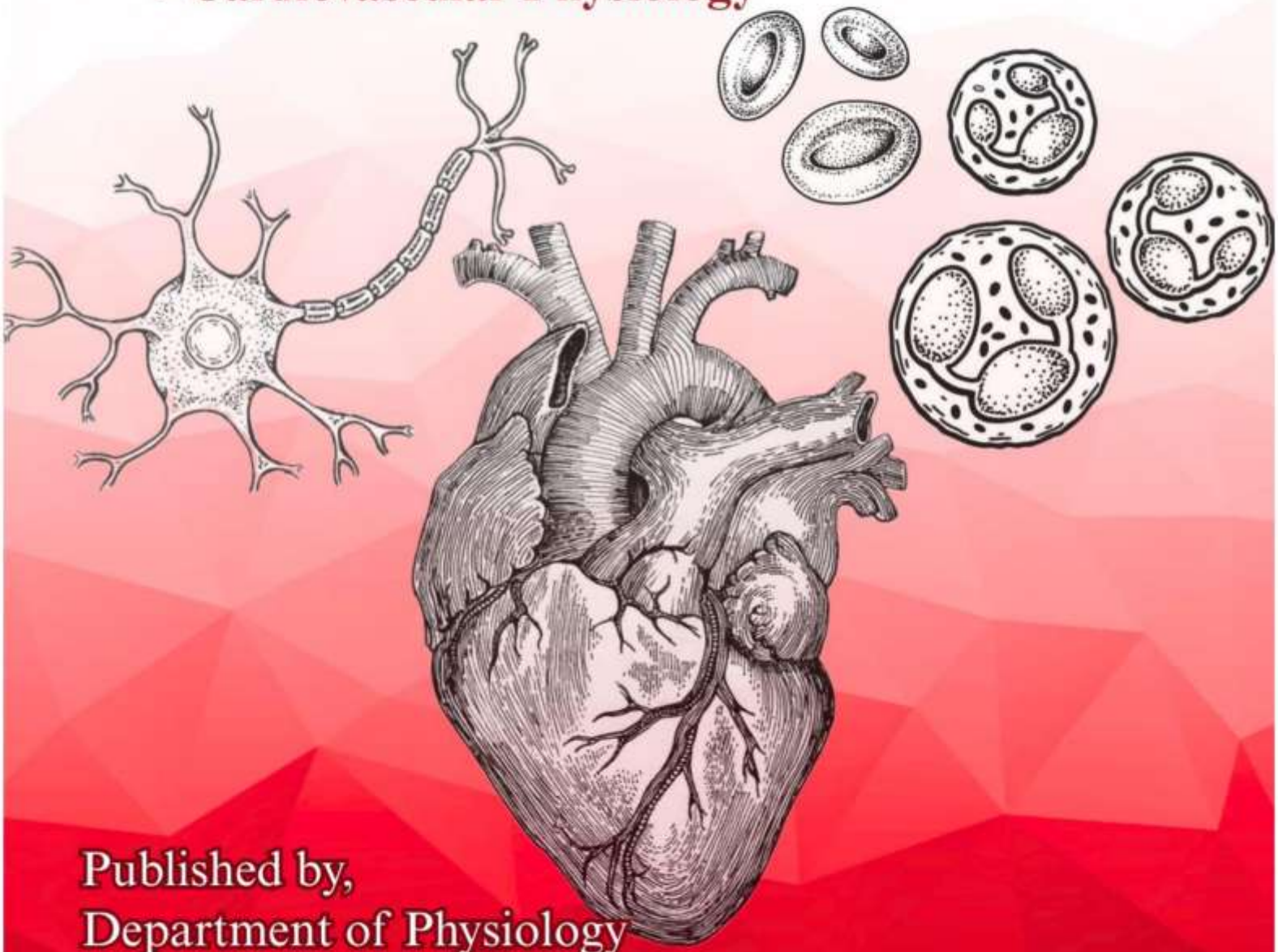
MASTERING PHYSIOLOGY
A Comprehensive Guide to MCQs, Essays, and OSPEs
Book – II

Uva Wellassa University

Batch 2 and 3 - Semester 1 (2026)

- **Body fluids, Nerve & Muscle**
- **Blood and Immunity**
- **Cardiovascular Physiology**



Published by,
Department of Physiology
Faculty of Medicine
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This book, including the multiple-choice questions (MCQs), answers, and rationales, is intended strictly for educational and examination review purposes for medical students. It is designed to reinforce learning and evaluate theoretical knowledge. It should not be treated as a clinical reference manual or used as a guide for real-world patient care, diagnosis, or treatment.

Mastering Physiology - A Comprehensive Guide to MCQs, Essays & OSPEs – Book II – Semester 1 (2026)

ISBN: 978-624-6685-51-5

Compiled by:
Department of Medical Education, Faculty of Medicine,
Uva Wellassa University of Sri Lanka,
Passara road, Badulla, Sri Lanka
90 000

Printed and published by:
Book – II: 26.01.2026. Rs. 1500/=

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Message from the Vice Chancellor

Dear Students,

It gives me great pleasure to extend my heartfelt congratulations and sincere appreciation to the Faculty of Medicine, Uva Wellassa University of Sri Lanka, and particularly to Senior Professor Muditha Vidanapathirana, Dean of the Faculty of Medicine, for their remarkable achievement in successfully publishing "Mastering Physiology – Semester 1 – Book – II (2026): A Comprehensive Guide to MCQs, Essays & OSPEs."

This publication serves as an exceptional academic resource, offering considerable value not only to the MBBS undergraduates of Uva Wellassa University of Sri Lanka but also to medical students throughout the country.

I strongly encourage students to make the best use of the high-quality learning materials developed by the Faculty of Medicine. Resources such as this guide can greatly enhance the learning process, making studies more organized, productive, and rewarding.

I wish you every success in your future academic pursuits and professional careers.

Senior Professor Kolitha B. Wijesekara
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26.01.2026

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PHYSIOLOGY PRACTICE MCQ (T/F & SBR) QUESTIONS

1. Body fluids, Nerve & Muscle
2. Blood and Immunity
3. Cardiovascular Physiology

Body fluids, Nerve & Muscle

(1)True or False regarding body fluid organization and compartments?

(A) Total body water constitutes approximately 60% of body weight in an average adult male.
(B) Intracellular fluid accounts for about two-thirds of total body water.
(C) Plasma volume forms the largest component of the extracellular fluid compartment.
(D) Na^+ is the major cation in the extracellular fluid, whereas K^+ is the major cation in the intracellular fluid.
(E) The protein concentration is higher in interstitial fluid than in plasma.

(2)True or False regarding membrane transport and cell signaling?

(A) Simple diffusion occurs down an electrochemical gradient and does not require a carrier protein.
(B) Facilitated diffusion requires energy derived from ATP hydrolysis.
(C) Endocrine signalling involves chemical messengers acting on adjacent cells.
(D) Second messengers amplify the signal generated by ligand–receptor interaction.
(E) Binding of a ligand to its receptor is the first step in a cell signalling pathway.

(3)True or False regarding pH, buffers, and hydrogen ion homeostasis?

(A) Normal arterial plasma pH is maintained between 7.35 and 7.45.
(B) H+ ions in the body are mainly generated from metabolic processes and CO2 hydration.
(C) A buffer is a substance that minimizes changes in pH by reversibly binding hydrogen ions.
(D) The bicarbonate buffer system is the most important extracellular buffer system.
(E) Arterial blood gas analysis is used to assess plasma pH and electrolyte status.

(4)True or False regarding body fluids?

(A) Starling forces determine capillary fluid movement.
(B) An increase in capillary hydrostatic pressure can lead to oedema formation.
(C) A decrease in plasma protein concentration promotes fluid movement into the interstitial space.
(D) Obstruction of lymphatic drainage may result in pitting oedema.
(E) Lymph returns excess interstitial fluid and plasma proteins back to the systemic circulation.

(5)True or False regarding nerve fibres and membrane potentials?

(A) Aα nerve fibres are large, myelinated fibres with fast conduction velocity.
(B) Unmyelinated C fibres conduct impulses faster than myelinated B fibres.
(C) The resting membrane potential is mainly determined by K+ permeability across the cell membrane.
(D) In depolarization phase of AP, voltage-gated Na+ channels open, & Na+ influx into cell occurs.
(E) Saltatory conduction occurs in unmyelinated nerve fibres.

(6)True or False regarding nerve conduction and nerve injury?

(A) Saltatory conduction occurs in myelinated nerve fibres and increases conduction velocity.
(B) In demyelinating neuropathies, conduction velocity is typically reduced.
(C) Wallerian degeneration occurs distal to the site of a complete nerve transection.
(D) Acetylcholine is the primary neurotransmitter released at the neuromuscular junction.
(E) Electromyography (EMG) primarily measures sensory nerve conduction velocity.

(7)True or False regarding water balance and dehydration?

(A) Total body water is approximately 60% of body weight in an average adult male.
(B) Dehydration refers to a decrease in total body sodium content.
(C) ADH primarily regulates ECF volume by controlling water reabsorption in the kidneys.
(D) In isotonic dehydration, both ECF volume and plasma osmolality decrease.
(E) 0.9% saline is considered an isotonic solution and mainly expands the ECF compartment.

(8)True or False regarding autonomic nervous system (ANS), receptors, neurotransmitters, and drugs?

(A) Sympathetic outflow originates from the thoracolumbar region of the spinal cord.
(B) Ach is the neurotransmitter released by all preganglionic autonomic neurons.
(C) Norepinephrine primarily targets muscarinic receptors in organs.
(D) An agonist binds to a receptor, producing a response similar to the endogenous ligand.
(E) Ach released by Parasympathetic postganglionic acts on nicotinic receptors at effector organs.

(9)True or False regarding physiology of skin and thermoregulation?

(A) The skin acts as a barrier preventing excessive water loss and entry of pathogens.
(B) Eccrine sweat glands play an important role in thermoregulation through evaporative heat loss.
(C) Cutaneous vasoconstriction increases heat loss from the body.
(D) The hypothalamus acts as the main temperature-regulating center of the body.
(E) Shivering increases heat production by increasing skeletal muscle activity.

(10)True or False regarding muscle physiology?

(A) The sarcomere is the functional unit of skeletal muscle and is bounded by two Z-lines.
(B) In skeletal muscle, calcium binds to troponin C to initiate contraction.
(C) Smooth muscle contraction depends on troponin for regulation.
(D) During moderate exercise, skeletal muscle mainly produces ATP through oxidative phosphorylation.
(E) The Fenn effect is greater heat during loaded shortening than isometric contraction.

Single Best Response Questions

(11) A 45-year-old man is diagnosed with a pituitary adenoma secreting excessive growth hormone (GH). GH binds to its receptor on target cells and initiates a cascade of intracellular events that ultimately alters gene transcription. No second messenger such as cAMP is generated, but receptor activation leads to phosphorylation of intracellular proteins.

Which of the following best describes the mechanism of action involved in this signalling pathway?

(A) Ligand-gated ion channel activation causing membrane depolarization
(B) G-protein–coupled receptor activation with cAMP as a second messenger
(C) Receptor tyrosine kinase activation leading to phosphorylation cascades
(D) Intracellular receptor binding with direct DNA interaction
(E) Transport of the hormone into the cell by facilitated diffusion

(12) A 60-year-old man with chronic obstructive pulmonary disease presents with increasing drowsiness and shortness of breath. Arterial blood gas analysis shows:

pH: 7.30
$PaCO_2$: 60 mmHg
HCO_3^-: 30 mmol/L

Which of the following mechanisms is primarily responsible for minimizing the change in plasma pH in this patient?

(A) Increased renal excretion of bicarbonate
(B) Immediate buffering of hydrogen ions by the bicarbonate buffer system
(C) Reduced hydrogen ion generation from cellular metabolism
(D) Increased alveolar ventilation to eliminate CO_2
(E) Increased phosphate buffering in the intracellular fluid

(13) A 58-year-old man with a history of chronic liver disease presents with progressive abdominal distension and bilateral ankle swelling. On examination, he has ascites and pitting oedema of both lower limbs. Laboratory investigations reveal low serum albumin levels.

Which of the following best explains the mechanism responsible for his oedema?

(A) Increased capillary hydrostatic pressure causing excessive filtration
(B) Decreased plasma oncotic pressure due to reduced plasma proteins
(C) Increased interstitial oncotic pressure due to lymphatic obstruction
(D) Decreased capillary permeability to proteins
(E) Increased lymphatic return to the systemic circulation

(14) A 35-year-old man sustains a deep laceration to his forearm. On examination, he has loss of fine touch and motor weakness in the affected area. Nerve conduction studies show markedly reduced conduction velocity in the injured nerve. The neurologist explains that the affected fibres are large and heavily myelinated.

Which of the following best describes the type of nerve fibre most likely affected?

(A) C fibres – small, unmyelinated fibres conducting slow pain
(B) B fibres – small, myelinated preganglionic autonomic fibres
(C) Aδ fibres – thin, myelinated fibres conducting fast pain
(D) Aα fibres – large, myelinated fibres conducting motor impulses
(E) Postganglionic sympathetic fibres – unmyelinated fibres

(15) A 40-year-old woman presents with progressive weakness and numbness in her limbs. Nerve conduction studies show markedly slowed conduction velocity with prolonged distal latencies but relatively preserved amplitude.

Which of the following is the most likely underlying mechanism?

(A) Axonal degeneration causing reduced action potential amplitude
(B) Demyelination causing impaired saltatory conduction
(C) Excess acetylcholine release at the neuromuscular junction
(D) Increased sodium channel density along the axon
(E) Complete nerve transection with Wallerian degeneration

(16) A 5-year-old child presents with acute diarrhea and signs of dehydration. Laboratory results show normal serum sodium concentration. The child is lethargic, with reduced skin turgor and tachycardia.

Which of the following is the most appropriate initial intravenous fluid?

(A) 5% dextrose in water
(B) 0.9% normal saline
(C) 3% hypertonic saline
(D) Half-normal saline (0.45% NaCl)
(E) Mannitol

(17) A 60-year-old man with benign prostatic enlargement is given a drug that blocks α_1-adrenergic receptors, leading to relaxation of smooth muscle in the bladder neck and prostate.

Which of the following best describes the action of this drug?

(A) It is an agonist that stimulates adrenergic receptors
(B) It is an antagonist that blocks adrenergic receptors
(C) It stimulates muscarinic receptors
(D) It increases acetylcholine release from sympathetic neurons
(E) It activates nicotinic receptors at autonomic ganglia

(18) A 22-year-old man is exercising outdoors at midday. His core body temperature rises, and he begins to sweat profusely. Activation of eccrine sweat glands helps reduce body temperature.

Which mechanism is primarily responsible for heat loss in this situation?

(A) Radiation
(B) Conduction
(C) Convection
(D) Evaporation of sweat from the skin surface
(E) Cutaneous vasoconstriction

(19) A physiologist records muscle electrical activity during voluntary contraction using surface electrodes placed over the biceps muscle. The recorded tracing shows summated motor unit potentials.

Which of the following is being recorded?

(A) Action potential of a single muscle fiber
(B) End plate potential
(C) Electromyogram (EMG)
(D) Mechanomyogram
(E) Intracellular calcium transient

Blood and Immunity

(20)True or False regarding blood, bone marrow, haemopoiesis, and RBC indices?

(A) Red bone marrow is the primary site of haemopoiesis in adults.
(B) Haematopoietic stem cells are multipotent and can give rise to all blood cell types.
(C) Erythropoietin is mainly produced by the liver in adults.
(D) Reticulocytes are immature red blood cells that still contain residual RNA.
(E) MCV indicates the average haemoglobin concentration within a red blood cell.

(21)True or False regarding anaemia, polycythaemia and haemoglobinopathies?

(A) Anaemia is defined as a decrease in haemoglobin concentration in blood.
(B) Iron deficiency anaemia typically causes microcytic hypochromic RBCs.
(C) Polycythaemia refers to an increased red blood cell mass.
(D) Sickle cell disease results from a mutation in the β-globin gene.
(E) β-thalassaemia is caused by reduced or absent β-globin chain synthesis.

(22)True or False regarding WBCs and immunity?

(A) Neutrophils are the most abundant leukocytes in peripheral blood.
(B) Innate immunity requires prior exposure to a pathogen.
(C) Lymphocytes are central to adaptive immune responses.
(D) Type I hypersensitivity is mediated mainly by IgG antibodies.
(E) Monocytes can differentiate into macrophages in tissues.

(23)True or False regarding haemostasis and platelet function?

(A) Haemostasis is the process that stops bleeding after vessel injury.
(B) Platelets adhere to damaged endothelium via von Willebrand factor.
(C) Platelets release ADP to reduce platelet aggregation.
(D) Platelets help form the primary haemostatic plug.
(E) Platelets contain fibrinogen and release it during activation.

(24)True or False regarding blood groups and transfusion?

(A) Group O individuals have both A and B antigens on RBCs.
(B) ABO blood groups are determined by antigens on RBC membranes.
(C) Rh-negative individuals lack the D antigen on RBCs.
(D) Anti-D antibodies are naturally present in Rh-negative persons.
(E) Mismatched transfusion can cause acute hemolytic reaction.

(25)True or False regarding bleeding disorders and investigations?

(A) Hemophilia A is caused by deficiency of factor VIII.
(B) Platelet disorders prolong bleeding time but not PT.
(C) Prothrombin time assesses the intrinsic pathway.
(D) Thrombocytopenia causes normal bleeding time.

(E) aPTT is prolonged in intrinsic pathway defects.

(26)True or False regarding blood component therapy, spleen & plasmin?

(A) Cryoprecipitate contains platelets.

(B) Packed RBC transfusion is used to treat anemia.

(C) Platelet transfusion is useful in thrombocytopenia.

(D) Splenectomy may increase circulating platelet count.

(E) Plasmin promotes formation of fibrin clot.

Single Best Response Questions

(27) A 24-year-old man presents with fatigue. Blood tests show Hb 8 g/dL. Peripheral smear shows small red blood cells. His RBC indices are:

MCV = 68 fL (low)
MCH = low
MCHC = slightly reduced

Which RBC index specifically reflects the average volume (size) of individual red blood cells?

(A) Haematocrit
(B) Mean corpuscular haemoglobin (MCH)
(C) Mean corpuscular haemoglobin concentration (MCHC)
(D) Mean corpuscular volume (MCV)
(E) Reticulocyte count

(28) A 22-year-old man presents with fatigue and pallor. Blood tests show low haemoglobin, low MCV, and hypochromic red blood cells. Serum ferritin is also reduced.

Which of the following is the most likely diagnosis?

(A) Iron deficiency anaemia
(B) Polycythaemia vera
(C) Sickle cell anaemia
(D) β-thalassaemia major
(E) Acute haemolytic anaemia

(29) A 6-year-old child receives a tetanus vaccine. The vaccine contains an antigen that stimulates the child's immune system to produce specific antibodies and memory lymphocytes.

Which type of immunity is produced?

(A) Passive natural immunity
(B) Passive artificial immunity
(C) Active natural immunity
(D) Active artificial immunity
(E) Innate immunity

(30) A 30-year-old man presents with easy bruising and prolonged bleeding after minor cuts. Laboratory tests show normal platelet count but impaired platelet aggregation.

Which of the following is the most likely defect?

(A) Reduced fibrin formation
(B) Defective platelet adhesion via von Willebrand factor
(C) Decreased red blood cell production
(D) Increased clot retraction
(E) Excess thrombin formation

(31) A newborn develops jaundice within 24 hours of birth. The mother is Rh-negative and the baby is Rh-positive. Direct Coombs test is positive.

What is the most likely cause of this condition?

(A) ABO incompatibility causing mild hemolysis
(B) Maternal anti-D antibodies destroying fetal RBCs
(C) Reduced bilirubin conjugation in the liver
(D) Excess production of fetal hemoglobin
(E) Infection leading to neonatal sepsis

(32) A 10-year-old boy presents with recurrent joint bleeding. Investigations show:

- **Normal platelet count**
- **Normal bleeding time**
- **Prolonged aPTT**
- **Normal PT**

What is the most likely diagnosis?

(A) Von Willebrand disease
(B) Hemophilia A
(C) Thrombocytopenia
(D) Vitamin K deficiency
(E) Disseminated intravascular coagulation

(33) A 35-year-old patient undergoes splenectomy after trauma. Two weeks later, blood tests show increased platelet count.

What is the most likely explanation?

(A) Increased platelet production by bone marrow
(B) Reduced destruction and sequestration of platelets
(C) Increased plasmin activity in blood
(D) Increased synthesis of clotting factors
(E) Reduced erythropoietin secretion

Cardiovascular Physiology

(34)True or False regarding cardiac cycle and ventricular function?

(A) Isovolumetric contraction occurs after AV valve closure.
(B) Stroke volume equals EDV minus ESV.
(C) Aortic pressure falls during ventricular ejection.
(D) Ejection fraction reflects systolic function of ventricle.
(E) Right ventricle generates higher pressure than left ventricle.

(35)True or False regarding heart sounds, murmurs & cardiac output?

(A) First heart sound is due to closure of AV valves.
(B) Aortic stenosis produces a diastolic murmur.
(C) Cardiac output equals stroke volume × heart rate.
(D) Frank-Starling law relates EDV to stroke volume.
(E) Positive inotropic effect decreases contractility.

(36)True or False regarding cardiac muscle & electrical activity?

(A) Cardiac muscle cells are connected by intercalated discs.
(B) SA node has the fastest pacemaker rate in the heart.
(C) Plateau phase in cardiac AP is due to K^+ influx.
(D) AV node delay allows proper ventricular filling.
(E) Mechanical contraction occurs before electrical depolarization.

(37)True or False regarding a normal electrocardiogram (ECG)?

(A) Standard paper speed is 25 mm/s.
(B) 1 small square equals 0.02 s.
(C) P wave represents atrial depolarization.
(D) QRS complex represents ventricular repolarization.
(E) PR interval reflects AV nodal delay.

(38)True or False regarding blood flow and vascular physiology?

(A) Blood flow = pressure difference / resistance.
(B) Increased vessel radius decreases resistance.
(C) Polycythaemia decreases vascular resistance.
(D) Turbulent flow occurs at high velocities.
(E) Veins act as major blood reservoirs.

(39)True or False regarding vascular regulation and baroreceptors?

(A) Autoregulation maintains constant flow despite pressure changes.
(B) Nitric oxide causes vasoconstriction.
(C) Baroreceptors are located in carotid sinus and aortic arch.
(D) Sympathetic activity causes vasodilation in most vessels.

(E) Valsalva maneuver can assess baroreceptor reflex.

(40)True or False regarding cardiovascular changes during exercise?

(A) Venous return decreases during exercise.
(B) Cardiac output increases during dynamic exercise.
(C) Stroke volume rises due to increased EDV.
(D) Myocardial oxygen use falls during exercise.
(E) Sympathetic activity increases myocardial contractility.

(41)True or False regarding assessment of cardiovascular function?

(A) ECG records the electrical activity of the heart.
(B) Troponin levels rise after myocardial injury.
(C) Echocardiography uses ionizing radiation.
(D) Doppler studies assess blood flow velocity.
(E) Coronary angiography visualizes coronary arteries.

(42)True or False regarding heart failure?

(A) Heart failure may reduce cardiac output.
(B) Pulmonary edema commonly occurs in right heart failure.
(C) Sympathetic activity decreases in heart failure.
(D) Reduced ejection fraction may occur in systolic failure.
(E) Peripheral edema is common in right heart failure.

(43)True or False Regarding blood pressure and venous pressure?

(A) Pulse pressure equals systolic minus diastolic pressure.
(B) JVP directly reflects left atrial pressure.
(C) Mean arterial pressure is nearer diastolic pressure.
(D) Korotkoff sounds occur during laminar flow.
(E) Inspiration normally reduces central venous pressure.

(44)True or False regarding coronary blood flow and shock?

(A) Coronary flow to the left ventricle is greatest in systole.
(B) Coronary vessels are compressed during ventricular systole.
(C) Myocardial hypoxia promotes coronary vasodilation.
(D) Shock may decrease coronary perfusion pressure.
(E) Coronary blood flow is unrelated to myocardial activity.

(45)True or False regarding blood flow through organs?

(A) Portal vein carries blood from liver to intestine.
(B) Coronary flow is greatest during left ventricular systole.
(C) Cerebral blood flow is tightly autoregulated.
(D) Skin blood flow helps regulate body temperature.
(E) Renal blood flow is high relative to kidney size.

Single Best Response Questions

(46) A 60-year-old man with ischemic heart disease undergoes echocardiography. His EDV is 120 mL and ESV is 60 mL.

What is his ejection fraction?

(A) 25%
(B) 40%
(C) 50%
(D) 60%
(E) 75%

(47) A 65-year-old man presents with exertional dyspnea. On auscultation, a harsh systolic murmur is heard at the right upper sternal border, radiating to the carotids.

Which of the following best explains the mechanism of this murmur?

(A) Turbulent flow across a narrowed aortic valve
(B) Backflow of blood into left atrium during systole
(C) Increased blood flow through a normal valve
(D) Closure of semilunar valves producing vibration
(E) Regurgitation of blood from aorta to left ventricle

(48) A 70-year-old man presents with bradycardia. ECG shows absence of P waves and a slow regular ventricular rhythm. The pacemaker is likely originating from the AV node.

Which of the following best explains the slower rate of the AV node compared to the SA node?

(A) Reduced calcium permeability during depolarization
(B) Steeper pacemaker potential slope in AV node
(C) Slower rate of spontaneous depolarization in AV node
(D) Increased potassium influx during phase 0
(E) Faster conduction velocity in AV node

(49) A 22-year-old medical student undergoes a routine ECG. The tracing is recorded at 25 mm/s. The R–R interval measures 4 large squares, the PR interval is 5 small squares, and the QRS duration is 2 small squares.

What is the most accurate interpretation?

(A) Heart rate 60 bpm, normal PR, normal QRS
(B) Heart rate 75 bpm, normal PR, normal QRS
(C) Heart rate 100 bpm, prolonged PR, normal QRS
(D) Heart rate 75 bpm, prolonged PR, prolonged QRS
(E) Heart rate 60 bpm, short PR, normal QRS

(50) A 60-year-old man with long-standing hypertension develops narrowing of a medium-sized artery. Despite a small reduction in vessel radius, there is a marked decrease in blood flow to the tissue.

Which principle best explains this finding?

(A) Flow is directly proportional to vessel length
(B) Resistance is inversely proportional to viscosity
(C) Resistance is inversely proportional to radius
(D) Resistance is inversely proportional to radius^4
(E) Flow is independent of vessel radius

(51) A 45-year-old man performs a Valsalva maneuver during a clinical test. During the strain phase, venous return decreases, leading to a fall in arterial pressure. This triggers a reflex increase in heart rate.

Which mechanism is primarily responsible for this response?

(A) Activation of chemoreceptors
(B) Increased parasympathetic outflow
(C) Decreased baroreceptor firing
(D) Increased baroreceptor firing
(E) Release of atrial natriuretic peptide

(52) A 24-year-old athlete begins vigorous exercise. His heart rate and systolic blood pressure rise markedly. The myocardium therefore requires more oxygen to meet the increased workload.

Which factor contributes most directly to the increased myocardial oxygen consumption?

(A) Reduced coronary blood flow
(B) Decreased ventricular wall tension
(C) Increased myocardial contractility
(D) Decreased heart rate
(E) Reduced systolic pressure

(53) A 58-year-old man presents with severe central chest pain radiating to the left arm for 4 hours. The clinician suspects an acute myocardial infarction and wants the most specific laboratory evidence of myocardial cell injury.

Which investigation is most useful?

(A) Echocardiography
(B) Coronary angiography
(C) Serum cardiac troponin level
(D) Doppler ultrasound
(E) Resting electrocardiogram

(54) A 68-year-old man presents with exertional dyspnea, orthopnea, and bilateral basal lung crepitations. Echocardiography shows a reduced ejection fraction.

Which physiological change most likely contributed to his symptoms?

(A) Decreased pulmonary capillary pressure
(B) Reduced left ventricular end-diastolic volume
(C) Increased pulmonary venous pressure
(D) Decreased sympathetic activity
(E) Reduced systemic venous pressure

(55) A 54-year-old man is being evaluated for hypertension. His blood pressure is recorded as 160/100 mmHg using a sphygmomanometer.

What is his pulse pressure?

(A) 40 mmHg
(B) 50 mmHg
(C) 60 mmHg
(D) 100 mmHg
(E) 160 mmHg

(56) A 63-year-old man develops severe hypotension following acute blood loss. He becomes pale, tachycardic, and confused. Reduced coronary perfusion is suspected.

Why is coronary blood flow to the left ventricle normally greatest during diastole?

(A) Aortic pressure falls to zero during systole
(B) Coronary arteries are compressed during systole
(C) Ventricular relaxation reduces aortic pressure
(D) Coronary resistance increases during diastole
(E) Myocardial oxygen demand is lowest in systole

(57) A 26-year-old man exercises outdoors on a hot day. He develops marked cutaneous vasodilation and sweating to maintain body temperature.

Which organ circulation is primarily responsible for this thermoregulatory response?

(A) Cerebral circulation
(B) Coronary circulation
(C) Renal circulation
(D) Hepatic circulation
(E) Cutaneous circulation

PHYSIOLOGY PRACTICE MCQ (T/F & SBR) ANSWERS

(1)

(A) **T** - In an average adult male, total body water (TBW) is about 60% of body weight. This percentage varies with age, sex, and body fat content—being lower in females, elderly individuals, and obese persons due to higher fat proportion.

(B) **T -** The intracellular fluid (ICF) compartment contains approximately two-thirds of total body water, while the extracellular fluid (ECF) accounts for the remaining one-third. This reflects the fact that most body cells are water-rich.

(C) **F** - The extracellular fluid is divided into interstitial fluid and plasma. Interstitial fluid constitutes about 75% of the ECF, while plasma accounts for only about 25%. Therefore, interstitial fluid is the largest component of the ECF.

(D) **T** - Sodium (Na^+) is the predominant cation in the extracellular fluid and plays a key role in maintaining ECF volume and osmolarity. Potassium (K^+) is the principal intracellular cation and is essential for maintaining resting membrane potential and normal cellular function.

(E) **F** - Plasma contains a higher concentration of proteins (such as albumin, globulins, and fibrinogen) compared to interstitial fluid. The capillary membrane restricts the movement of large proteins, leading to lower protein levels in the interstitial fluid.

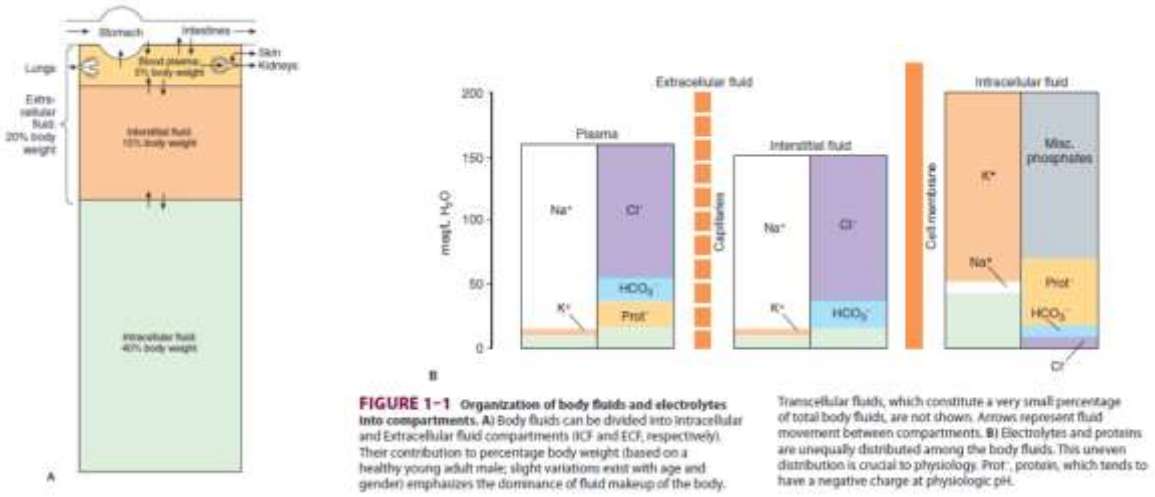


FIGURE 1–1 Organization of body fluids and electrolytes into compartments. **A)** Body fluids can be divided into intracellular and extracellular fluid compartments (ICF and ECF, respectively). Their contribution to percentage body weight (based on a healthy young adult male; slight variations exist with age and gender) emphasizes the dominance of fluid makeup of the body. Transcellular fluids, which constitute a very small percentage of total body fluids, are not shown. Arrows represent fluid movement between compartments. **B)** Electrolytes and proteins are unequally distributed among the body fluids. This uneven distribution is crucial to physiology. Prot$^-$, protein, which tends to have a negative charge at physiologic pH.

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(2)

(A) **T -** Simple diffusion is a passive process in which substances move from an area of higher concentration to lower concentration (or down an electrochemical gradient for ions). It does not involve carrier proteins or energy expenditure. Examples include diffusion of gases like O_2 and CO_2 across the lipid bilayer.

(B) **F** - Facilitated diffusion is also a passive process. Although it requires a specific carrier or channel protein, the movement of the substance still occurs down its concentration or electrochemical gradient and does not require ATP. Energy-dependent transport using ATP is seen in active transport, not facilitated diffusion.

(C) **F** - Endocrine signalling involves hormones released into the bloodstream that act on distant target cells. Signalling between adjacent cells is characteristic of paracrine or juxtacrine signalling, not endocrine signalling.

(D) **T** - Second messengers (such as cAMP, IP_3, DAG, Ca^{2+}) are generated inside the cell following receptor activation. One activated receptor can produce many second messenger molecules, leading to signal amplification and a large cellular response from a small initial stimulus.

(E) **T** - Cell signalling begins when a ligand (e.g. hormone, neurotransmitter, growth factor) binds to its specific receptor. This ligand–receptor interaction triggers intracellular signalling cascades that ultimately lead to a cellular response.

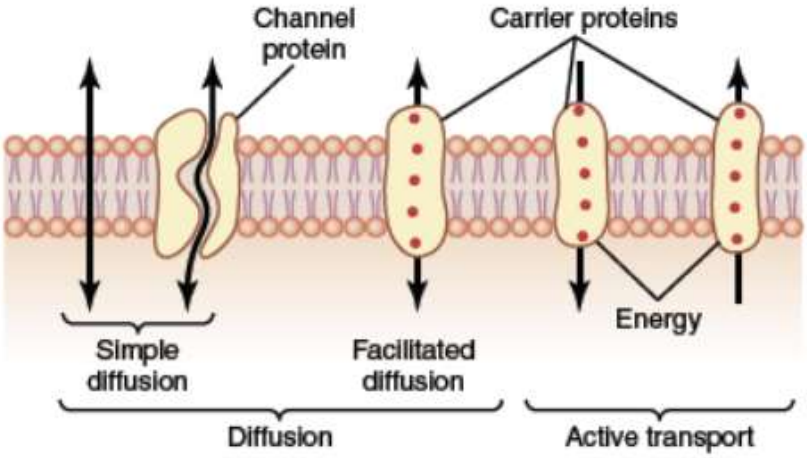


Figure 4-2. Transport pathways through the cell membrane and the basic mechanisms of transport.

Guyton and Hall Textbook of Medical Physiology 14th Edition p. 51

(3)

(A) **T** - Arterial blood pH is tightly regulated within a narrow range of 7.35–7.45, corresponding to a hydrogen ion concentration of approximately 40 nmol/L. Even small deviations outside this range can significantly alter enzyme activity, protein structure, membrane excitability, and cellular metabolism. Maintenance of this range is essential for normal physiological function.

(B) **T** - Hydrogen ions are produced continuously from:

- Carbon dioxide hydration, where CO_2 combines with water to form carbonic acid (via carbonic anhydrase), which dissociates into H^+ and HCO_3^-. This is the major source of acid load.
- Metabolic acids such as lactic acid, sulfuric acid, phosphoric acid, and ketoacids generated during normal metabolism.

Together, these processes contribute to daily acid production that must be buffered and excreted.

(C) **T** – Buffers are weak acids or bases that resist changes in pH by accepting or donating hydrogen ions. They act immediately to limit fluctuations in pH when acids or bases are added. Major physiological buffers include:

- Bicarbonate buffer system
- Phosphate buffer system
- Protein buffers (especially hemoglobin)

Buffers do not eliminate hydrogen ions but temporarily neutralize their effect until lungs and kidneys restore balance.

(D) **T** - The bicarbonate buffer system (H_2CO_3/HCO_3^-) is the principal buffer in extracellular fluid due to:

- Its high concentration in plasma

Its ability to be regulated independently by the lungs (CO_2 excretion) and kidneys (H^+ excretion and HCO_3^- regulation)

This open buffer system allows effective control of plasma pH over both short and long terms.

(E) **F** - Arterial blood gas (ABG) analysis is primarily used to assess:

- pH
- $PaCO_2$
- PaO_2
- HCO_3^- (calculated)

It does not directly measure electrolytes such as Na^+, K^+, or Cl^-. Electrolyte levels are assessed using serum biochemistry tests, though ABG findings must often be interpreted alongside electrolyte results in acid–base disorders.

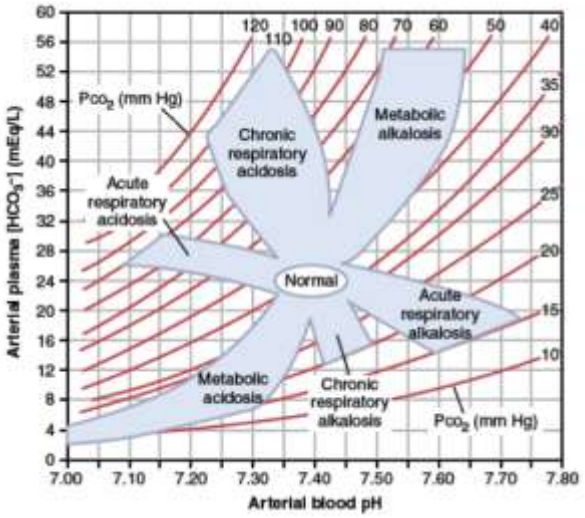


Figure 31-11. Acid–base nomogram showing arterial blood pH, arterial plasma HCO_3^-, and P_{CO_2} values. The *central open circle* shows the approximate limits for acid–base status in normal people. The *shaded areas* in the nomogram show the approximate limits for the normal compensations caused by simple metabolic and respiratory disorders. For values lying outside the shaded areas, one should suspect a mixed acid–base disorder. (*Modified from Cogan MG, Rector FC Jr: Acid-Base Disorders in the Kidney, 3rd ed. Philadelphia: WB Saunders, 1986.*)

Guyton and Hall Textbook of Medical Physiology 14th Edition p. 419

(4)

(A) **T** - Starling forces (capillary hydrostatic pressure, interstitial hydrostatic pressure, plasma oncotic pressure, and interstitial oncotic pressure) regulate fluid exchange across capillary walls.

(B) **T** - Increased hydrostatic pressure (e.g., in heart failure or venous obstruction) promotes excess filtration of fluid into the interstitial space, leading to oedema.

(C) **T** - Reduced plasma proteins (especially albumin) lower plasma oncotic pressure, decreasing fluid reabsorption at the venous end of capillaries and favoring oedema formation.

(D) **F** - Lymphatic obstruction typically causes non-pitting oedema because protein-rich fluid accumulates in the interstitium, leading to tissue fibrosis.

(E) **T** - The lymphatic system prevents protein accumulation in the interstitial space by returning excess fluid and proteins to the venous circulation, maintaining fluid balance.

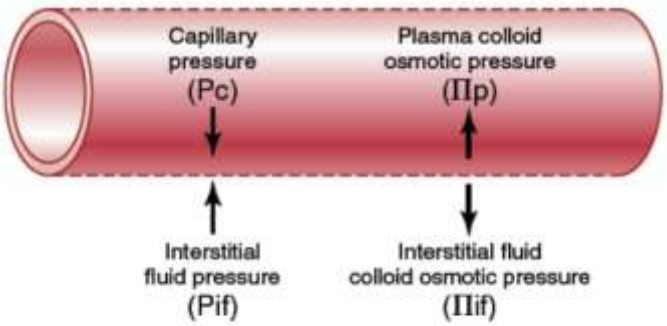


Figure 16-5. Fluid pressure and colloid osmotic pressure forces operate at the capillary membrane and tend to move fluid outward or inward through the membrane pores.

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(5)

(A) **T** - Aα fibres have the largest diameter and thick myelination, resulting in the highest conduction velocities (e.g., motor neurons to skeletal muscle).

(B) **F** - C fibres are small and unmyelinated, making them the slowest-conducting fibres. Myelinated B fibres conduct faster due to saltatory conduction.

(C) **T** - At rest, the membrane is most permeable to potassium due to leak channels. The outward diffusion of K^+ largely determines the resting membrane potential (approximately −70 mV in neurons).

(D) **T** - Rapid opening of voltage-gated Na^+ channels cause sodium influx, leading to membrane depolarization and the rising phase of the action potential.

(E) **F** - Saltatory conduction occurs only in myelinated fibres, where impulses jump between nodes of Ranvier. Unmyelinated fibres conduct impulses continuously and more slowly.

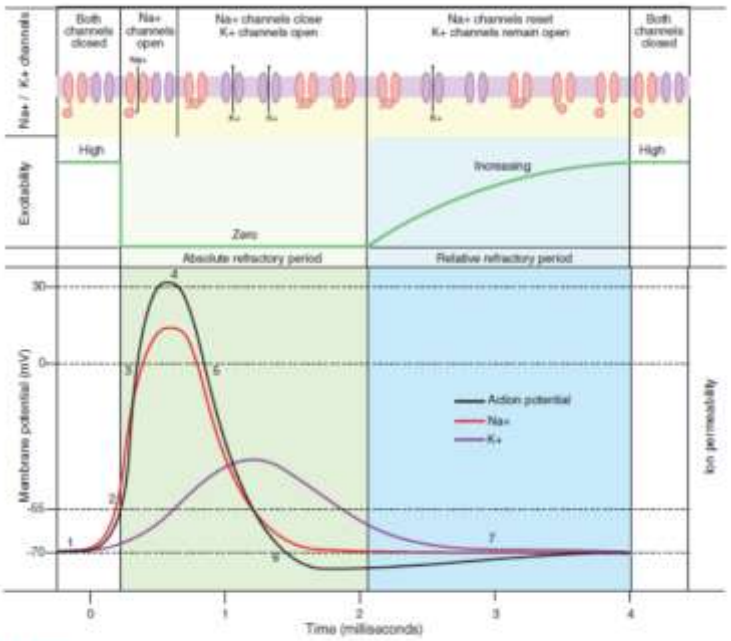


FIGURE 4–6 **Changes in membrane potential and relative membrane permeability to Na^+ and K^+ during an action potential.** Steps 1 through 7 are detailed in the text. These changes in threshold for activation (excitability) are correlated with the phases of the action potential. (Modified from Silverthorn DU: Human Physiology: An Integrated Approach, 5th ed. Pearson, 2010.)

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(6)

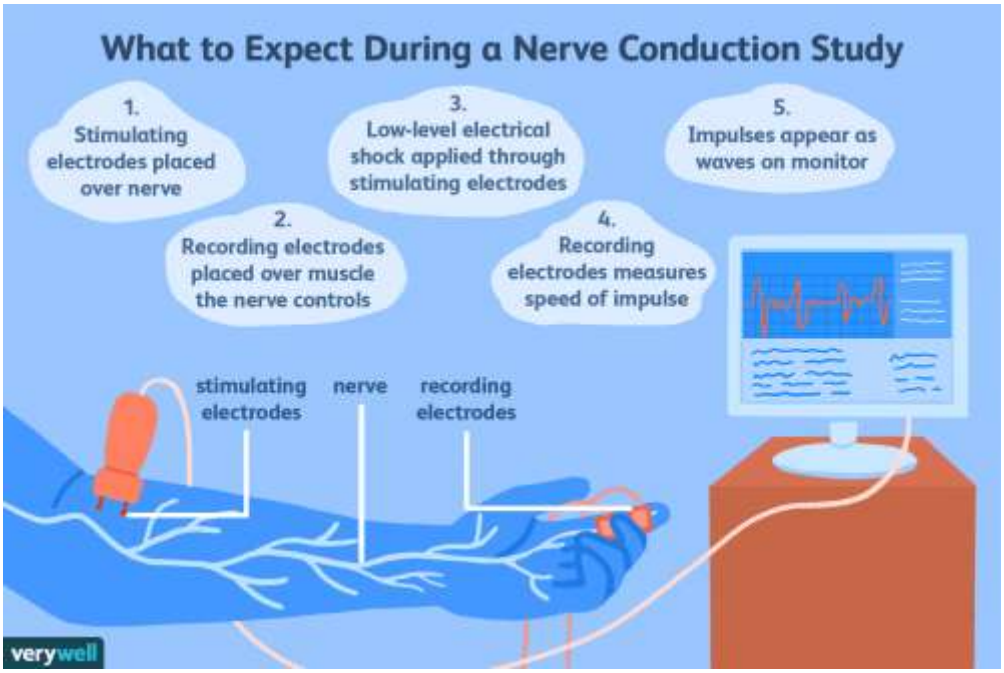
(A) **T** - In myelinated fibres, action potentials jump between nodes of Ranvier, greatly increasing conduction speed compared to unmyelinated fibres.

(B) **T** - Loss of myelin disrupts saltatory conduction, leading to slowed conduction velocity and prolonged latency on nerve conduction studies.

(C) **T** - After axonal injury, the distal segment degenerates due to loss of connection with the cell body.

(D) **T** - Motor neurons release acetylcholine at the neuromuscular junction to stimulate skeletal muscle contraction.

(E) **F** - EMG records electrical activity of muscle fibres. Nerve conduction studies (NCS) measure motor and sensory conduction velocity.



(7)

(A) **T** - In adult males, total body water (TBW) is about 60% of body weight (lower in females and elderly due to higher fat content).

(B) **F** - Dehydration refers primarily to loss of total body water. Sodium may be lost proportionately (isotonic), more than water (hyponatremic), or less than water (hypernatremic).

(C) **F** - ADH primarily regulates plasma osmolality by controlling water reabsorption in the collecting ducts.
ECF volume is mainly regulated by the renin–angiotensin–aldosterone system (RAAS) through sodium balance.

(D) **F** - In isotonic dehydration, ECF volume decreases, but plasma osmolality remains normal because water and sodium are lost proportionately.

(E) **T** - 0.9% NaCl is isotonic and remains in the extracellular space, expanding plasma and interstitial fluid volume without causing significant intracellular shifts.

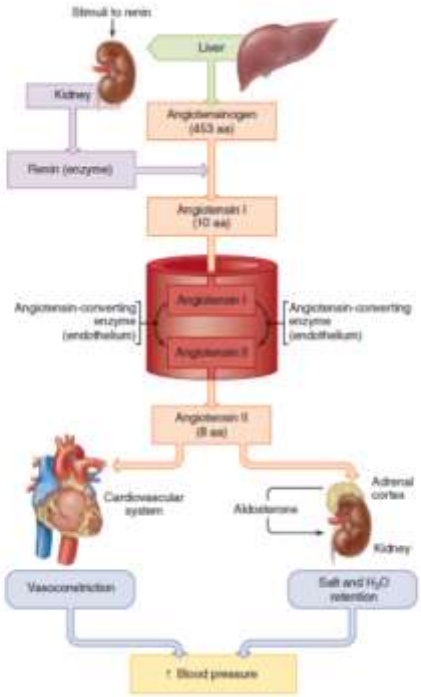


FIGURE 38–5 **Summary of the renin–angiotensin system and the stimulation of aldosterone secretion by angiotensin II.** The plasma concentration of renin is the rate-limiting step in the renin–angiotensin system; therefore, it is the major determinant of plasma angiotensin II concentration.

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(8)

(A) **T** - Sympathetic nerves arise from T1–L2 spinal cord segments (thoracolumbar outflow).

(B) **T** - Both sympathetic and parasympathetic preganglionic neurons release acetylcholine, acting on nicotinic (Nn) receptors in autonomic ganglia.

(C) **F** - Norepinephrine acts mainly on adrenergic receptors (α_1, α_2, β_1, β_2), not muscarinic receptors.

(D) **T** - An agonist activates the receptor, mimicking the natural neurotransmitter or hormone.

(E) **F** - Parasympathetic postganglionic ACh acts on muscarinic receptors, not nicotinic receptors.
(Nicotinic receptors are at autonomic ganglia, not the effector organ.)

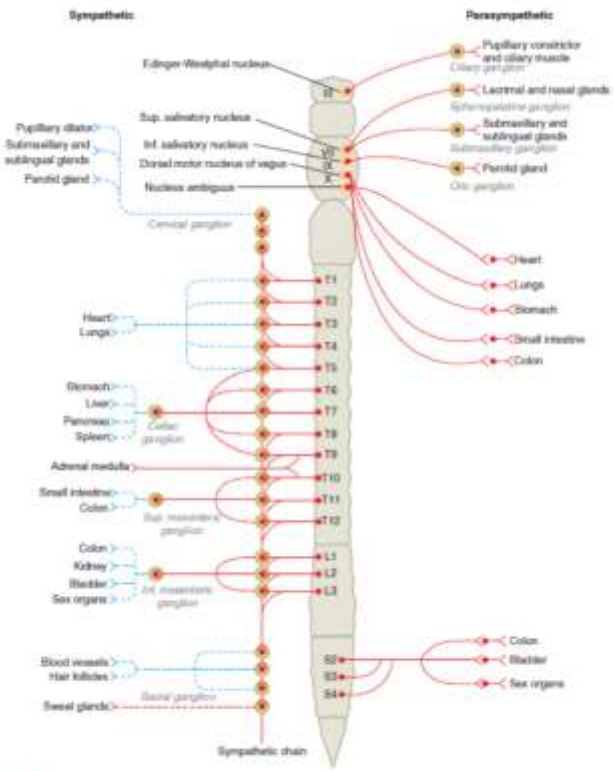


FIGURE 13-3 **Organization of sympathetic (left) and parasympathetic (right) nervous systems.** Cholinergic nerves are shown in red and noradrenergic nerves are shown in blue. Preganglionic nerves are solid lines; postganglionic nerves are dashed lines. (Courtesy of P. Berges, Michigan State University.)

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(9)

(A) **T** - The epidermis, especially the stratum corneum, contains keratin and lipid layers that make it relatively waterproof. This prevents excessive evaporation of water from the body. It also acts as a physical and immunological barrier against bacteria, viruses, and toxins.

(B) **T** - Eccrine sweat glands secrete watery sweat onto the skin surface. When sweat evaporates, it removes heat energy from the body. This is the main mechanism of heat loss in hot environments or during exercise.

(C) **F** - Cutaneous vasoconstriction actually reduces heat loss, not increases it. When skin blood vessels constrict, less warm blood reaches the skin, so less heat is lost to the environment. This occurs in cold conditions to conserve body heat.

(D) **T** - The hypothalamus acts like the body's thermostat. It receives input from:

- Central thermoreceptors (brain, spinal cord)
- Peripheral thermoreceptors (skin)

It activates responses such as:

- Sweating
- Vasodilation / vasoconstriction
- Shivering

(E) **T** - Shivering = rapid, involuntary skeletal muscle contractions. Muscle contraction uses ATP, which generates heat as a by-product. This helps increase body temperature during cold exposure

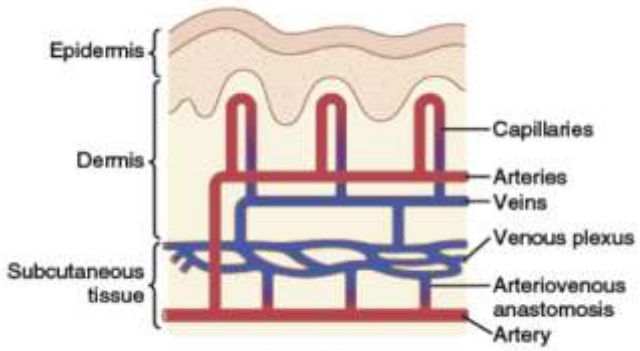


Figure 74-2. Skin circulation.

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(10)

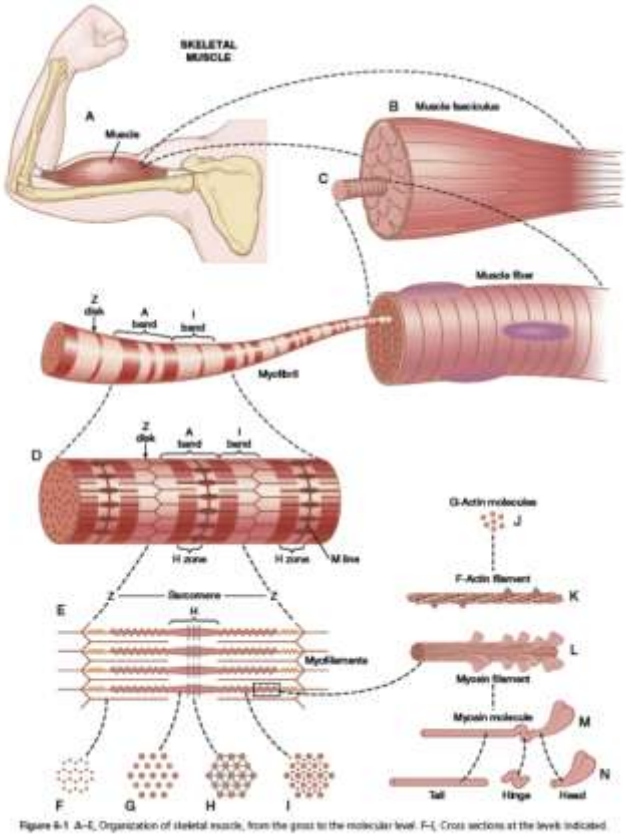
(A) **T** - The sarcomere is the basic contractile unit of skeletal muscle. It extends from one Z-line to the next and contains actin and myosin filaments.

(B) **T** - During excitation–contraction coupling, Ca^{2+} binds to troponin C, which moves tropomyosin away from actin's binding sites, allowing cross-bridge formation.

(C) **F** - Smooth muscle does not have troponin. Instead, Ca^{2+} binds to calmodulin, activating myosin light chain kinase (MLCK) to initiate contraction.

(D) **T** - In moderate, sustained exercise, ATP is primarily generated via aerobic metabolism (oxidative phosphorylation) in mitochondria. (High-intensity short bursts rely more on anaerobic glycolysis and phosphocreatine.)

(E) **T** - The Fenn effect states that more energy (and therefore more heat) is produced when a muscle shortens while lifting a load, compared to an isometric contraction at the same initial length.



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(11)**Correct Answer: C. Receptor tyrosine kinase activation leading to phosphorylation cascades**

Explanation

Growth hormone acts via a cell surface receptor that does not use classic second messengers like cAMP.

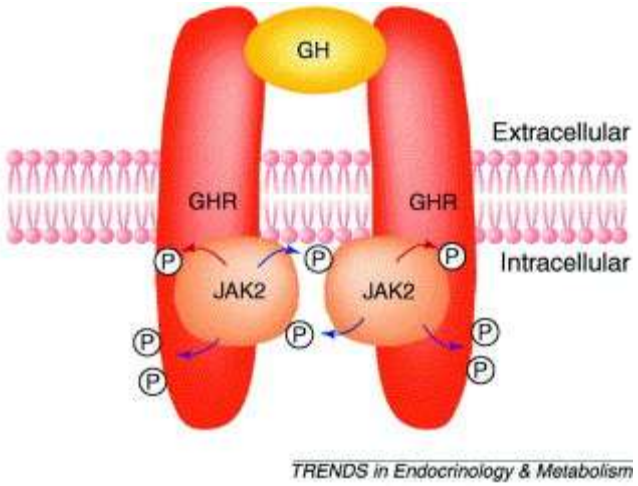
GH receptors belong to the cytokine receptor family, which signal through JAK–STAT pathways, a form of receptor-associated tyrosine kinase signalling.

Ligand binding causes receptor dimerization, activation of intracellular kinases, and phosphorylation of transcription factors that regulate gene expression.

GPCRs use second messengers like cAMP or IP_3/DAG (option B).

Steroid hormones act via intracellular receptors (option D).

Hormones do not enter cells via facilitated diffusion to initiate signalling (option E).



(12)**Correct Answer: B. Immediate buffering of hydrogen ions by the bicarbonate buffer** system

Explanation

The patient has respiratory acidosis due to CO_2 retention.

Increased CO_2 leads to increased formation of carbonic acid, raising H^+ concentration and lowering pH.

The bicarbonate buffer system is the main extracellular buffer and provides immediate buffering by binding excess hydrogen ions.

Renal compensation (option A) occurs over hours to days, not immediately.

Increased ventilation (option D) would correct the cause but is not the buffering mechanism.

Phosphate buffering plays a minor role compared to bicarbonate.

Table 31-3 Extracellular Fluid Characteristics of Primary Acid–Base Disturbances[a]

	pH	H^+	P_{CO_2}	HCO_3^-
Normal	7.4	40 mEq/L	40 mm Hg	24 mEq/L
Respiratory acidosis	↓	↑	↑↑	↑
Respiratory alkalosis	↑	↓	↓↓	↓
Metabolic acidosis	↓	↑	↓	↓↓
Metabolic alkalosis	↑	↓	↑	↑↑

[a]The primary event is indicated by the double arrows (↑↑ or ↓↓). Note that respiratory acid–base disorders are initiated by an increase or decrease in P_{CO_2}, whereas metabolic disorders are initiated by an increase or decrease in HCO_3^-.

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(13)**Correct Answer: B. Decreased plasma oncotic pressure due to reduced plasma proteins**

Explanation

Chronic liver disease reduces albumin synthesis.

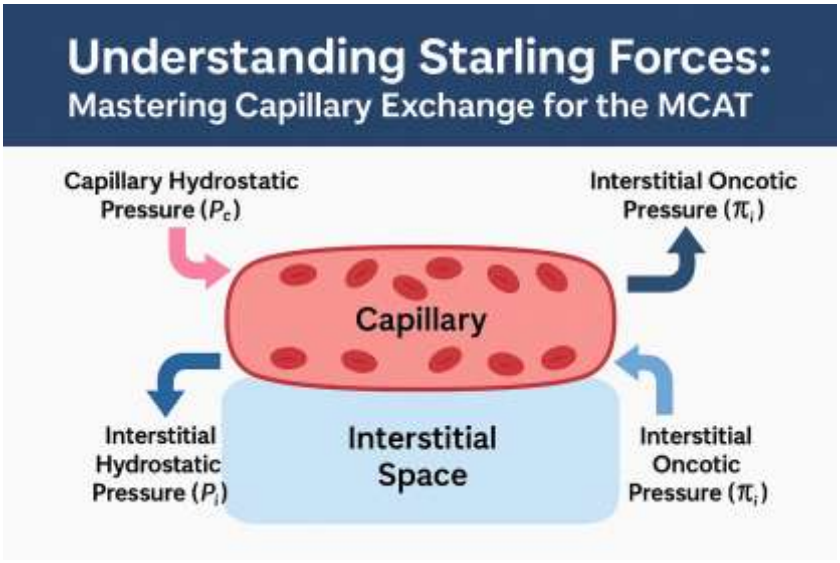
Albumin is the main contributor to plasma oncotic (colloid osmotic) pressure.

Reduced oncotic pressure decreases fluid reabsorption at the venous end of capillaries.

This results in net fluid movement into the interstitial space → pitting oedema and ascites.

This represents a derangement of Starling forces.

Lymphatic drainage may initially compensate but becomes overwhelmed.



(14)**Correct Answer: D. Aα fibres – large, myelinated fibres conducting motor impulses**

Explanation

Aα fibres are large-diameter, heavily myelinated fibres with the fastest conduction velocity.

They supply skeletal muscle (motor fibres) and are responsible for proprioception.

Large diameter and myelination reduce internal resistance and allow saltatory conduction, increasing conduction speed.

Loss of motor function and fine touch suggests involvement of large myelinated fibres.

C fibres and postganglionic sympathetic fibres are unmyelinated and conduct slowly.

Aδ fibres conduct fast pain but are thinner and slower than Aα fibres.

TABLE 4–1 Types of mammalian nerve fibers.

Fiber Type	Function	Fiber Diameter (μm)	Conduction Velocity (m/s)	Spike Duration (ms)	Absolute Refractory Period (ms)
Aα	Proprioception; somatic motor	12–20	70–120		
Aβ	Touch, pressure	5–12	30–70	0.4–0.5	0.4–1
Aγ	Motor to muscle spindles	3–6	15–30		
Aδ	Pain, temperature	2–5	12–30		
B	Preganglionic autonomic	<3	3–15	1.2	1.2
C_1 Dorsal root	Pain, temperature	0.4–1.2	0.5–2	2	2
C_2 Sympathetic	Postganglionic sympathetic	0.3–1.3	0.7–2.3	2	2

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(15)**Correct Answer: B. Demyelination causing impaired saltatory conduction**

Explanation

Conduction velocity depends largely on myelination and fibre diameter.

Demyelination disrupts saltatory conduction → slowed conduction velocity and prolonged latencies.

Axonal degeneration typically reduces amplitude rather than markedly slowing velocity.

Nerve conduction studies help differentiate demyelinating vs axonal neuropathies.

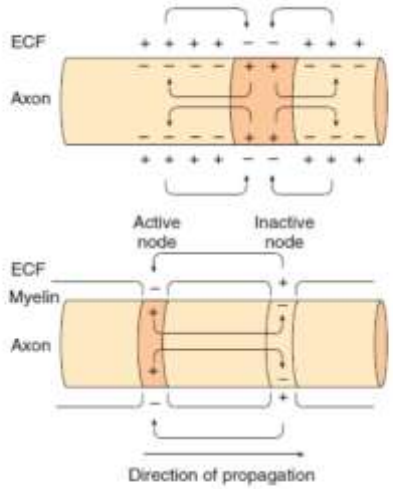


FIGURE 4–9 **Local current flow (movement of positive charges) around an impulse in an axon. Top:** Unmyelinated axon. **Bottom:** Myelinated axon. Positive charges from the membrane ahead of and behind the action potential flow into the area of negativity represented by the action potential ("current sink"). In myelinated axons, depolarization appears to "jump" from one node of Ranvier to the next (saltatory conduction).

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(16)**Correct Answer: B. 0.9% normal saline**

Explanation

Acute diarrhea commonly causes isotonic dehydration (loss of water and sodium proportionately).

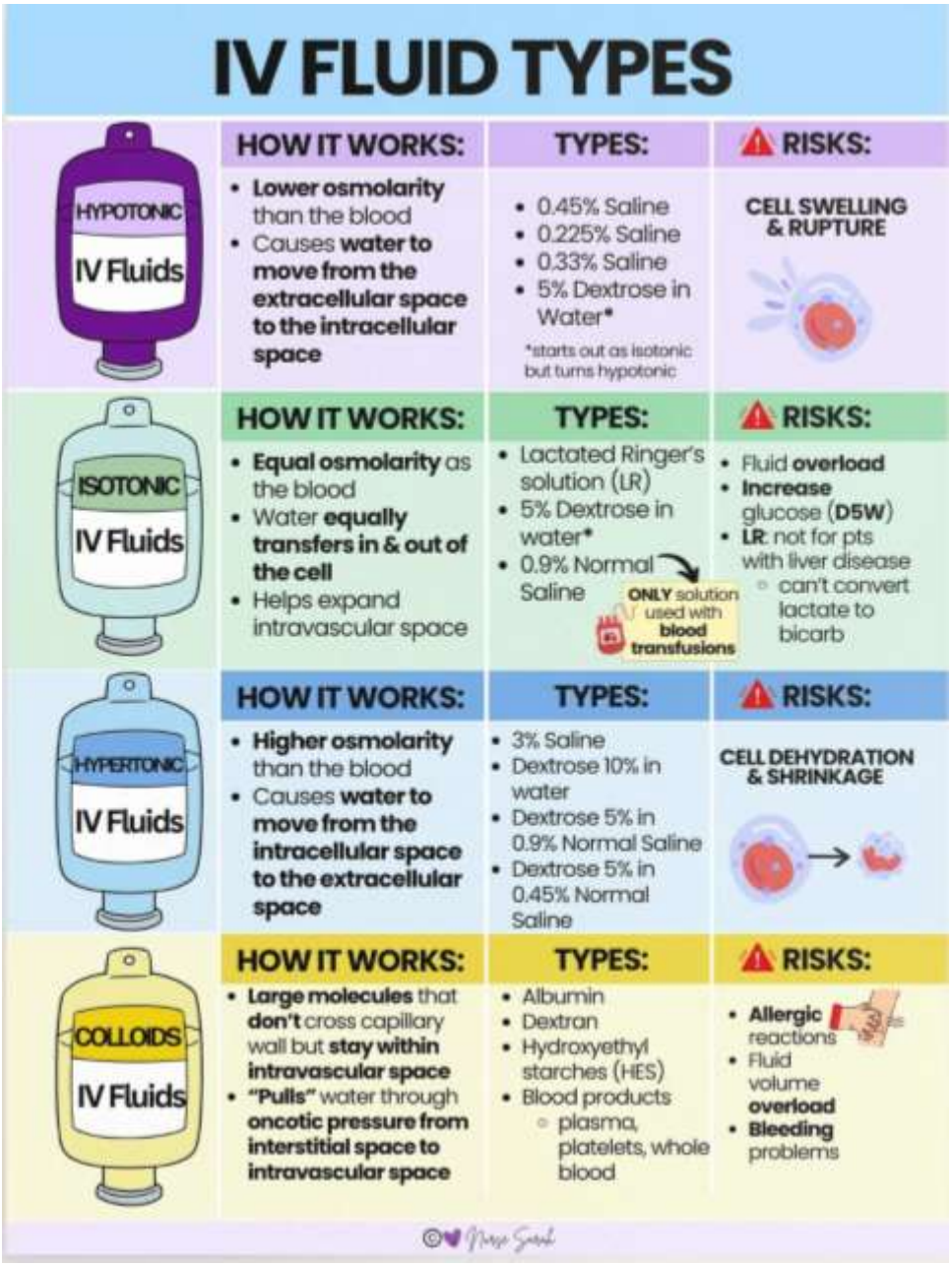
Serum sodium is normal → isotonic fluid loss.

0.9% saline is isotonic and expands the ECF compartment, restoring circulating volume.

5% dextrose distributes into total body water and is not ideal for initial volume resuscitation.

Hypertonic saline is used in severe hyponatremia.

Mannitol is an osmotic diuretic.



(17)**Correct answer: B. It is an antagonist that blocks adrenergic receptors**

Explanation (marking point):

An antagonist binds to a receptor without activating it, preventing the endogenous neurotransmitter (e.g., norepinephrine) from producing its effect. Blocking α_1 receptors causes smooth muscle relaxation.

TABLE 13–2 Examples of drugs that affect processes involved in autonomic neurotransmission.

Transmission Process	Drug	Site of Drug Action	Drug Action
Neurotransmitter synthesis	Hemicholinium	Membrane of cholinergic nerve terminals	Blocks choline uptake; slows synthesis
	Metyrosine	Cytoplasm of noradrenergic nerve terminals	Inhibits tyrosine hydroxylase; blocks synthesis
Neurotransmitter storage mechanism	Vesamicol	Vesicles in cholinergic nerve terminals	Prevents storage of acetylcholine
	Reserpine	Vesicles in noradrenergic nerve terminals	Prevents storage of norepinephrine
Neurotransmitter release mechanism	Norepinephrine, dopamine, acetylcholine, prostaglandins	Receptors on cholinergic and adrenergic nerve terminals	Modulates transmitter release
Neurotransmitter reuptake mechanism	Cocaine, tricyclic antidepressants	Adrenergic nerve terminals	Inhibits uptake; prolongs transmitter's action on postsynaptic receptors
Inactivation of neurotransmitter	Edrophonium, neostigmine, physostigmine,	Acetylcholinesterase in cholinergic synapses	Inhibits enzyme; prolongs and intensifies actions of acetylcholine
Adrenoceptor activation	α_1: Phenylephrine	Sympathetic postganglionic nerve-effector organ junctions (eg, blood vessels, hair follicles, radial muscle)	Binds to and activates α-adrenoceptors; ↑ IP_3/DAG cascade (α_1) or ↓ cAMP (α_2)
	α_2: Clonidine		
	β_1: Dobutamine	Sympathetic postganglionic nerve-effector organ junctions (eg, heart, bronchial smooth muscle, uterine smooth muscle)	Binds to and activates β-adrenoceptors; ↑ cAMP
	β_2: Albuterol, ritodrine, salmeterol, terbutaline		
Adrenoceptor blockade	Nonselective: Phenoxybenzamine	Sympathetic postganglionic nerve-effector organ junctions (eg, blood vessels)	Binds to and blocks α-adrenoceptors
	α_1: Prazosin, terazosin		
	α_2: Yohimbine		
	β_1, β_2: Propranolol	Sympathetic postganglionic nerve-effector organ junctions (eg, heart, bronchial smooth muscle)	Binds to and blocks β-adrenoceptors
	$\beta_1 > \beta_2$: Atenolol, esmolol		
Nicotinic receptor activation	Nicotine	Receptors on autonomic ganglia	Binds to nicotinic receptors; opens Na^+, K^+ channels in postsynaptic membrane
Nicotinic receptor blockade	Hexamethonium, trimethaphan	Receptors on autonomic ganglia	Binds to and blocks nicotinic receptors
Muscarinic receptor activation	Bethanecol	Cholinergic receptors on smooth muscle, cardiac muscle, and glands	Binds to and activates muscarinic receptors; ↑ IP_3/DAG cascade or ↓ cAMP
Muscarinic receptor blockade	Atropine, ipratropium, scopolamine, tropicamide	Cholinergic receptors on smooth muscle, cardiac muscle, and glands	Binds to and blocks muscarinic receptors

Many of these drugs can also act on cholinergic and adrenergic receptors in the central nervous system. For example, the main actions of clonidine and yohimbine to alter blood pressure are by their actions in the brain. cAMP, cyclic adenosine monophosphate; IP_3/DAG, inositol 1,4,5-triphosphate and diacylglycerol.

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(18)**Correct answer: D. Evaporation of sweat from the skin surface**

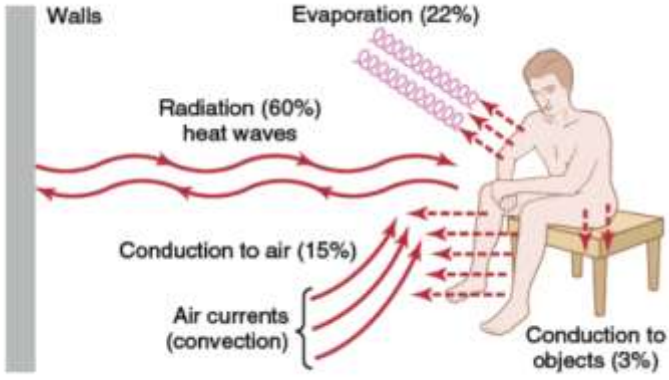


Figure 74-4. Mechanisms of heat loss from the body.

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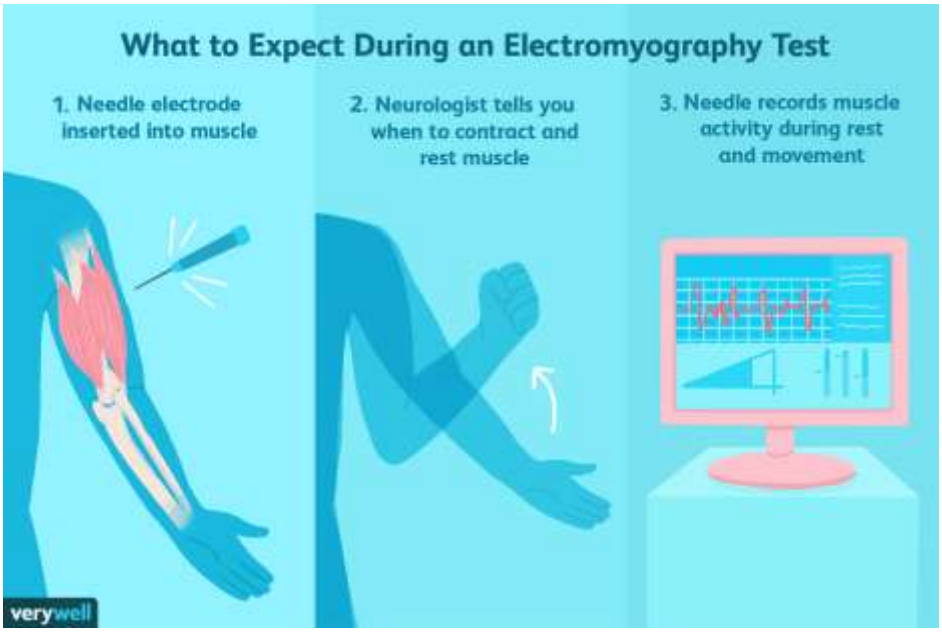
(19)**Correct answer: C. Electromyogram (EMG)**

Explanation

EMG records the electrical activity of multiple motor units during muscle contraction.

It reflects neuromuscular transmission and motor unit recruitment.

It does NOT directly record force (that would be a myogram).



(20)

(A) **T** - Explanation: In adults, haemopoiesis mainly occurs in red bone marrow of flat bones (sternum, ribs, vertebrae, pelvis).

(B) **T** - Explanation: Multipotent haematopoietic stem cells differentiate into erythroid, myeloid, and lymphoid lineages.

(C) **F** - Explanation: In adults, erythropoietin is mainly produced by peritubular interstitial cells of the kidney. The liver is the main source only in the fetus.

(D) **T** - Explanation: Reticulocytes contain residual ribosomal RNA, which disappears as they mature into erythrocytes.

(E) **F** - Explanation: MCV measures the average volume (size) of RBCs. Haemoglobin concentration is measured by MCHC.

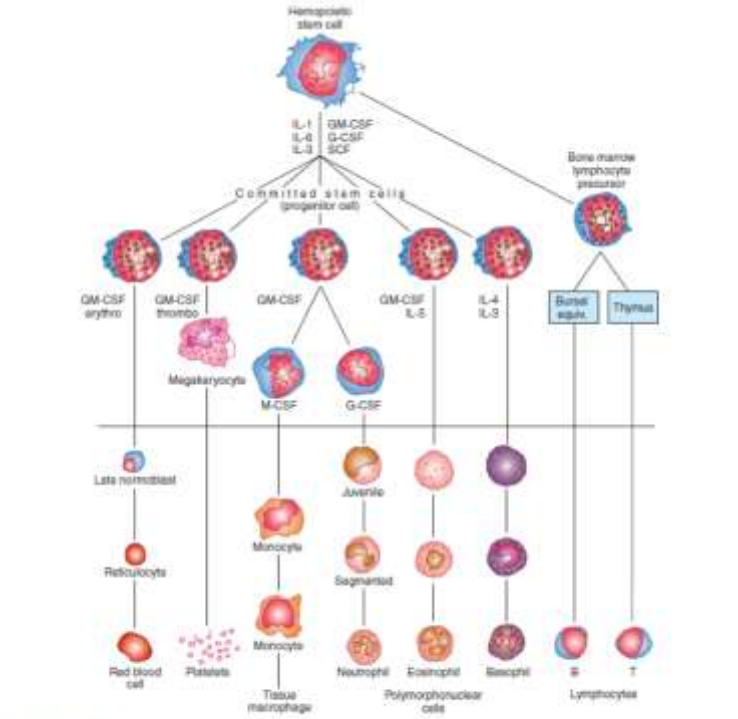


FIGURE 31–3 Development of various formed elements of the blood from bone marrow cells. Cells below the horizontal line are found in normal peripheral blood. The principal sites of action of erythropoietin (erythro) and the various colony-stimulating factors (CSF) that stimulate the differentiation of the components are indicated. G, granulocyte; M, macrophage; IL, interleukin; thrombo, thrombopoietin; erythro, erythropoietin; SCF, stem cell factor.

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(21)

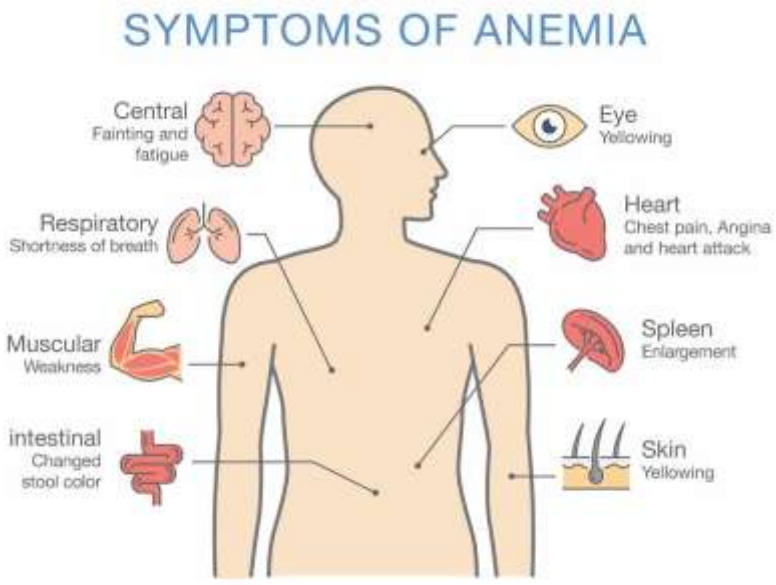
(A) **T** - Anaemia is generally defined as Hb concentration below the normal range for age and sex, often associated with reduced oxygen-carrying capacity.

(B) **T** - Reduced haemoglobin synthesis produces smaller (microcytic) and paler (hypochromic) red cells.

(C) **T** - Polycythaemia is characterized by increased RBC mass, leading to elevated haemoglobin and haematocrit.

(D) **T** - It is caused by a point mutation in the β-globin gene that produces HbS, leading to RBC sickling under low oxygen conditions.

(E) **T** - β-thalassaemia occurs due to defective production of β-globin chains, causing ineffective erythropoiesis and anaemia.



(22)

(A) **T** - Neutrophils account for about 50–70% of circulating WBCs, making them the most abundant.

(B) **F** - Innate immunity is immediate and non-specific and does not require prior exposure.

(C) **T** - B lymphocytes and T lymphocytes mediate adaptive (acquired) immunity.

(D) **F** - Type I hypersensitivity is mediated by IgE, leading to mast cell degranulation (e.g., allergies, anaphylaxis).

(E) **T** - Circulating monocytes migrate into tissues and differentiate into macrophages.

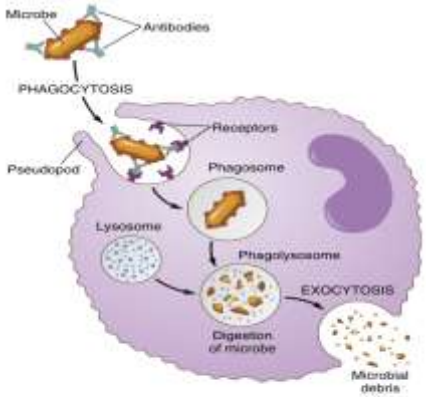
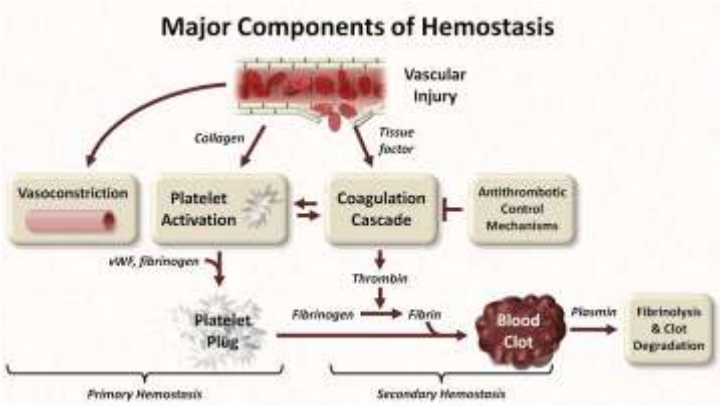


Figure 34-3. Phagocytosis of pathogens, such as bacteria, by a phagocytic cell, such as a macrophage. Antibodies coat the bacteria, making them more susceptible to phagocytosis by the macrophage that engulfs the bacterium, bringing it into the cell and forming a *phagosome*. Lysosomes then attach to the phagosome to form a *phagolysosome*, which digests the invading pathogen. The phagocytic cell then releases the digested products by *exocytosis*.

Guyton and Hall Textbook of Medical Physiology 14th Edition p. 432

(23)

(A) **T** - Haemostasis involves vasoconstriction, platelet plug formation, and coagulation to stop bleeding.
(B) **T** - von Willebrand factor (vWF) bridges platelets to exposed subendothelial collagen, aiding adhesion.
(C) **F** - ADP promotes platelet aggregation by activating nearby platelets.
(D) **T** - Platelets aggregate to form the primary (platelet) plug at the injury site.
(E) **F** - Fibrinogen is mainly a plasma protein (from the liver); platelets release factors but are not the main source.



(24)

(A) **F** - Group O RBCs have no A or B antigens; they have anti-A and anti-B antibodies in plasma.
(B) **T** - The ABO system is based on A and B antigens present on RBC membranes.
(C) **T** - Rh-negative means absence of the D antigen on red cells.
(D) **F** - Anti-D antibodies develop only after exposure (e.g., transfusion, pregnancy).
(E) **T** - ABO incompatibility can cause rapid intravascular hemolysis, which is life-threatening.

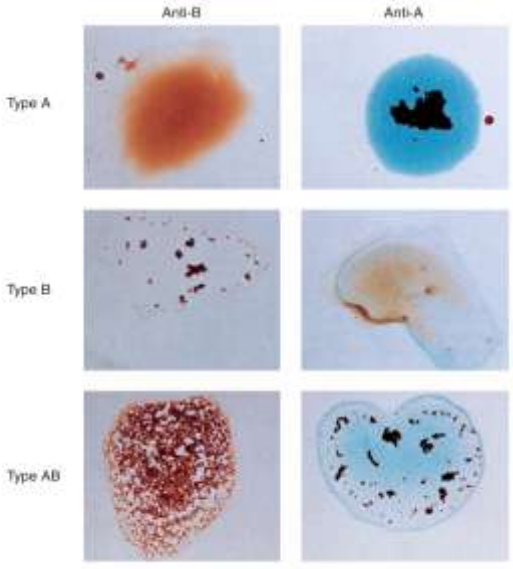
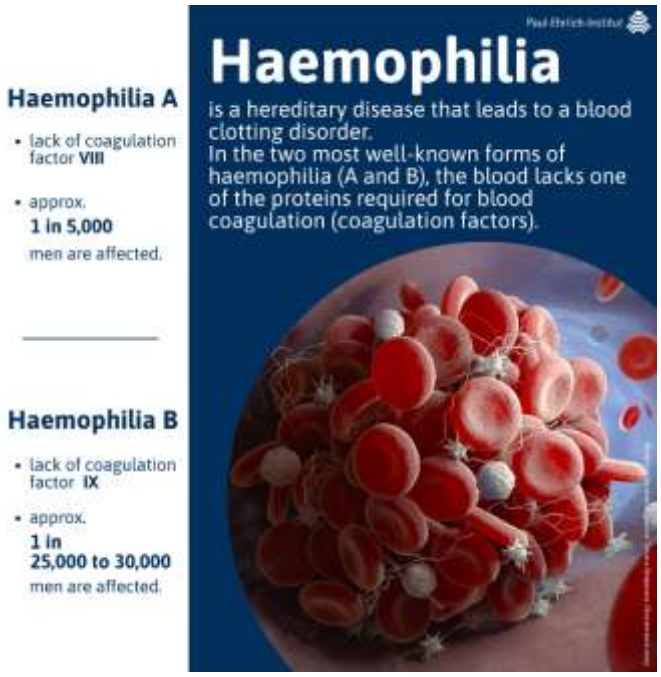


FIGURE 31–10 Red cell agglutination in incompatible plasma.

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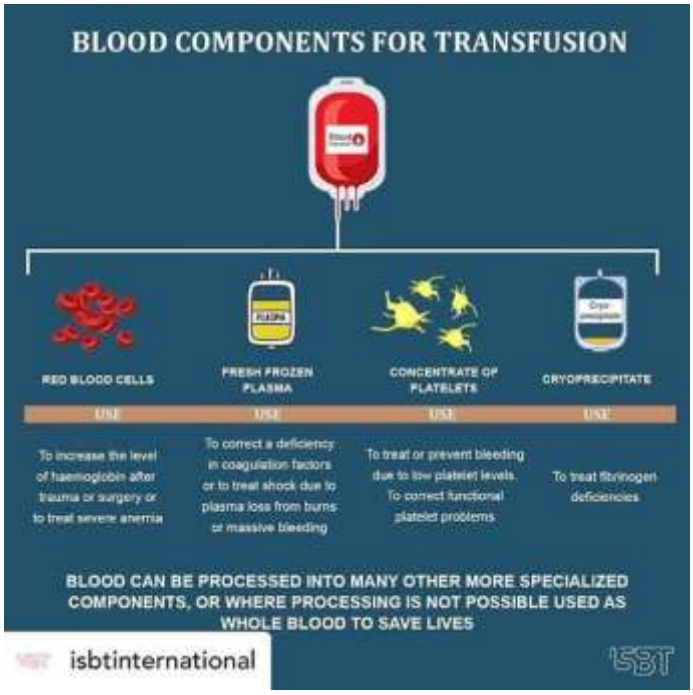
(25)

(A) **T** - Hemophilia A = Factor VIII deficiency.
(B) **T** - Platelet disorders → ↑ bleeding time, PT usually normal.
(C) **F** - PT assesses extrinsic pathway (mainly Factor VII).
(D) **F** - Thrombocytopenia → prolonged bleeding time, not normal.
(E) **T** - aPTT is prolonged in intrinsic pathway defects.



(26)

(A) **F** - Cryoprecipitate contains fibrinogen, factor VIII, vWF, not platelets.
(B) **T** - PRBCs increase oxygen-carrying capacity.
(C) **T** - Used to prevent/treat bleeding due to low platelets.
(D) **T** - Reduced sequestration → thrombocytosis.
(E) **F** - Plasmin causes fibrinolysis (breaks down fibrin).



(27)**Correct answer: D. Mean corpuscular volume (MCV)**

Explanation:

MCV measures the average size of RBCs. Low MCV indicates microcytic anaemia (e.g., iron deficiency, thalassemia).

TABLE 31–2 Characteristics of human red cells.[a]

		Male	Female
Hematocrit (Hct) (%)		47	42
Red blood cells (RBC) ($10^6/\mu L$)		5.4	4.8
Hemoglobin (Hb) (g/dL)		16	14
Mean corpuscular volume (MCV) (fL)	$= \frac{\text{Hct} \times 10}{\text{RBC } (10^6/\mu L)}$	87	87
Mean corpuscular hemoglobin (MCH) (pg)	$= \frac{\text{Hb} \times 10}{\text{RBC } (10^6/\mu L)}$	29	29
Mean corpuscular hemoglobin concentration (MCHC) (g/dL)	$= \frac{\text{Hb} \times 100}{\text{Hct}}$	34	34
Mean cell diameter (MCD) µm)	= Mean diameter of 500 cells in smear	7.5	7.5

[a]Cells with MCVs > 95 fL are called macrocytes; cells with MCVs < 80 fL are called microcytes; cells with MCHCs < 25 g/dL are called hypochromic.

Ganong's Review of Medical Physiology 24th Edition p.559

(28)**Correct Answer: (A) Iron deficiency anaemia**

Explanation

Iron deficiency anaemia typically presents with:

- Low haemoglobin
- Low MCV (microcytic RBCs)
- Hypochromia
- Low serum ferritin

These features reflect impaired haemoglobin synthesis due to iron deficiency.

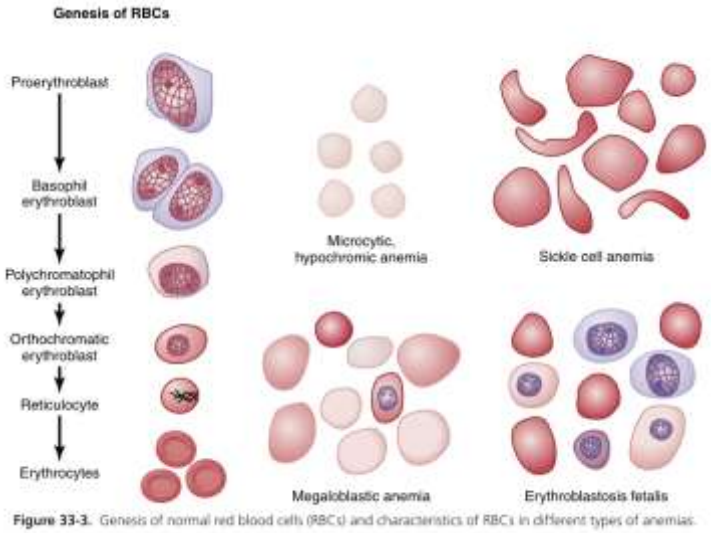


Figure 33-3. Genesis of normal red blood cells (RBCs) and characteristics of RBCs in different types of anemias.

Guyton and Hall Textbook of Medical Physiology 14th Edition p. 422

(29)**Correct answer: (D) Active artificial immunity**

Explanation

Vaccination introduces antigen artificially, which stimulates the body to produce antibodies and memory cells.

This leads to active artificial immunity, providing long-term protection due to immunological memory.

	Active	Passive
Natural	An individual develops a disease, and the immune system make antibodies and memory cells.	A mother passes on antibodies to a baby (e.g. through the placenta).
Artificial	A vaccination injects an inactive pathogen to activate an immune response and antibody production.	Injection of antibodies from another animal.

Table 1. Active and Passive Immunity.

(30)**Correct Answer: (B) Defective platelet adhesion via von Willebrand factor**

Explanation

Platelet adhesion to the damaged vessel wall requires von Willebrand factor (vWF), which binds:

- Subendothelial collagen
- Platelet glycoprotein receptors

A defect leads to:

- Impaired platelet plug formation
- Prolonged bleeding despite normal platelet count

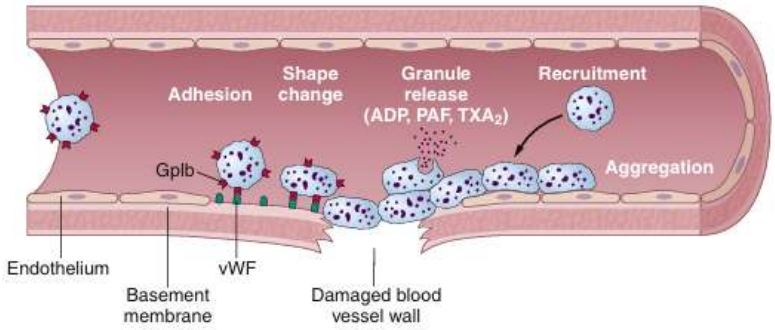


Figure 37-1. Formation of a platelet plug in a severed blood vessel. Endothelial injury and exposure of the vascular extracellular matrix facilitates platelet adhesions and activation, which changes their shape and causes release of adenosine diphosphate (ADP), thromboxane A_2 (T_xA_2), and platelet-activating factor (PAF). These platelet-secreted factors recruit additional platelets (aggregation) to form a hemostatic plug. Von Willebrand factor (vWF) serves as an adhesion bridge between subendothelial collagen and the glycoprotein Ib (GpIb) platelet receptor.

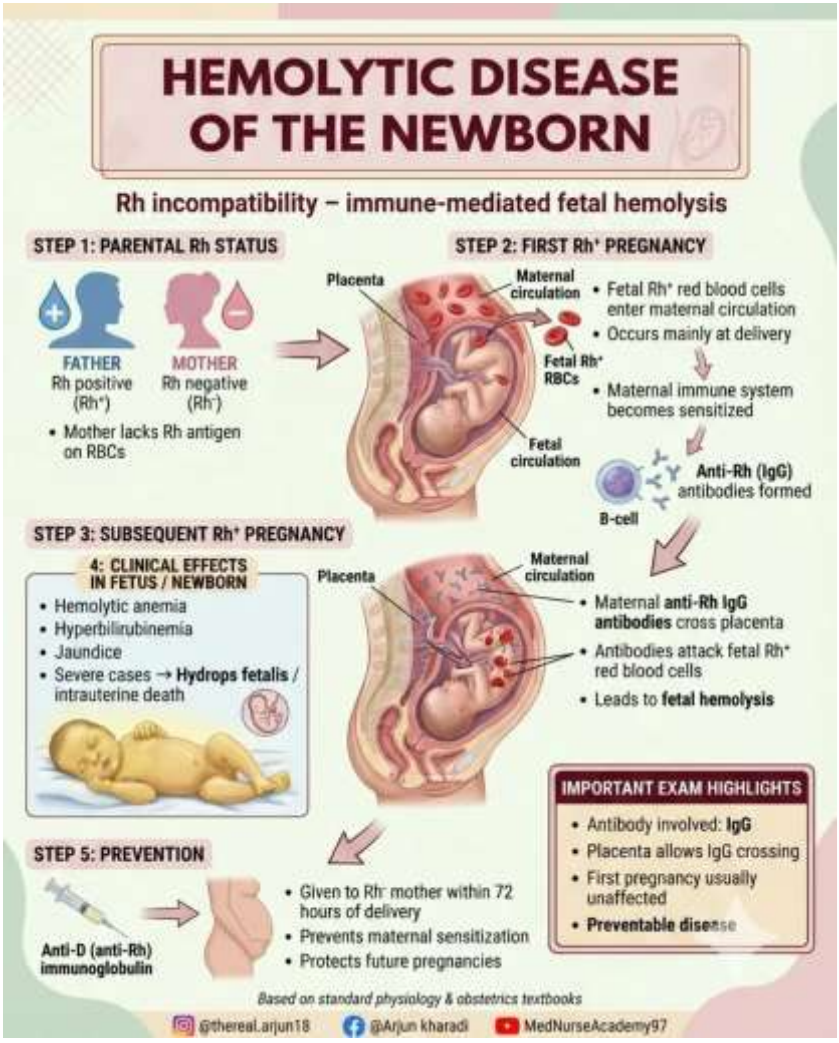
Guyton and Hall Textbook of Medical Physiology 14th Edition p. 478

(31)**Correct Answer: (B) Maternal anti-D antibodies destroying fetal RBCs**

Explanation

This is hemolytic disease of the newborn (erythroblastosis fetalis):

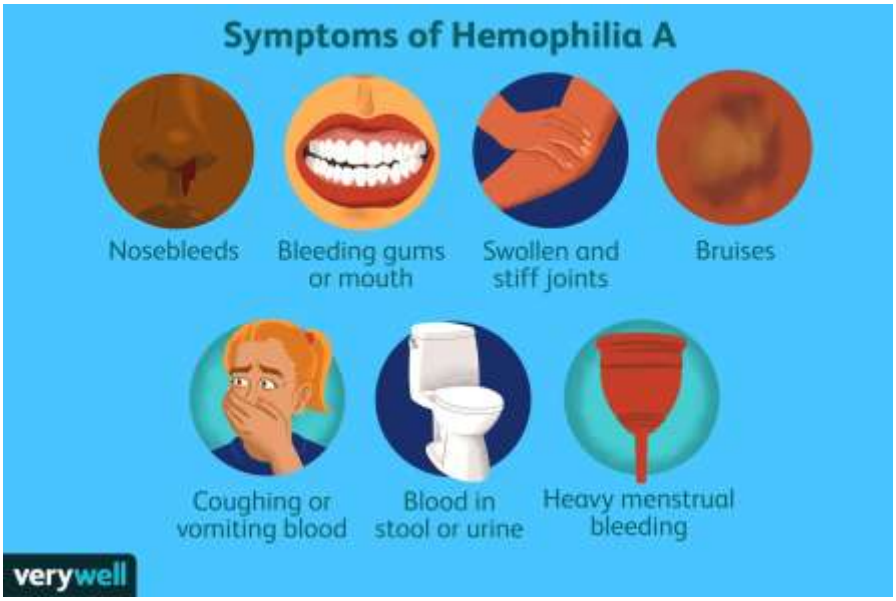
- Rh-negative mother exposed to Rh-positive fetal blood → forms anti-D antibodies
- In subsequent pregnancies, IgG anti-D crosses placenta
- Causes hemolysis of fetal RBCs → anemia, jaundice



(32)**Correct Answer: (B) Hemophilia A**

Explanation

- Intrinsic pathway defect → prolonged aPTT
- Normal PT & bleeding time → platelets and extrinsic pathway intact
- Hemarthrosis (joint bleeding) is classic for hemophilia



(33)**Correct Answer: (B) Reduced destruction and sequestration of platelets**

Explanation

Spleen normally removes aged platelets and acts as a reservoir

After splenectomy → ↓ sequestration + ↓ destruction

Leads to reactive thrombocytosis

Indications for splenectomy

Traumatic

- Rupture after blunt injury to the abdomen
- Iatrogenic injury during another procedure (particularly mobilization of the splenic flexure of the colon)

Haematological

- Immune thrombocytopenia
- Hereditary spherocytosis
- Autoimmune haemolytic anaemias
- Malaria
- Schistosomiasis
- Leishmaniasis
- Staging of haematological malignancies (e.g. Hodgkin's disease)

With other viscera

- Radical gastrectomy
- Pancreatectomy

Miscellaneous

- Treatment for gastric varices
- Treatment of splenic artery aneurysms
- Treatment of splenic cysts/tumours

(34)

(A) **T** - It begins immediately after AV valves close and before semilunar valves open; volume stays constant while pressure rises.
(B) **T** - SV = End-diastolic volume − End-systolic volume. This represents the amount of blood ejected per beat.
(C) **F** - Aortic pressure rises during ejection as blood is pumped into the aorta, then falls afterward.
(D) **T** - EF is a key indicator of ventricular contractility and systolic function.
(E) **F** - The left ventricle generates much higher pressure to pump blood into systemic circulation.

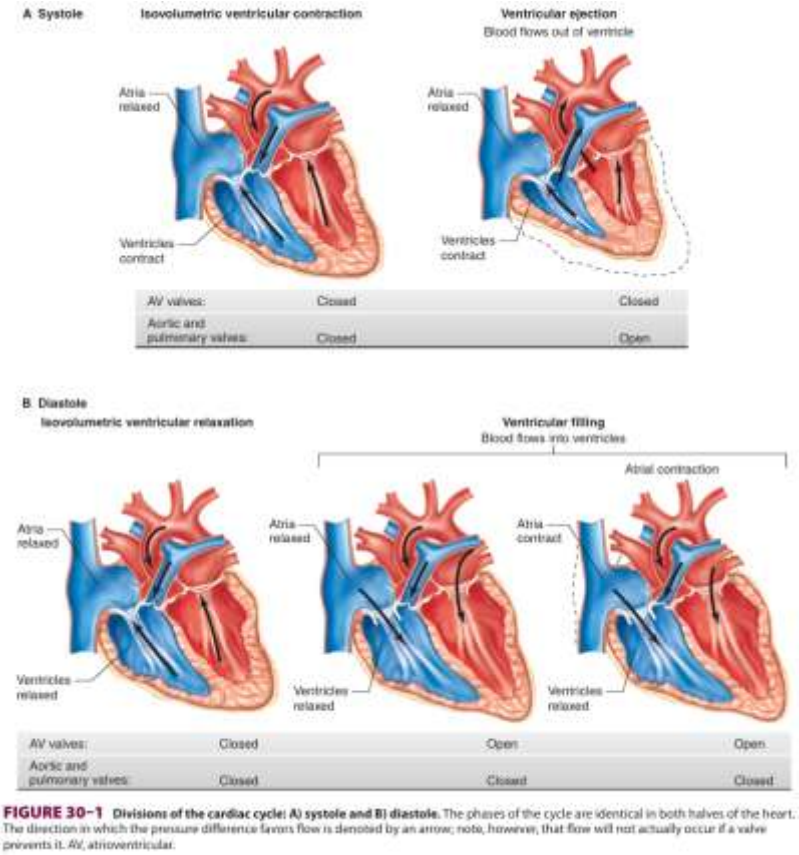


FIGURE 30–1 Divisions of the cardiac cycle: A) systole and B) diastole. The phases of the cycle are identical in both halves of the heart. The direction in which the pressure difference favors flow is denoted by an arrow; note, however, that flow will not actually occur if a valve prevents it. AV, atrioventricular.

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(35)

(A) **T** - S1 is due to mitral and tricuspid valve closure.
(B) **F** - Aortic stenosis → systolic ejection murmur.
(C) **T** - CO = SV × HR.
(D) **T** - ↑ EDV → ↑ stretch → ↑ stroke volume.
(E) **F** - Positive inotropy → increases contractility.

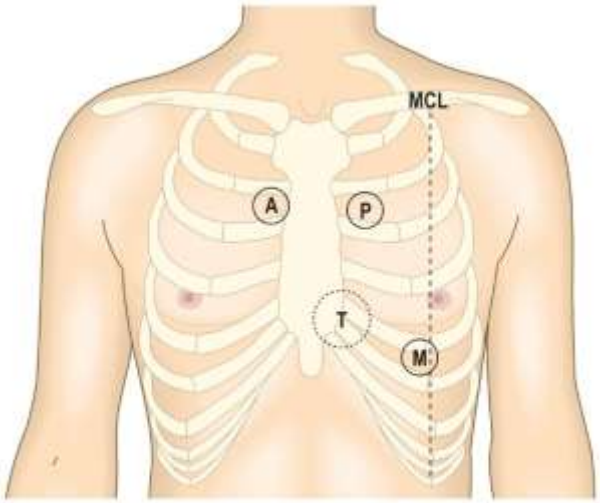


Fig. 4.17 Sites for auscultation. Sites at which murmurs from the relevant valves are usually, but not preferentially, heard. *A*, aortic; *M*, mitral; *MCL*, mid-clavicular line; *P*, pulmonary; *T*, tricuspid.

Macleod's Clinical Examination 14th Edition p. 54

(36)

(A) **T** - Intercalated discs enable electrical coupling via gap junctions.
(B) **T** - SA node has the highest intrinsic firing rate.
(C) **F** - Plateau is due to Ca^{2+} influx, not K^{+}.
(D) **T** - AV delay ensures atria empty before ventricles contract.
(E) **F** - Electrical activity precedes mechanical contraction.

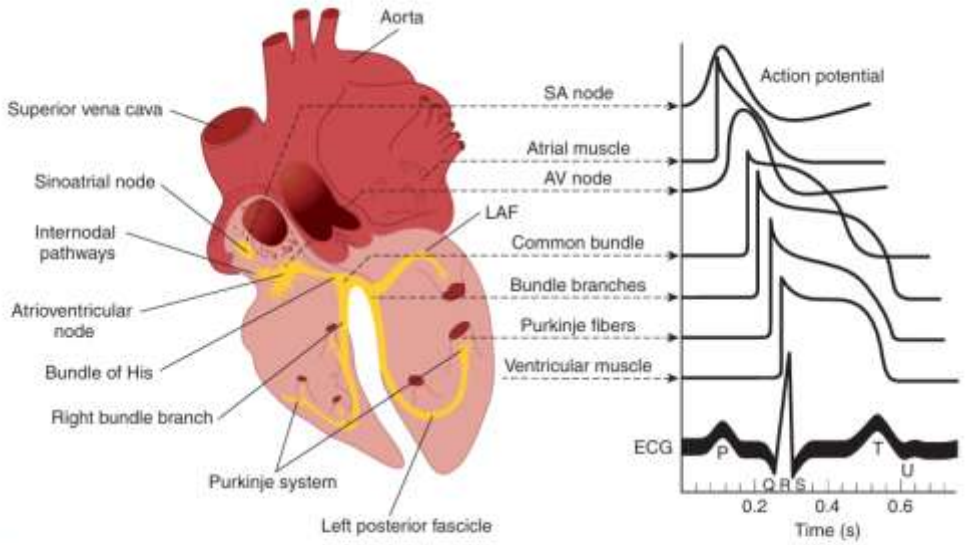


FIGURE 29–1 Conducting system of the heart. **Left:** Anatomical depiction of the human heart with additional focus on areas of the conduction system. **Right:** Typical transmembrane action potentials for the SA and AV nodes, other parts of the conduction system, and the atrial and ventricular muscles are shown along with the correlation to the extracellularly recorded electrical activity, that is, the electrocardiogram (ECG). The action potentials and ECG are plotted on the same time axis but with different zero points on the vertical scale for comparison. LAF, left anterior fascicle.

Ganong's Review of Medical Physiology 24th Edition p. 522

(37)

(A) **T**
(B) **F** - should be 0.04 s
(C) **T**
(D) **F** - it is depolarization
(E) **T**

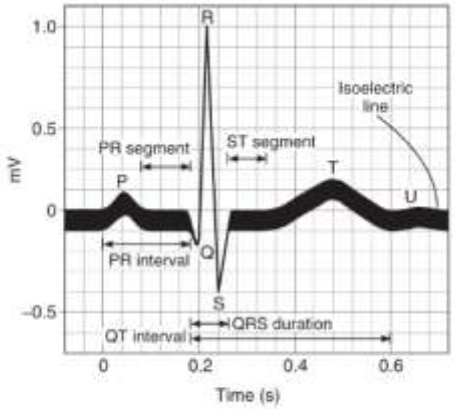


FIGURE 29–5 **Waves of the ECG.** Standard names for individual waves and segments that make up the ECG are shown. Electrical activity that contributes the observed deflections are discussed in the text and in Table 29–2.

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(38)

(A) **T**
(B) **T**
(C) **F -** It increases resistance
(D) **T**
(E) **T**

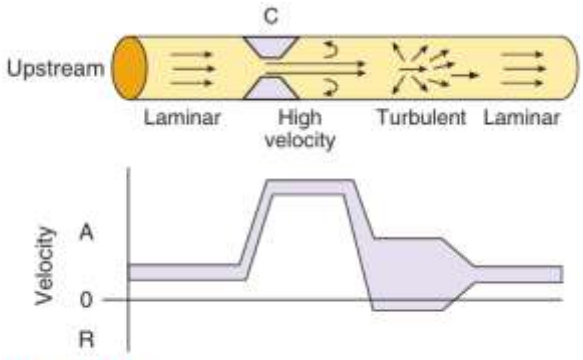


FIGURE 31–19 **Top:** Effect of constriction (C) on the profile of velocities in a blood vessel. The arrows indicate direction of velocity components, and their length is proportional to their magnitude. **Bottom:** Range of velocities at each point along the vessel. In the area of turbulence, there are many different anterograde (A) and some retrograde (R) velocities. (Modified and reproduced with permission from Richards KE: Doppler echocardiographic diagnosis and quantification of vascular heart disease. Curr Probl Cardiol 1985 Feb;10(2):1–49.)

Ganong's Review of Medical Physiology p. 574

(39)

(A) **T**
(B) **F** - NO causes vasodilation
(C) **T**
(D) **F** - causes vasoconstriction
(E) **T**

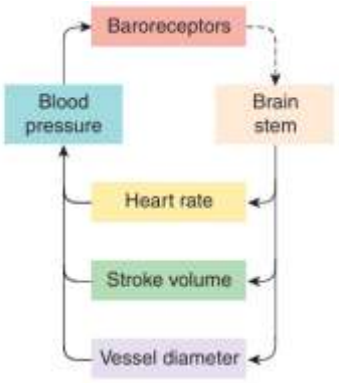
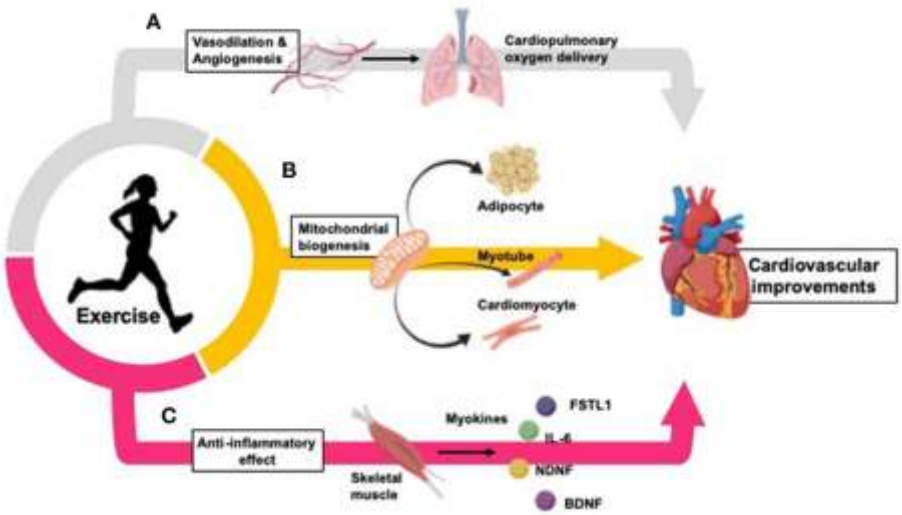


FIGURE 32–1 Feedback control of blood pressure. Brain stem excitatory input to sympathetic nerves to the heart and vasculature increases heart rate and stroke volume and reduces vessel diameter. Together these increase blood pressure, which activates the baroreceptor reflex to reduce the activity in the brain stem.

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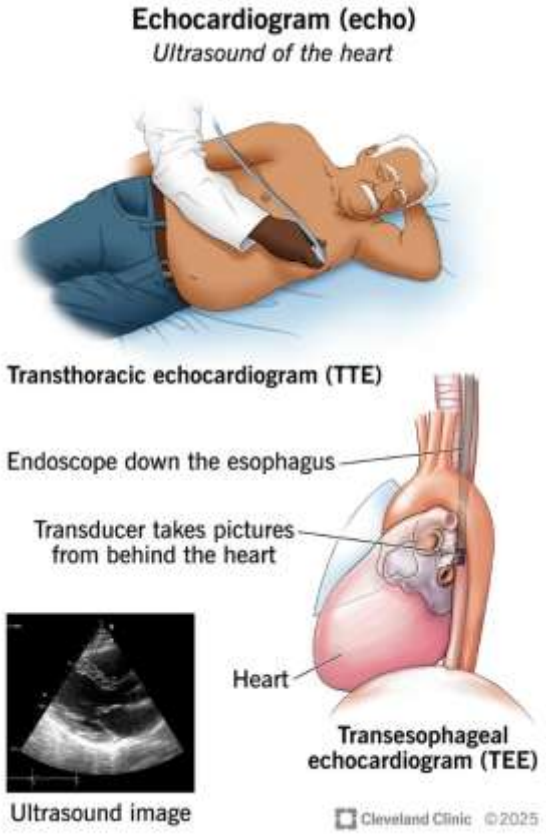
(40)

(A) **F** - it increases
(B) **T**
(C) **T**
(D) **F** - it increases
(E) **T**



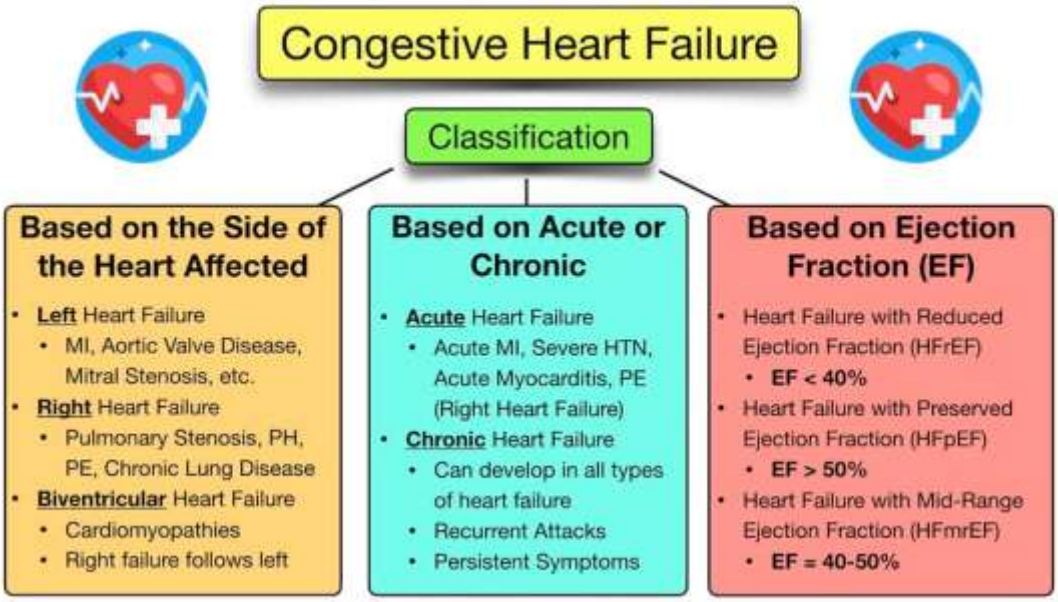
(41)

(A) **T**
(B) **T**
(C) **F** - uses ultrasound
(D) **T**
(E) **T**



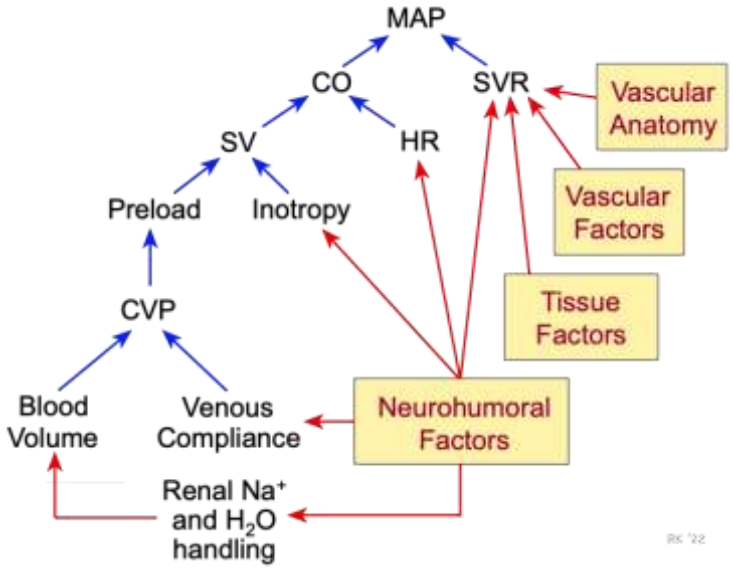
(42)

(A) **T**
(B) **F** - in left heart failure
(C) **F** - it increases
(D) **T**
(E) **T**



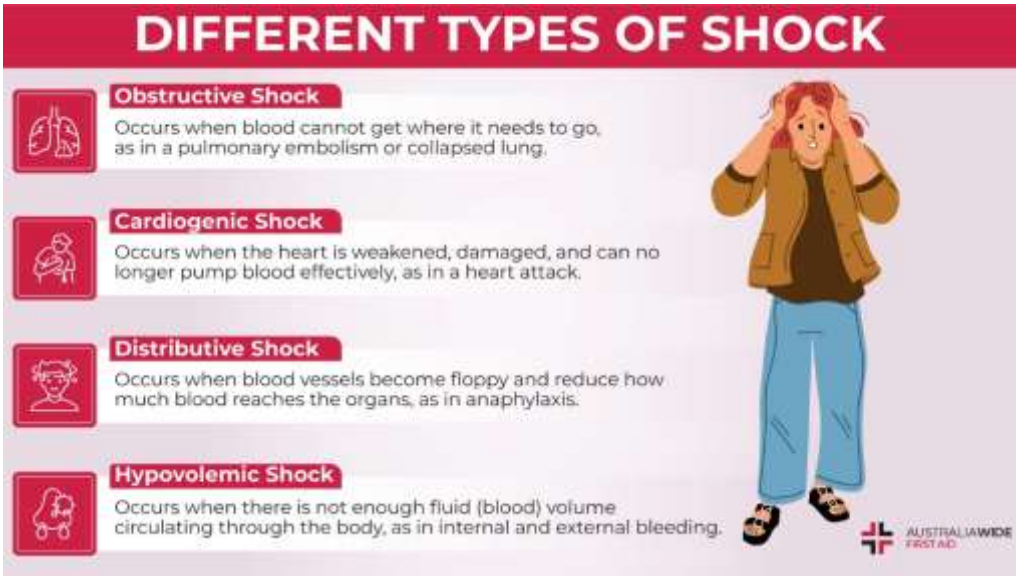
(43)

(A) **T**
(B) **F** - right arterial pressure
(C) **T**
(D) **F** - sounds occur during turbulent flow
(E) **T**



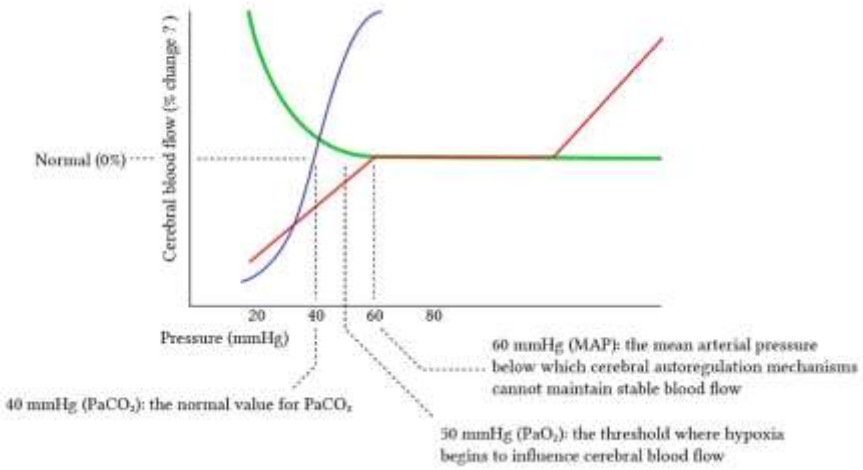
(44)

(A) **F**
(B) **T**
(C) **T**
(D) **T**
(E) **F**



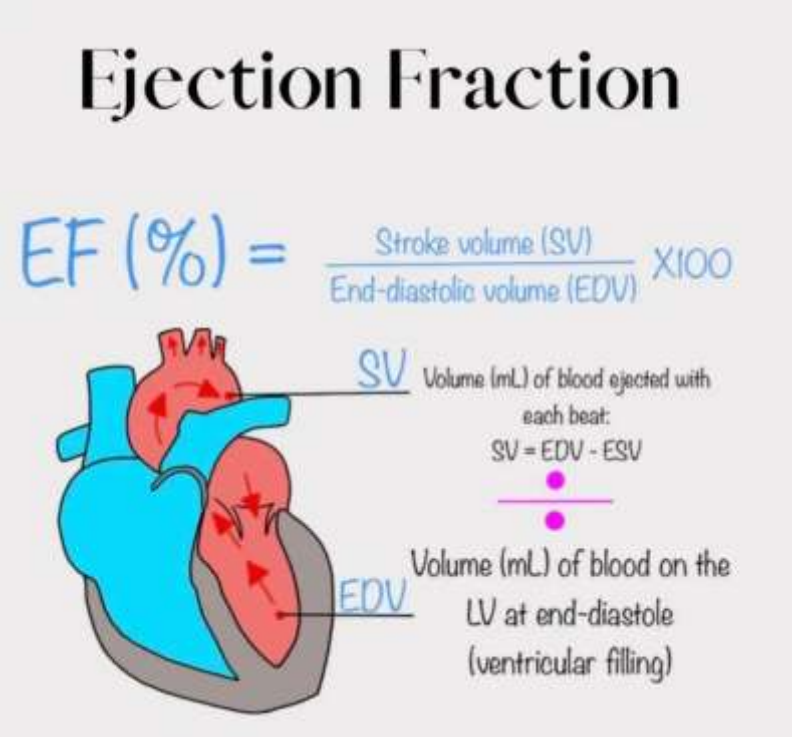
(45)

(A) **F** - from intestine to liver
(B) **F** - greatest during diastole
(C) **T**
(D) **T**
(E) **T**



(46)**Correct Answer: C**

Explanation:
EF = (SV / EDV) × 100
SV = EDV − ESV = 120 − 60 = 60 mL
EF = (60 / 120) × 100 = 50%



(47)**Correct Answer: (A) Turbulent flow across a narrowed aortic valve**

Explanation

- Features = aortic stenosis
- Narrow valve → high-velocity turbulent flow during systole
- Produces harsh ejection systolic murmur radiating to carotids

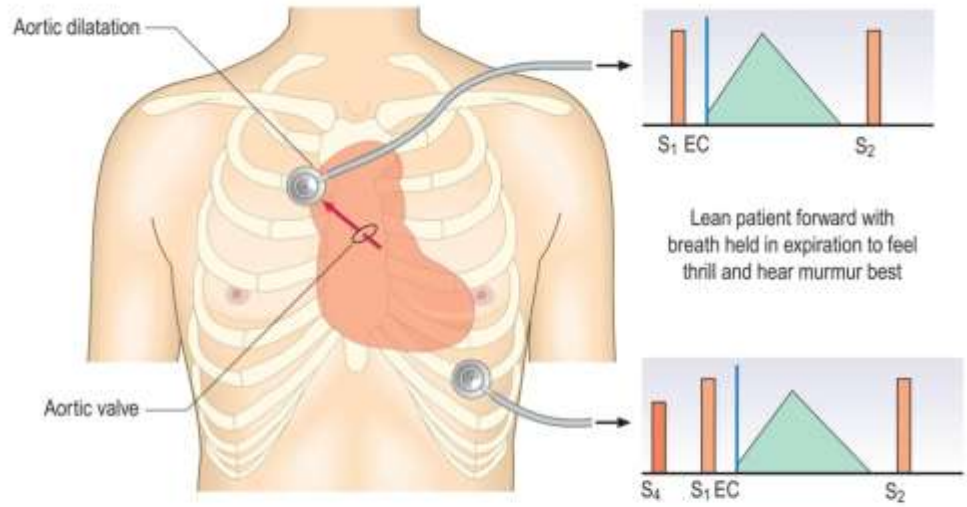


Fig. 4.24 Aortic stenosis. There is a systolic pressure gradient across the stenosed aortic valve. The resultant high-velocity jet impinges on the wall of the aorta *(arrow)*, and is best heard with the diaphragm in the aortic area. Alternatively, the bell may be placed in the suprasternal notch. The ejection systolic murmur follows an ejection click (EC).

Macleod's Clinical Examination 14th Edition p. 59

(48)**Correct Answer: (C) Slower rate of spontaneous depolarization in AV node**

Explanation

- Pacemaker rate depends on slope of phase 4 (pacemaker potential)
- AV node has slower depolarization → lower intrinsic rate
- Hence acts as a backup pacemaker (40–60 bpm)

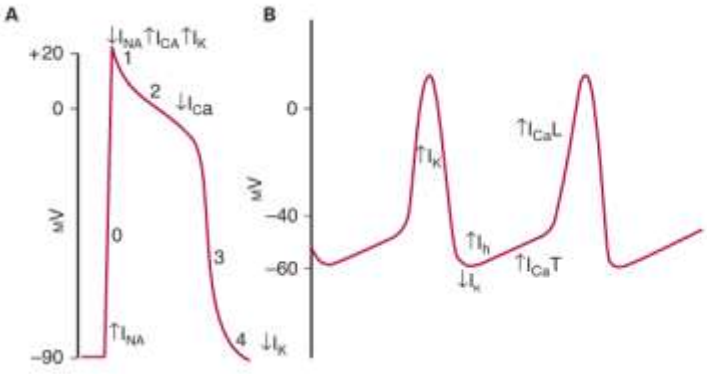


FIGURE 29–2 Comparison of action potentials in ventricular muscle and diagram of the membrane potential of pacemaker tissue. A) Phases of action potential in ventricular myocyte (0–4, see text for details) are superimposed with principal changes in current that contribute to changes in membrane potential. **B)** The principal current responsible for each part of the potential of pacemaker tissue is shown under or beside the component. L, long-lasting; T, transient. Other ion channels contribute to the electrical response. Note that the resting membrane potential of pacemaker tissue is somewhat lower than that of atrial and ventricular muscle.

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(49)**Correct Answer: B. Heart rate 75 bpm, normal PR, normal QRS**

Explanation (aligned with Guyton & Ganong):

- Heart rate:HR = 300 / large squares = 300 / 4 = 75 bpm
- PR interval:1 small square = 0.04 s → 5 squares = 0.20 s (upper normal limit)
- QRS duration:2 squares = 0.08 s (normal)

TABLE 29–2 ECG intervals.

Intervals	Normal Durations		Events in the Heart during Interval
	Average	Range	
PR interval[a]	0.18[b]	0.12–0.20	Atrioventricular conduction
QRS duration	0.08	to 0.10	Ventricular depolarization
QT interval	0.40[c]	to 0.43	Ventricular action potential
ST interval (QT minus QRS)	0.32	…	Plateau portion of the ventricular action potential

[a]Measured from the beginning of the P wave to the beginning of the QRS complex.

[b]Shortens as heart rate increases from average of 0.18 s at a rate of 70 beats/min to 0.14 s at a rate of 130 beats/min.

[c]Can be lower (0.35) depending on the heart rate

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(50)**Correct Answer: D. Resistance is inversely proportional to radius⁴**

- From Poiseuille's law, R ∝ 1/r4
- Even a small decrease in radius → large increase in resistance → ↓ flow
- Explains why arterioles are the main resistance vessels

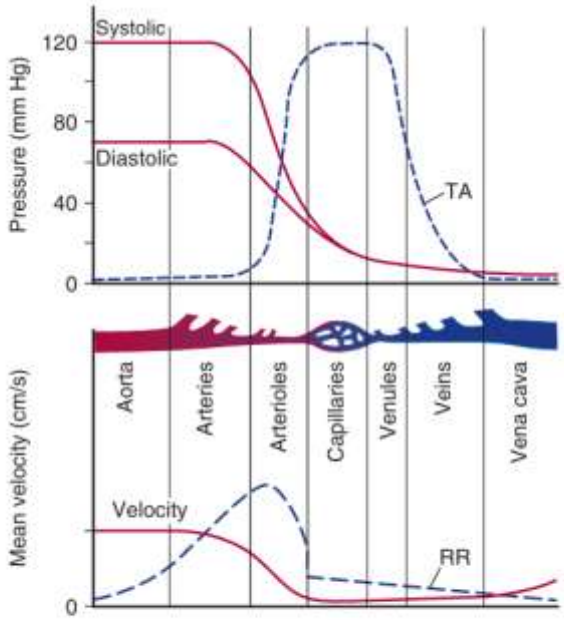


FIGURE 31–23 Diagram of the changes in pressure and velocity as blood flows through the systemic circulation. TA, total cross-sectional area of the vessels, which increases from 4.5 cm^2 in the aorta to 4500 cm^2 in the capillaries (Table 31–9). RR, relative resistance, which is highest in the arterioles.

Ganong's Review of Medical Physiology p. 577

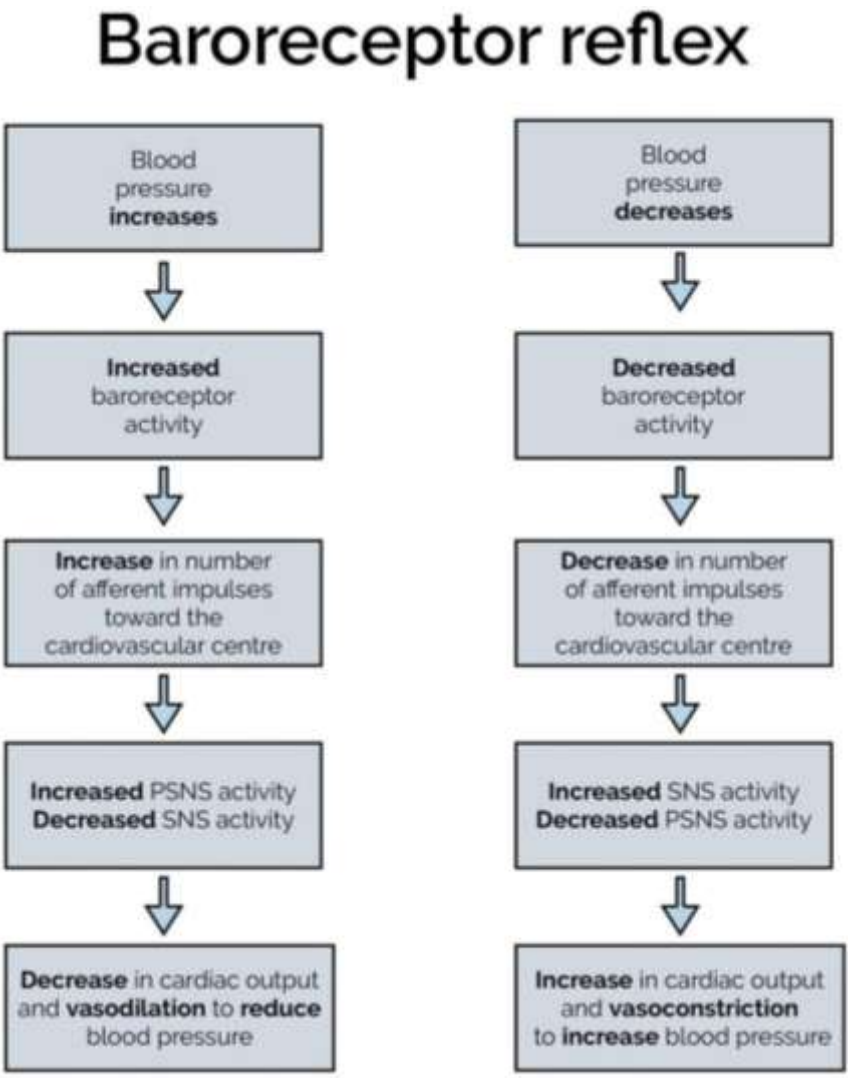
(51)**Correct Answer: C. Decreased baroreceptor firing**

↓ Venous return → ↓ arterial pressure

↓ Stretch of baroreceptors → ↓ firing

Medulla responds → ↑ sympathetic, ↓ parasympathetic

Result → ↑ heart rate and vasoconstriction



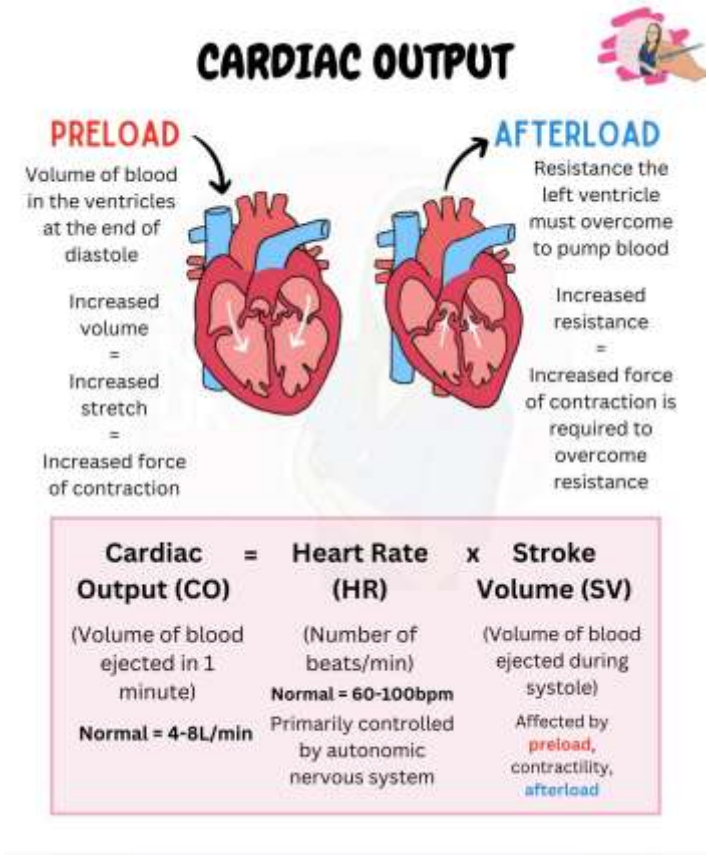
(52)**Correct Answer: C. Increased myocardial contractility**

Explanation

Major determinants of myocardial oxygen consumption include:

- Heart rate
- Myocardial contractility
- Ventricular wall tension (related to pressure and volume)

During exercise, sympathetic stimulation increases contractility and cardiac work, thereby increasing oxygen demand.

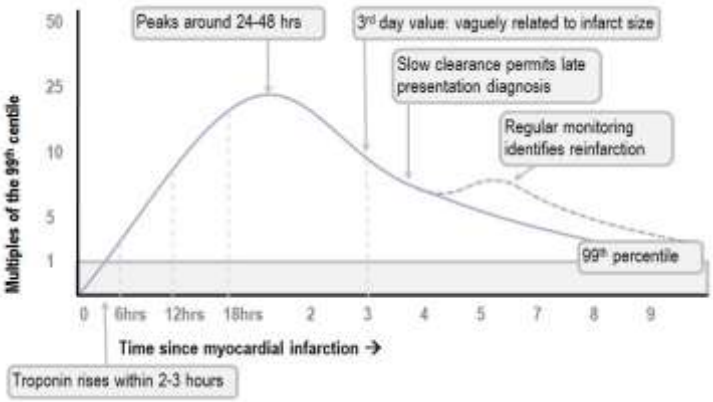


(53)**Correct Answer: C. Serum cardiac troponin level**

Explanation

Cardiac troponins are highly specific markers of myocardial injury

- ECG identifies electrical abnormalities but may not confirm cell death alone
- Echocardiography assesses structure and function
- Doppler evaluates blood flow
- Angiography visualizes coronary vessels but is not the primary biochemical test for myocardial necrosis

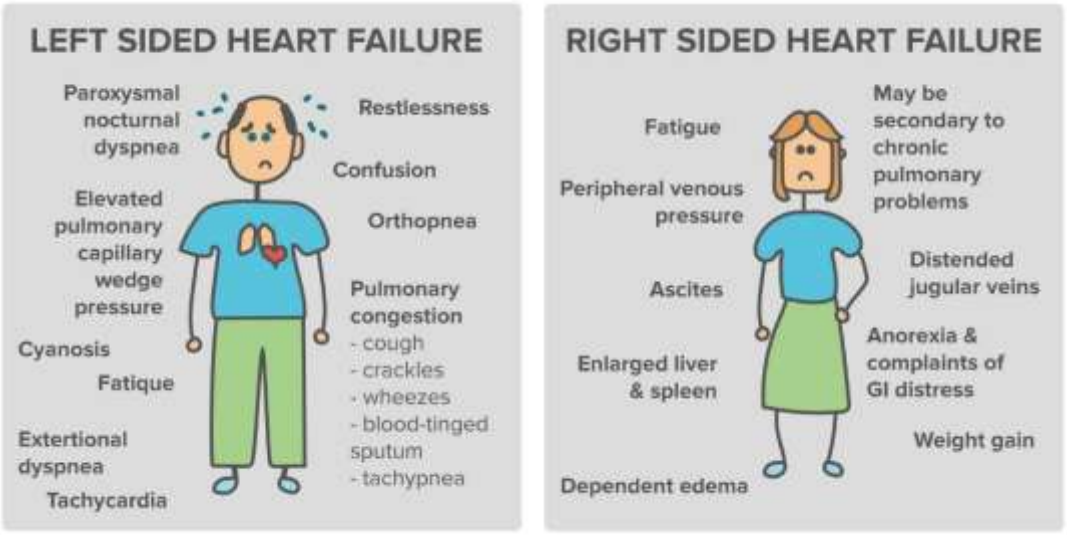


(54)**Correct Answer: C. Increased pulmonary venous pressure**

Explanation

In left ventricular failure, impaired pumping causes blood to back up into the pulmonary veins

- ↑ Pulmonary venous and capillary pressure → pulmonary edema → dyspnea and crepitations
- Reduced ejection fraction indicates impaired systolic function
- Sympathetic activity is usually increased as compensation



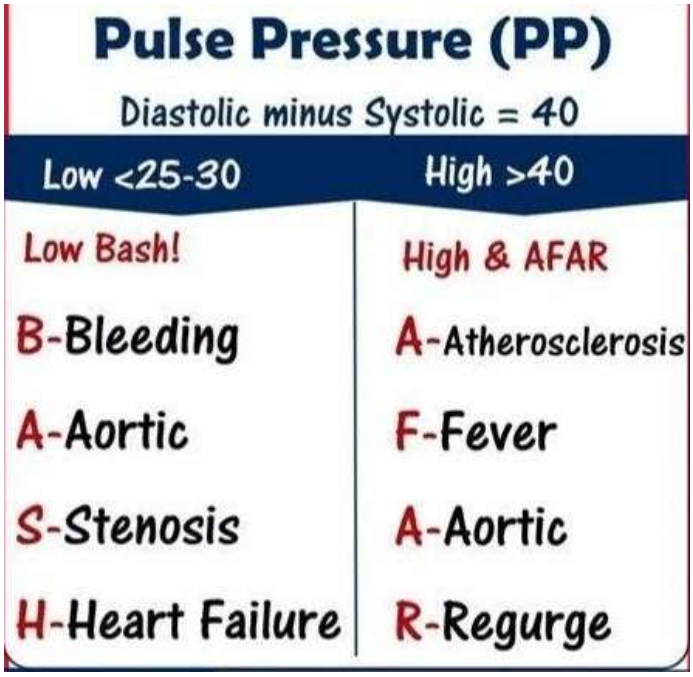
(55)**Correct Answer: C. 60 mmHg**

Explanation

Pulse pressure = Systolic pressure − Diastolic pressure

160 – 100 = 60 mmHg

- Systolic pressure: peak arterial pressure during ventricular systole
- Diastolic pressure: lowest arterial pressure during ventricular diastole
- Pulse pressure: difference between systolic and diastolic pressures
- Mean arterial pressure lies closer to diastolic pressure because diastole lasts longer than systole



(56)**Correct Answer: B. Coronary arteries are compressed during systole**

Explanation

During ventricular systole, contraction compresses intramyocardial coronary vessels, especially in the left ventricle

- Therefore, most left coronary perfusion occurs during diastole when the myocardium relaxes
- In shock, reduced arterial pressure decreases coronary perfusion, worsening myocardial ischemia

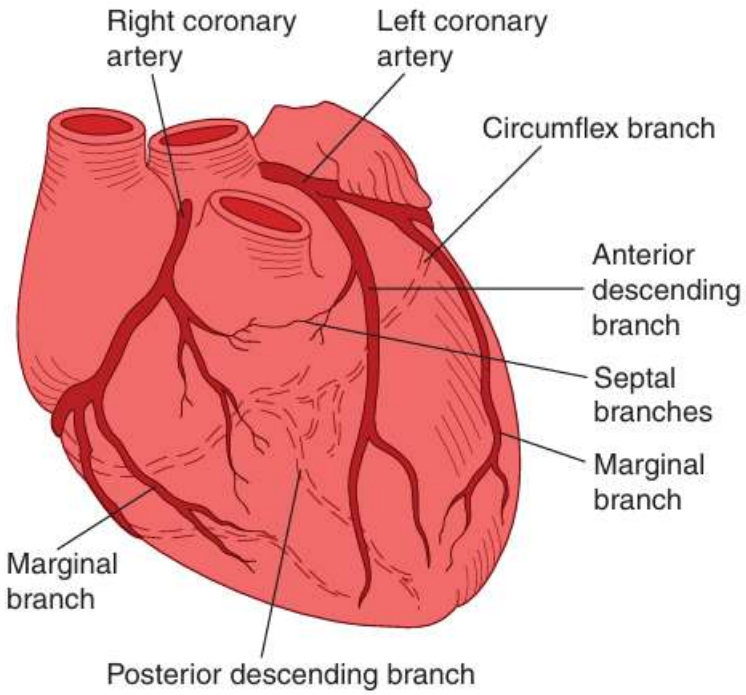


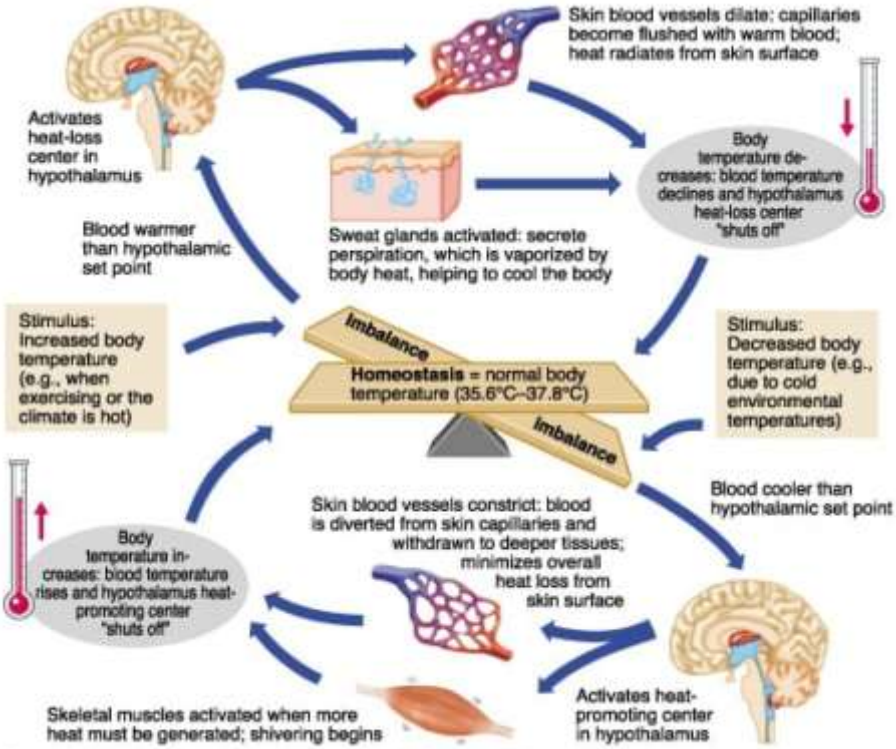
FIGURE 33–11 Coronary arteries and their principal branches in humans. (Reproduced with permission from Ross G: The cardiovascular system. In: *Essentials of Human Physiology*. Ross G [editor]. Copyright © 1978 by Year Book Medical Publishers.)

Ganong's Review of Medical Physiology p. 610

(57)**Correct Answer: E. Cutaneous circulation**

Explanation:

- Skin circulation plays a major role in thermoregulation
- Heat exposure → cutaneous vasodilation → ↑ skin blood flow → heat loss
- Sweating further assists cooling
- Other organs have specialized circulations for metabolism, filtration, or oxygen delivery rather than temperature regulation



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PHYSIOLOGY SGD & TUTE QUESTIONS & ANSWERS

Water Balance and Dehydration

(1)

(1.1) Describe the distribution of total body water in an average adult and the composition of the major body fluid compartments. (50 marks)

A. Distribution of Total Body Water (25 Marks)

Point	Marks
Total body water (TBW) is approximately 60% of body weight in an average adult male	5
Intracellular fluid (ICF) constitutes approximately 2/3 of TBW (≈40% body weight)	5
Extracellular fluid (ECF) constitutes approximately 1/3 of TBW (≈20% body weight)	5
Interstitial fluid forms approximately 75% of ECF (≈15% body weight)	5
Plasma forms approximately 25% of ECF (≈5% body weight)	5

B. Composition of Major Fluid Compartments (25 Marks)

Intracellular Fluid (ICF)

Point	Marks
Rich in potassium (K^+)	3
Rich in magnesium (Mg^{2+})	2
Rich in phosphate and proteins	3

Extracellular Fluid (ECF)

Point	Marks
Rich in sodium (Na^+)	4
Rich in chloride (Cl^-)	3
Rich in bicarbonate (HCO_3^-)	3

Plasma

Point	Marks
Higher protein concentration than interstitial fluid	4
Proteins contribute to plasma oncotic pressure	3

(1.2) State the factors that regulate extracellular fluid (ECF) volume. (20 marks)

Factor	Marks
Renin–Angiotensin–Aldosterone System (RAAS)	5
Aldosterone-mediated sodium retention	5
Antidiuretic hormone (ADH)	3
Thirst mechanism	2
Atrial natriuretic peptide (ANP)	3
Renal sodium excretion	2

(1.3) Define dehydration and classify it based on severity. (30 marks)

Definition (10 Marks)

Point	Marks
Loss of body water	4
May be accompanied by electrolyte loss	3
Results in deficit of total body fluid volume	3

Classification Based on Severity (20 Marks)

Classification	Criteria	Marks
Mild dehydration	Loss of <5% body weight	6
Moderate dehydration	Loss of 5–10% body weight	7
Severe dehydration	Loss of >10% body weight	7

(2)A 5-year-old child is brought to the emergency department with a 3-day history of severe diarrhea and vomiting. On examination, the child is lethargic, tachycardic, has dry mucous membranes and poor skin turgor. Laboratory findings show normal serum sodium concentration.

(2.1) State the diagnosis of this condition. (10 marks)

Point	Marks
Dehydration identified	5
Isotonic / isonatraemic dehydration specified	5

(2.2) Describe the changes occurring in body fluid compartments in this patient. (20 marks)

Point	Marks
Loss of fluid from gastrointestinal tract	4
Loss mainly from extracellular fluid (ECF) compartment	4
Serum sodium remains normal	3
Osmolality remains approximately normal	3
No significant shift of water between ECF and ICF	3
Reduction in plasma volume/interstitial fluid volume	3

(2.3) Outline the principles of fluid replacement in this child. (20 marks)

Point	Marks
Assess severity of dehydration	3
Restore circulating volume rapidly	4
Replace fluid deficit	4
Replace ongoing losses from diarrhoea/vomiting	3
Maintain normal daily fluid requirements	3
Monitor clinical status/electrolytes	3

(2.4) Name the appropriate intravenous fluid and describe its composition. (10 marks)

Appropriate Fluid: Normal Saline (0.9% Sodium Chloride) (4 marks)

Composition

Component	Marks
Sodium 154 mmol/L	3
Chloride 154 mmol/L	3

Alternative Accepted Answer
Ringer's Lactate (Hartmann's Solution)

If named correctly with appropriate composition:
Sodium ≈130 mmol/L
Chloride ≈109 mmol/L
Potassium ≈4 mmol/L
Calcium ≈2–3 mmol/L
Lactate ≈28 mmol/L

(2.5) Briefly describe two other disease conditions that cause body fluid derangements and explain the underlying mechanism. (40 marks)

Example 1: Diabetes Insipidus (20 Marks)

Point	Marks
ADH deficiency or resistance	4
Reduced water reabsorption in collecting ducts	4
Large volumes of dilute urine produced	4
Water loss exceeds sodium loss	4
Hypernatraemic dehydration develops	4

Example 2: Congestive Cardiac Failure (20 Marks)

Point	**Marks**
Reduced cardiac output	4
Reduced effective arterial blood volume	4
Activation of RAAS and ADH	4
Sodium and water retention	4
Oedema/fluid overload develops	4

Other Acceptable Conditions (20 Marks Each)

Chronic Kidney Disease

- Reduced renal excretion of water/sodium
- Fluid retention
- Oedema
- Hypertension

Nephrotic Syndrome

- Proteinuria
- Hypoalbuminaemia
- Reduced plasma oncotic pressure
- Fluid shift to interstitial space
- Generalized oedema

SIADH

- Excess ADH secretion
- Excess water retention
- Dilutional hyponatraemia

Diabetes Mellitus

- Hyperglycaemia
- Osmotic diuresis
- Polyuria
- Dehydration

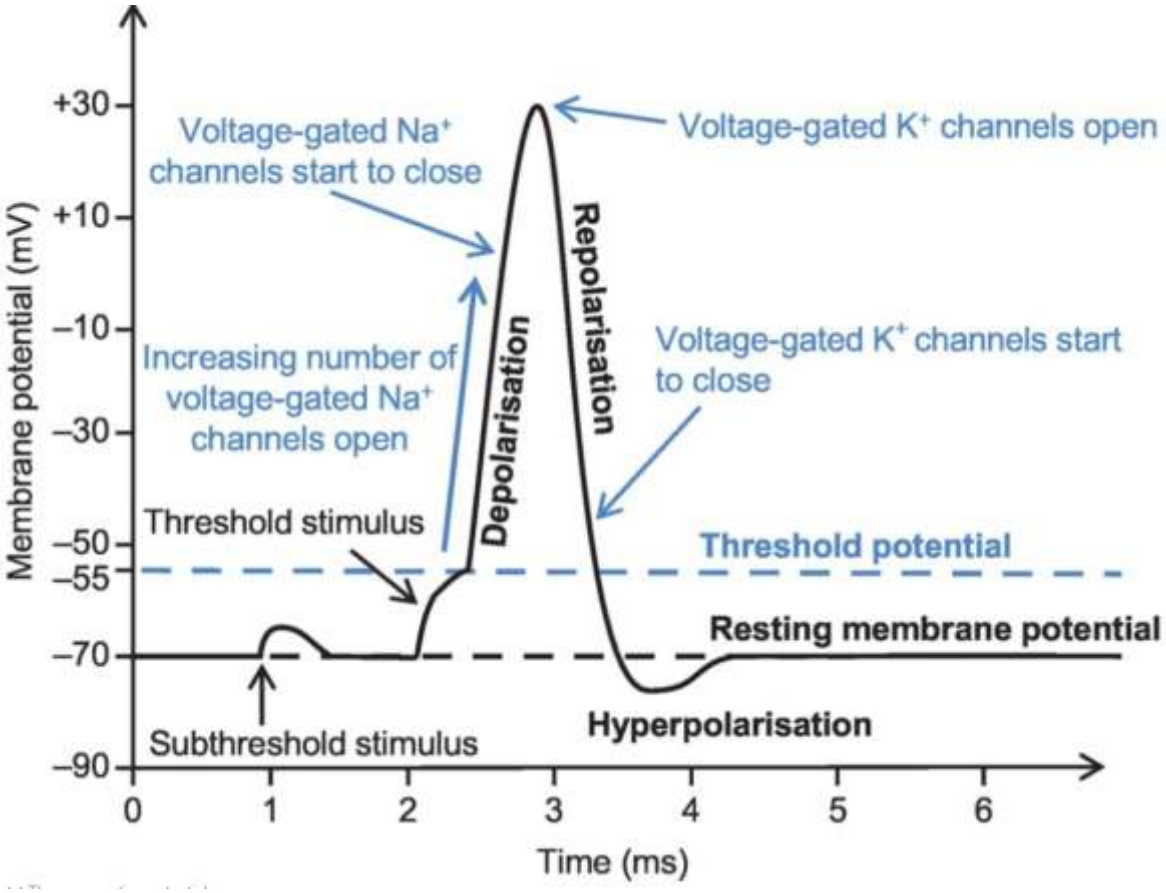
Membrane Potentials, Action Potentials and Neuromuscular Disorders

(1)An unconscious patient brought to the hospital was found to have elevated serum K+ levels (hyperkalemia). He was resuscitated at ETU and the K+ levels were corrected.

(1.1) Describe the role of K+ in maintaining the resting membrane potential. (25 marks)

Point	Marks
High intracellular K^+ concentration	4
Membrane highly permeable to K^+ at rest	4
K^+ diffuses out through leak channels	4
Inside becomes electrically negative	4
Equilibrium between concentration and electrical gradients	4
Role of Na^+/K^+ pump in maintaining gradients	3

(1.2) Describe the movement K+ ions across the nerve membrane during the generation of an action potential using a labelled diagram. (30 marks)



Point	Marks
Resting state with K^+ leak	3
Depolarization due to Na^+ influx	4
Opening of voltage-gated K^+ channels	5
K^+ efflux during repolarization	5
Hyperpolarization due to delayed closure of K^+ channels	5
Return to resting membrane potential	3
Correct labelled diagram	5

(1.3) Describe the physiological basis of the following statement; "Hyperkalemia makes the neuron more excitable". (25 marks)

Point	Marks
Increased extracellular K^+ concentration	4
Reduced K^+ concentration gradient	4
Reduced K^+ efflux from cell	4
Resting membrane potential becomes less negative	5
Membrane closer to threshold	4
Smaller stimulus required/action potentials generated more easily	4

(1.4) Name one possible abnormality/disease this patient could have developed due to hyperkalemia. (20 marks)

Cardiac arrhythmia (e.g., ventricular fibrillation)

OR

- Cardiac arrest
- Ventricular tachycardia
- Skeletal muscle paralysis

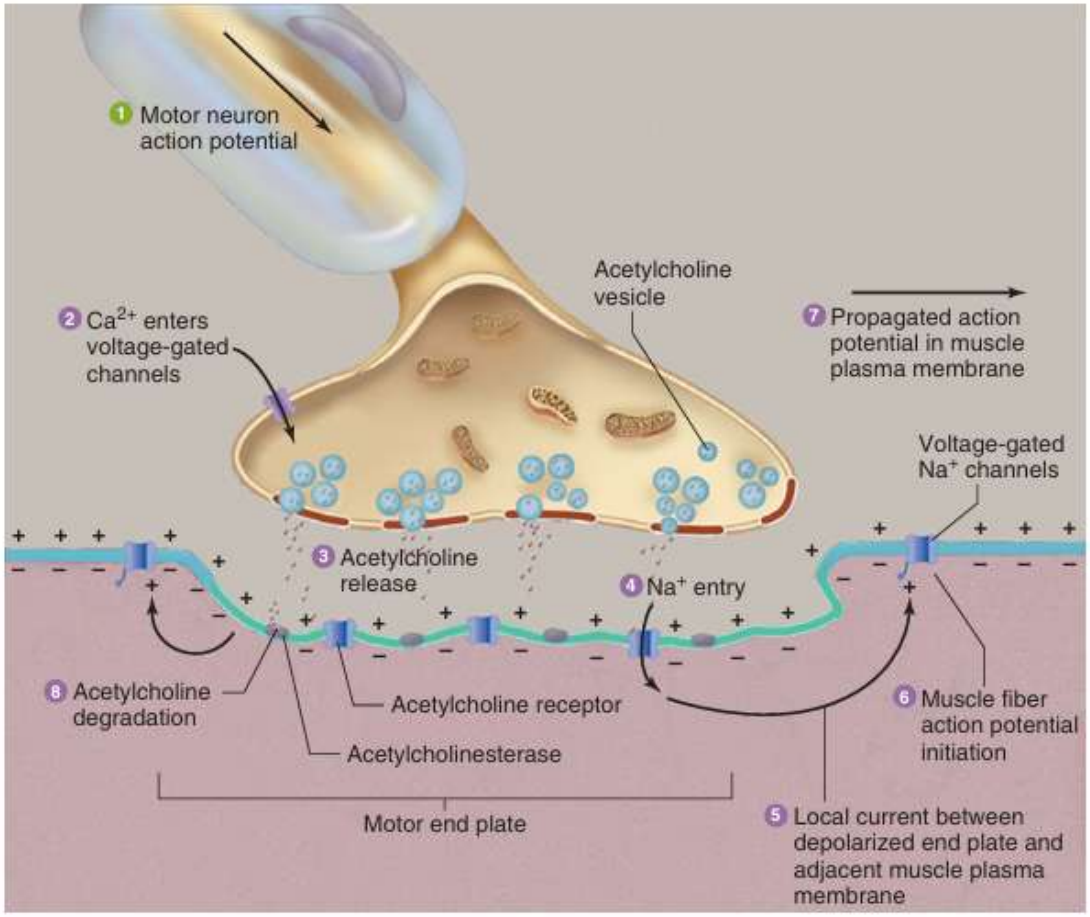
Explanation

Hyperkalaemia alters membrane excitability of cardiac muscle cells and may produce life-threatening disturbances of cardiac rhythm.

Point	Marks
Correct abnormality/disease identified	10
Brief physiological explanation	10

(2)A 23-year-old male patient was presented to the hospital complaining of progressively reduced muscle strength with repeated use of the muscle and difficulty in speaking. On examination he was found to have ptosis. After further investigations he was diagnosed with Myasthenia Gravis.

(2.1) Describe the normal function of neuromuscular junction using a labelled diagram. (50 marks)



Point	Marks
Action potential reaches nerve terminal	4
Opening of voltage-gated Ca^{2+} channels	5
Ca^{2+} influx into nerve terminal	5
Release of ACh by exocytosis	5
Binding of ACh to nicotinic receptors	5
End-plate potential generation	5
Muscle action potential generated	5
Initiation of muscle contraction	5

Point	Marks
Breakdown of ACh by acetylcholinesterase	4
Correct labelled diagram	7

(2.2) State the abnormality that occurs at neuromuscular junction in Myasthenia gravis. (15 marks)

Point	Marks
Autoimmune disease identified	4
Antibodies against nicotinic ACh receptors	5
Reduced number/function of receptors	3
Impaired neuromuscular transmission	3

(2.3) Describe the physiological basis of using cholinesterase inhibitors as a treatment method for Myasthenia gravis. (25 marks)

Point	Marks
Reduced ACh receptors in Myasthenia gravis	4
Acetylcholinesterase normally degrades ACh	4
Cholinesterase inhibitors block enzyme activity	4
Increased ACh concentration in synaptic cleft	4
Increased receptor activation	3
Improved end-plate potential generation	3
Improved muscle strength	3

(2.4) Name two other neuromuscular disorders. (10 marks)

Any two:

Lambert–Eaton Myasthenic Syndrome
Botulism
Muscular Dystrophy
Amyotrophic Lateral Sclerosis (ALS)
Guillain–Barré Syndrome

Point	Marks
First correct disorder	5
Second correct disorder	5

Red Blood Cells

(1)

(1.1) List the major components of blood and state one primary function of each component. (40 marks)

Major Components of Blood

Component	Primary Function	Marks
Plasma	Transport of nutrients, hormones, waste products and proteins	10
Red blood cells (Erythrocytes)	Transport of oxygen and carbon dioxide	10
White blood cells (Leukocytes)	Body defence and immunity	10
Platelets (Thrombocytes)	Haemostasis and blood clotting	10

(1.2) Outline the stages of haemopoiesis starting from the haematopoietic stem cell up to the formation of the myeloid and lymphoid lineages. (30 marks)

Haemopoietic Stem Cell Differentiation

Stage	Marks
Haematopoietic stem cell (HSC)	5
Multipotent progenitor cell	3
Common myeloid progenitor (CMP)	5
Common lymphoid progenitor (CLP)	5
Myeloid lineage gives rise to erythrocytes, granulocytes, monocytes and platelets	6
Lymphoid lineage gives rise to B lymphocytes, T lymphocytes and NK cells	6

(1.3) State two physiological factors that regulate haemopoiesis and briefly explain their roles. (30 marks)

Factor 1: Erythropoietin (EPO) (15 Marks)

Point	Marks
Produced mainly by kidneys	4
Released in response to hypoxia	4
Stimulates erythroid progenitor cells in bone marrow	4
Increases red blood cell production	3

Factor 2: Colony-Stimulating Factors (CSFs) / Interleukins (15 Marks)

Point	Marks
Produced by stromal cells/macrophages/T cells	4
Stimulate proliferation of progenitor cells	4
Promote differentiation of specific blood cell lines	4
Regulate leukocyte production	3

Other Acceptable Factors
Full marks may also be awarded for any two of the following:
Thrombopoietin (15 Marks)

Point	Marks
Produced mainly by liver	4
Stimulates megakaryocyte development	4
Increases platelet production	4
Regulates platelet count	3

Interleukin-3 (15 Marks)

Point	Marks
Produced by activated T cells	4
Stimulates pluripotent stem cells	4
Supports growth of multiple cell lines	4
Enhances haemopoiesis	3

Stem Cell Factor (SCF) (15 Marks)

Point	**Marks**
Produced by bone marrow stromal cells	4
Maintains stem cell survival	4
Stimulates proliferation of progenitor cells	4
Supports early haemopoiesis	3

(2)

(2.1) List the stages of erythropoiesis from proerythroblast to mature erythrocyte. (30 marks)

Stage	Marks
Proerythroblast (Pronormoblast)	5
Basophilic erythroblast (Early normoblast)	5
Polychromatophilic erythroblast (Intermediate normoblast)	5
Orthochromatic erythroblast (Late normoblast)	5
Reticulocyte	5
Mature erythrocyte	5

(2.2) Identify two hormones or factors that regulate erythropoiesis and state their role. (20 marks)

Factor 1: Erythropoietin (10 Marks)

Point	Marks
Produced mainly by kidneys	3
Released in response to hypoxia	3
Stimulates erythroid progenitor cells	2
Increases RBC production	2

Factor 2: Any One of the Following (10 Marks)

Iron

Point	Marks
Required for haemoglobin synthesis	4
Essential for normal erythropoiesis	3
Deficiency causes impaired RBC production	3

Vitamin B12

Point	Marks
Required for DNA synthesis	4
Necessary for maturation of erythroblasts	3
Deficiency causes megaloblastic anaemia	3

Folic Acid

Point	Marks
Required for DNA synthesis	4
Supports cell division in marrow	3
Deficiency impairs erythropoiesis	3

Androgens

Point	Marks
Stimulate erythropoietin production	4
Enhance erythropoiesis	3
Contribute to higher Hb levels in males	3

(2.3) List the following red blood cell indices and state what each measure:

(2.3.1) Mean corpuscular volume (MCV)

Point	Marks
Correct identification of index	5
Measures average volume/size of a red blood cell	5

(2.3.2) Mean corpuscular haemoglobin (MCH)

Point	Marks
Correct identification of index	5
Measures average amount of haemoglobin per red blood cell	5

(2.3.3) Mean corpuscular haemoglobin concentration (MCHC)

Point	Marks
Correct identification of index	5
Measures average concentration of haemoglobin within RBCs	5

(2.3.4) Red cell distribution width (RDW) (40 marks)

Point	Marks
Correct identification of index	5
Measures variation in RBC size (anisocytosis)	5

(2.4) State one clinical situation in which RBC indices are useful and explain briefly how they aid diagnosis. (20 marks)

Example: Investigation of Anaemia

Point	Marks
Anaemia identified as clinical situation	5
MCV helps classify anaemia (microcytic, normocytic, macrocytic)	5
MCH/MCHC help assess haemoglobin content	5
RDW helps differentiate causes of anaemia	5

Alternative Accepted Answers
Iron Deficiency Anaemia

Point	Marks
Microcytic hypochromic pattern identified	5
Low MCV	5
Low MCH/MCHC	5
Increased RDW	5

Megaloblastic Anaemia

Point	Marks
Macrocytic anaemia identified	5
High MCV	5
Helps detect B12/folate deficiency	5
Supports diagnostic workup	5

Clotting and Anti-clotting

(1)

(1.1) State the major physiological process involved in haemostasis (20 marks)

Process	Marks
Vasoconstriction (vascular spasm)	5
Platelet plug formation (primary haemostasis)	5
Blood coagulation/clot formation (secondary haemostasis)	5
Clot retraction and vessel repair	3
Fibrinolysis	2

(1.2) Explain the physiological basis of the following;

(1.2.1) Vitamin K inhibitors are used to prevent blood clotting (40 marks)

Point	Marks
Vitamin K required for synthesis of clotting factors	5
Factors II, VII, IX and X are vitamin K dependent	8
Vitamin K required for γ-carboxylation of these factors	7
Carboxylation enables calcium binding and activation	5
Vitamin K inhibitors (e.g. warfarin) block vitamin K recycling	5
Reduced synthesis of functional clotting factors	5
Coagulation process becomes impaired	3
Blood clot formation is reduced/prevented	2

(1.2.2) A patient with thrombocytopenia was found to have a prolonged bleeding time (40 marks)

Point	Marks
Thrombocytopenia = reduced platelet count	5
Platelets essential for primary haemostasis	5
Platelets normally adhere to damaged endothelium	5
Platelets become activated and aggregate	5
Platelet plug formation becomes defective	8
Initial haemostasis delayed	5
Bleeding from small vessels continues for longer	4
Bleeding time becomes prolonged	3

(2)A boy was hospitalized with bleeding into the knee joint after a fall. On investigation, he was found to have prolonged activated partial thromboplastin time, while platelet count, bleeding time and prothrombin time were normal.

(2.1) State the most likely bleeding disorder in this boy (20 marks)

Haemophilia A (Factor VIII deficiency) (20 marks)

(2.2) Explain the physiological basis for the above test results (80 marks)

A. Deficiency of Factor VIII (or IX) affects the intrinsic pathway (20 Marks)

Point	Marks
Haemophilia A caused by Factor VIII deficiency	5
Factor VIII participates in intrinsic coagulation pathway	5
Factor VIII acts with Factor IXa to activate Factor X	5
Deficiency impairs coagulation cascade	5

B. Activated Partial Thromboplastin Time (aPTT) is prolonged (20 Marks)

Point	Marks
aPTT assesses intrinsic and common pathways	5
Factor VIII deficiency slows intrinsic pathway	5
Clot formation takes longer	5
Therefore aPTT becomes prolonged	5

C. Platelet Count and Bleeding Time are Normal (20 Marks)

Point	Marks
Platelets are quantitatively normal	5
Platelet function (primary haemostasis) remains normal	5
Platelet plug formation occurs normally	5
Therefore bleeding time remains normal	5

D. Prothrombin Time (PT) is Normal (20 Marks)

Point	Marks
PT evaluates extrinsic and common pathways	5
Extrinsic pathway depends mainly on Factor VII	5
Factor VIII not involved in PT measurement	5
Therefore PT remains normal	5

WBC and Immunity

(1)In the immunization schedule of Sri Lanka, mumps vaccination is included at 12 months (1st dose) and at 3 years (3rd dose).

(1.1) List five components of immune system and state one function of each. (25 marks)

Award 5 marks each (2 marks for component + 3 marks for function)

Component	Function	Marks
Lymphocytes (B cells/T cells)	Specific immune responses	5
Antibodies (Immunoglobulins)	Neutralization of pathogens and toxins	5
Macrophages	Phagocytosis and antigen presentation	5
Complement system	Lysis of microorganisms and opsonization	5
Bone marrow	Production of immune cells	5
Thymus	Maturation of T lymphocytes	5
Lymph nodes	Site of antigen presentation and lymphocyte activation	5
Spleen	Filters blood and mounts immune responses	5
Natural killer (NK) cells	Destruction of virus-infected and tumour cells	5

(1.2) List the main types of immunoglobulins found in the body. (10 marks)

Immunoglobulin	Marks
IgG	2
IgA	2
IgM	2
IgE	2
IgD	2

(1.3) Describe special characteristics of above-mentioned immunoglobulins. (25 marks)

IgG (5 Marks)

Point	Marks
Most abundant immunoglobulin in plasma	2
Crosses placenta and provides passive immunity to fetus	3

IgA (5 Marks)

Point	Marks
Major antibody in secretions (saliva, tears, breast milk, mucosa)	3
Provides mucosal immunity	2

IgM (5 Marks)

Point	Marks
First antibody produced during primary immune response	3
Pentameric structure; highly effective in agglutination/complement activation	2

IgE (5 Marks)

Point	Marks
Mediates allergic reactions	3
Involved in defence against parasites	2

IgD (5 Marks)

Point	Marks
Present on surface of B lymphocytes	3
Functions as B-cell receptor	2

(1.4) Explain the physiological basis of giving two doses of the same vaccine with a time interval. (40 marks)

Primary Immune Response (15 Marks)

Point	Marks
First vaccine dose introduces antigen	3
Antigen activates naïve B and T lymphocytes	4
Primary immune response develops	3
Antibody production occurs (mainly IgM initially)	2
Memory B and T cells are generated	3

Secondary (Booster) Response (20 Marks)

Point	Marks
Second dose re-exposes immune system to same antigen	4
Memory cells rapidly recognize antigen	4
Faster immune response develops	3
Greater antibody production occurs	3
Predominantly IgG response	2
Antibodies have higher affinity	2
Longer-lasting protection achieved	2

Importance of Time Interval (5 Marks)

Point	Marks
Allows formation and maturation of memory cells	3
Maximizes effectiveness of booster response	2

(2)Write short notes on the following

(2.1) Macrophage's role in immunity (25 marks)

Point	Marks
Macrophages are phagocytic cells of the monocyte-macrophage system	3
Engulf and destroy microorganisms by phagocytosis	5
Remove dead cells and tissue debris	3
Process and present antigens to T lymphocytes (APC function)	5
Secrete cytokines (e.g., IL-1, TNF-α)	4
Activate and regulate immune responses	3
Participate in inflammation and tissue repair	2

(2.2) Role of cytotoxic lymphocytes (25 marks)

Point	Marks
Cytotoxic T lymphocytes ($CD8^+$ T cells) are part of cell-mediated immunity	4
Recognize antigen presented with MHC class I molecules	5
Destroy virus-infected cells	5
Destroy tumour cells	3
Release perforin causing pore formation	3
Release granzymes inducing apoptosis	3
Important in immune surveillance	2

(2.3) Function of basophils (25 marks)

Point	Marks
Basophils are granulocytes involved in allergic reactions	4
Possess Fc receptors for IgE	4
Antigen-IgE interaction activates basophils	4
Release histamine	4
Histamine causes vasodilation and increased vascular permeability	4
Release heparin	2
Contribute to immediate hypersensitivity reactions	3

(2.4) Function of eosinophils (25 marks)

Point	Marks
Eosinophils are granulocytes involved in parasitic defence	5
Destroy parasites by releasing toxic granule proteins	5
Release major basic protein and eosinophil cationic protein	4
Participate in allergic reactions	3
Modulate inflammatory responses	3
Phagocytose antigen-antibody complexes	3
Help limit effects of histamine and other mediators	2

Blood Grouping and Transfusion

(1)Describe the physiological basis of the following

(1.1) Blood group O is considered a universal donor (50 marks)

Point	Marks
ABO blood group system based on presence/absence of A and B antigens on RBCs	5
Group O red cells lack A antigen	5
Group O red cells lack B antigen	5
Therefore recipient anti-A antibodies cannot react with donor RBCs	8
Recipient anti-B antibodies cannot react with donor RBCs	8
Agglutination is prevented	5
Hemolytic transfusion reactions are avoided	5
O negative blood lacks Rh(D) antigen as well	5
Therefore O negative blood can be transfused in emergencies	4

(1.2) Rhogam is administered to a Rh-negative mother following the delivery of a Rh-positive baby. (50 marks)

Maternal Sensitization (20 marks)

Point	Marks
Mother is Rh negative	4
Baby is Rh positive	4
Fetal RBCs may enter maternal circulation during delivery	5
Maternal immune system recognizes Rh(D) antigen as foreign	4
Maternal sensitization occurs	3

Antibody Formation (10 Marks)

Point	Marks
Mother produces anti-D antibodies	5
Memory B cells are formed	5

Effect on Future Pregnancies (10 Marks)

Point	Marks
Anti-D antibodies cross placenta in subsequent pregnancy	4
Destroy Rh-positive fetal RBCs	3
Cause haemolytic disease of the newborn (HDN)	3

Role of Rhogam (10 Marks)

Point	Marks
Rhogam contains anti-D immunoglobulin	3
Binds Rh-positive fetal RBCs in maternal circulation	3
Prevents maternal immune recognition and sensitization	2
Prevents formation of maternal anti-D antibodies and protects future pregnancies	2

Dynamics of Blood Flow

(1)Explain the physiological basis of the following:

(1.1) A 58-year-old man presents with headache, dizziness, and a ruddy complexion. Investigations reveal a markedly elevated haematocrit. His blood pressure is also elevated. (50 marks)

Expected Diagnosis

Polycythaemia (particularly Polycythaemia Vera)

Physiological Basis (50 Marks)

Increased Red Cell Mass and Haematocrit (20 Marks)

Point	Marks
Increased erythrocyte production	5
Increased red cell mass	5
Elevated haematocrit	5
Increased oxygen-carrying capacity of blood	5

Increased Blood Viscosity (15 Marks)

Point	Marks
Elevated haematocrit increases blood viscosity	5
Increased resistance to blood flow	5
Increased cardiac workload/peripheral resistance	5

Clinical Features (15 Marks)

Point	Marks
Reduced cerebral blood flow contributes to headache	5
Hyperviscosity contributes to dizziness	5
Increased RBC mass causes ruddy/plethoric complexion	5

(1.2) A 65-year-old man complains of calf pain on walking that is relieved by rest. On examination, lower limb pulses are weak, while upper limb pulses are normal. (50 marks)

Expected Diagnosis

Peripheral Arterial Disease (PAD) causing intermittent claudication

Physiological Basis (50 Marks)

Arterial Narrowing (15 Marks)

Point	Marks
Atherosclerotic narrowing of lower limb arteries	5
Reduced arterial blood flow to muscles	5
Lower limb pulses become weak	5

Exercise-Induced Ischaemia (20 Marks)

Point	Marks
Exercise increases oxygen demand of skeletal muscles	5
Blood supply cannot increase adequately because of arterial narrowing	5
Muscle ischaemia develops	5
Anaerobic metabolism occurs	5

Pain and Relief by Rest (15 Marks)

Point	Marks
Lactate and metabolic by-products accumulate	5
Ischaemic muscle pain (claudication) develops	5
Rest reduces oxygen demand allowing recovery and pain relief	5

Electrical Activity of the Heart

(1)The cardiac electrical activity that triggers heartbeat originates in a specialized cardiac conduction system.

(1.1) Name all the parts of the cardiac conduction system. (20 marks)

Component	Marks
Sinoatrial (SA) node	4
Atrioventricular (AV) node	4
Bundle of His (AV bundle)	4
Right and Left bundle branches	4
Purkinje fibres	4

(1.2) What is the normal cardiac pacemaker? Describe the reason for it to be the pacemaker that determines the heart rate. (25 marks)

Expected Answer

Sinoatrial (SA) node

Point	Marks
SA node identified as normal pacemaker	5
Possesses automaticity/spontaneous depolarization	5
Highest intrinsic firing rate among cardiac pacemakers (60–100/min)	5
Fastest rate of phase 4 depolarization	5
Suppresses other pacemakers by overdrive suppression	5

(1.3) What is the significance of bundle of His in the cardiac conduction system? (15 marks)

Point	Marks
Conducts impulses from AV node to ventricles	5
Only normal electrical connection between atria and ventricles	5
Ensures coordinated ventricular activation and contraction	5

(1.4) Describe the reciprocal activation of autonomic innervation that regulate the heart rate. (20 marks)

Parasympathetic Effects (10 Marks)

Point	Marks
Vagus nerve supplies SA and AV nodes	3
Acetylcholine released	2
Decreases rate of SA node firing	3
Slows heart rate (negative chronotropic effect)	2

Sympathetic Effects (10 Marks)

Point	Marks
Sympathetic cardiac nerves supply SA node and myocardium	3
Noradrenaline released	2
Increases SA node firing rate	3
Increases heart rate (positive chronotropic effect)	2

(1.5) Describe how the cardiac excitation spread across the heart. (20 marks)

Point	Marks
Impulse originates in SA node	3
Spreads through both atria causing atrial depolarization	4
Reaches AV node	3
Brief AV nodal delay occurs	3
Conducted through Bundle of His	2
Travels through right and left bundle branches	2
Distributed by Purkinje fibres	2
Ventricular depolarization and contraction occur	1

(2)

(2.1) Using a labelled diagram compare the action potentials in a cardiac ventricular muscle and pacemaker tissue (60 marks)

A. Correct Labelled Diagram (20 Marks)

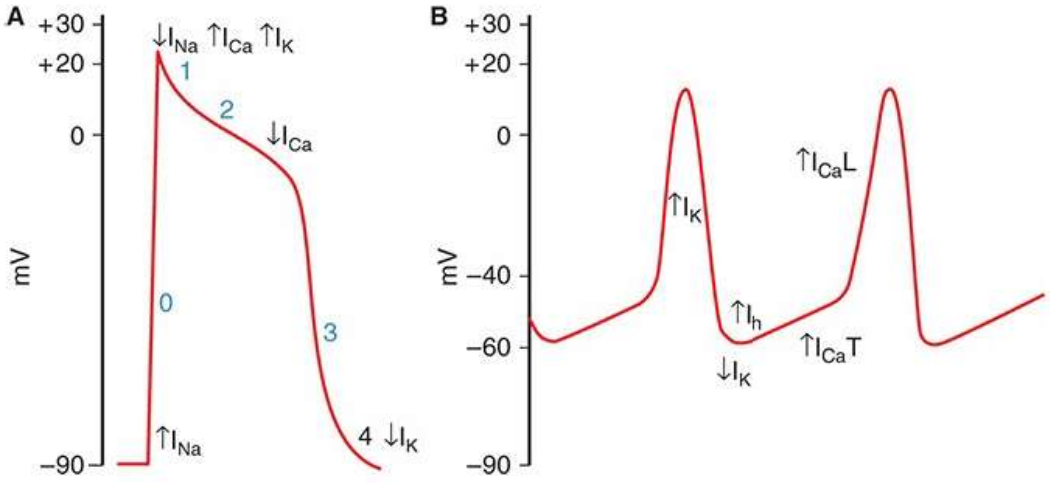


FIGURE 29–2 Comparison of action potentials in ventricular muscle and diagram of the membrane potential of pacemaker tissue. A) Phases of action potential in ventricular myocyte (0–4, see text for details) are superimposed with principal changes in current that contribute to changes in membrane potential. **B)** The principal current responsible for each part of the potential of pacemaker tissue is shown under or beside the component. L, long-lasting; T, transient. Other ion channels contribute to the electrical response. Note that the resting membrane potential of pacemaker tissue is somewhat lower than that of atrial and ventricular muscle.

The diagram should clearly show:

Feature	Marks
Ventricular muscle action potential curve	5
Pacemaker action potential curve	5
Proper axes (Membrane potential vs Time)	3
Labelled phases of ventricular AP	4
Labelled pacemaker potential/phase 4 depolarization	3

B. Comparison of Ventricular Muscle and Pacemaker Action Potentials (40 Marks)

Feature	Ventricular Muscle	Pacemaker Cell	Marks
Resting membrane potential	Stable (~ -90 mV)	Unstable (~ -60 mV)	5
Phase 4	Flat/stable	Spontaneous depolarization	5
Automaticity	Absent	Present	5
Depolarization	Fast Na^+ influx	Slow Ca^{2+} influx	10
Plateau phase	Present	Absent	5
Repolarization	K^+ efflux	K^+ efflux	5
Determines heart rhythm	No	Yes	5

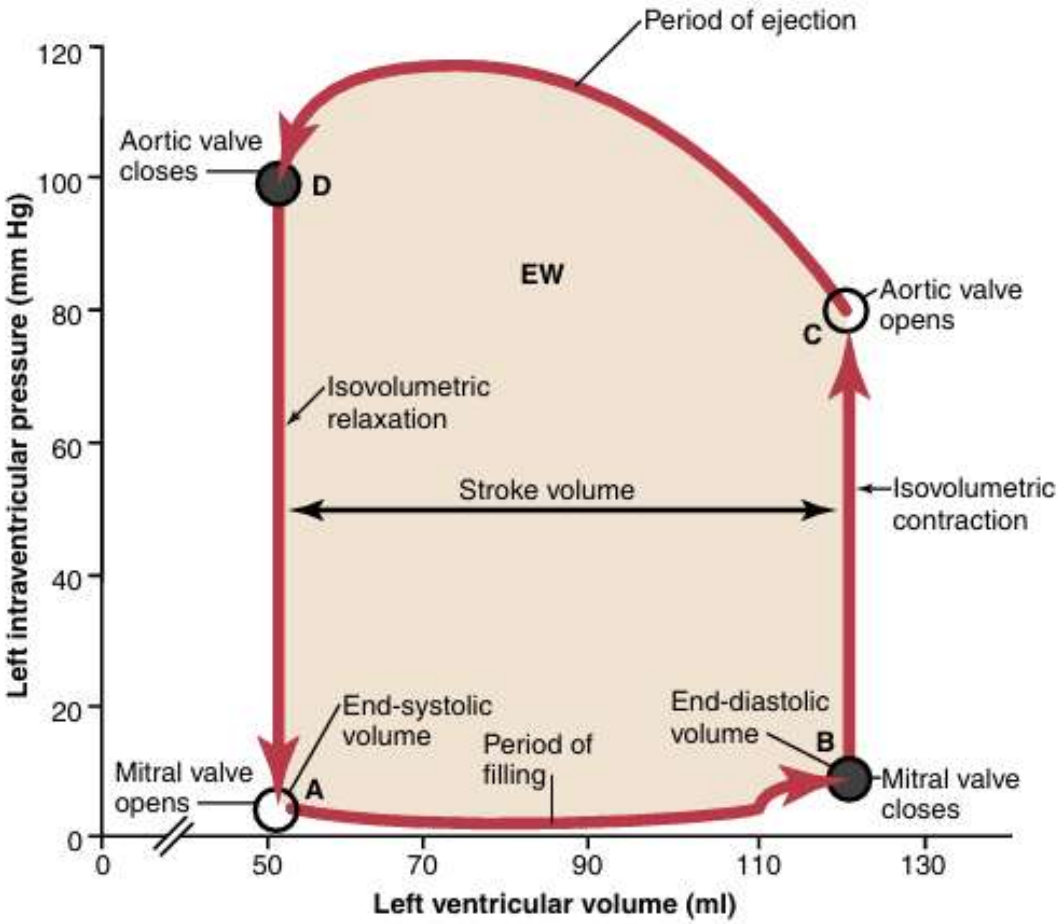
(2.2) Describe how the pacemaker potentials are formed in pacemaker cells. (40 marks)

Point	Marks
Pacemaker cells have no stable resting membrane potential	5
Repolarization ends at approximately -60 mV	3
Hyperpolarization activates funny (If) channels	6
Slow inward Na^+ current enters cell	5
Gradual depolarization (pacemaker potential) occurs	5
T-type Ca^{2+} channels open during late phase 4	4
Threshold potential reached	3
L-type Ca^{2+} channels open causing depolarization	4
K^+ channels open causing repolarization	3
Cycle repeats automatically	2

Cardiac Cycle

(1)

(1.1) Draw and label a left ventricular pressure-volume loop of a healthy adult male, indicating the expected values for left ventricular pressures and volumes. (30 marks)



A. Correct Pressure–Volume Loop Diagram (15 Marks)

Component	**Marks**
Correct loop shape drawn	3
X-axis labelled (Volume, mL)	2
Y-axis labelled (Pressure, mmHg)	2
End-diastolic point identified	2
End-systolic point identified	2
Direction of loop shown correctly	2
Four phases represented	2

B. Labelling of Phases (8 Marks)

Phase	Marks
Ventricular filling	2
Isovolumetric contraction	2
Ventricular ejection	2
Isovolumetric relaxation	2

C. Expected Pressures and Volumes (7 Marks)

Parameter	Expected Value	Marks
End-diastolic volume (EDV)	~120–130 mL	2
End-systolic volume (ESV)	~50–60 mL	2
Peak LV systolic pressure	~120 mmHg	2
End-diastolic pressure	~5–10 mmHg	1

(1.2) Calculate the stroke volume in the above individual. (10 marks)

Formula

Stroke Volume (SV) = End-Diastolic Volume − End-Systolic Volume

Using typical values:

SV = 120 mL − 50 mL

SV = 70 mL

Point	Marks
Correct formula stated	4
Correct substitution of values	3
Correct answer (≈70 mL)	3

(1.3) Based on the formula used in the above calculation, explain the physiological basis for the change in stroke volume in a patient,

(1.3.1) Who is administered a β-adrenergic agonist (which increases the contractility of the heart and heart rate) (30 marks)

Expected Change
Stroke volume increases

Point	Marks
β-adrenergic agonist stimulates β_1 receptors	4
Increased intracellular Ca^{2+} availability	5
Increased myocardial contractility (positive inotropy)	5
More complete ventricular emptying	4
End-systolic volume decreases	5
Since SV = EDV − ESV, stroke volume increases	5
Increased heart rate may further increase cardiac output	2

(1.3.2) Immediately following a massive haemorrhage (30 marks)

Expected Change
Stroke volume decreases

Point	Marks
Massive haemorrhage causes loss of blood volume	5
Venous return decreases	5
End-diastolic volume (preload) decreases	5
Ventricular filling decreases	4
Frank–Starling mechanism less effective	4
Force of contraction decreases	3
Stroke volume decreases	4

PHYSIOLOGY
CAT-1
MOCK PAPERS & ANSWERS

2023/2024 (2nd Batch)
CAT-1 Mock Exam

CAT-1 (BATCH 2) MOCK MCQS

MULTIPLE CHOICE QUESTIONS
Time: 1 hour

This paper consists of 10 True or False type questions and 10 Single Best Answer type questions.

(1)Which of the following causes of oedema and mechanism are correctly matched?

(A) Filariasis – Increase hydrostatic pressure.
(B) Chronic liver disease – Increase capillary permeability.
(C) Heart failure - Increase hydrostatic pressure in capillaries.
(D) Renal failure - Increase total body water content.
(E) Protein loss enteropathy – Decrease oncotic pressure.

(2)True or False regarding the body fluids?

(A) Interstitial fluid has higher osmotic pressure than plasma.
(B) A newborn has more water than children as a percentage of total body water.
(C) Plasma volume is 25% of extracellular fluid.
(D) Total body water is estimated by inulin.
(E) Increase Na+ loss causes reduction in ECF.

(3)True or False regarding iron deficiency anemia?

(A) Total iron binding capacity is increased.
(B) Hematocrit decrease.
(C) Mean corpuscular volume (MCV) Increase in red blood cells.
(D) Percentage saturation of transferring is Decrease.
(E) Extra medullary erythropoiesis occurs.

(4)Acquired immunity is seen after,

(A) Chickenpox infection
(B) Giving Rhogam to Rh negative mother
(C) Passing of antibodies from mother in breast milk.
(D) Antigen given as an injection
(E) Crossing the maternal antibody through the placenta.

(5)True or False regarding RMP?

(A) Represents electronic equilibrium.
(B) Established by Na+/K+ ATPase.
(C) Mainly determined by intra and extra cellular Na+ concentration.
(D) More K+ channels open than Na+ channels.
(E) Membrane is more permeable to Na+ than K+.

(6)True or False regarding smooth muscles,

(A) Troponin is present in smooth muscles.
(B) Source of Ca^{2+} for smooth muscle is the extracellular fluid.
(C) Relaxation time depends on the intracellular Ca^{2+} concentration.
(D) Smooth muscles undergo atrophy when they are denervated.
(E) Cell striations cannot be seen due to absence of actin and myosin.

(7)Following are steps involved in synaptic transmission except,

(A) Arrival of an action potential to the terminal bulb of pre synaptic cell.
(B) Opening of the voltage gated Ca^{2+} channels.
(C) Ca^{2+} mediated neurotransmitter vesicles are formed.
(D) Bounding of vesicles to membrane and docking.
(E) Initiating the signal in the presynaptic membrane.

(8)True or False regarding electrocardiogram?

(A) PR interval is forming the beginning of P wave to beginning of R wave.
(B) The T wave represents atrial depolorization.
(C) Cardiac axis of 30° is normal.
(D) A prolonged ST wave can be seen in 1st degree heart block.
(E) P wave is inverted in AVR.

(9)True or False regarding?

(A) The 2nd heart sound is due to closure of AV valves.
(B) The 2nd heart sound is physiologically split into two during inspiration.
(C) Murmurs due to mitral stenosis can be heard during systole.
(D) 4th heart sound is physiological.
(E) Atrial systole results in 3rd heart sound

(10)True or False regarding shock?

(A) Peripheries are warm to touch in sepsis.
(B) Baroreceptor activation is reduced.
(C) Cardiac tamponade causes cardiogenic shock.
(D) Heart failure is a cause for pulmonary oedema.
(E) Synaptic activation is reduced.

Question number 11 to 20 are Single Best Response (SBR) type. Select the best response to each question.

(11) A 40-year-old woman noted eye drooping while removing her makeup. In the evening, she experienced double vision and arm weakness.

What may cause this?

(A) Type 1 Diabetes Mellitus
(B) Myasthenia gravis
(C) Lupus erythematosus
(D) Rheumatic fever
(E) Glomerular nephritis

(12) 60 years old man was presented at the emergency room with a severe central chest pain for 20 min.

What can be observed in an early stage of myocardial infraction?

(A) Inverted T wave
(B) ST elevation
(C) ST depression
(D) Q wave
(E) Prolonged of PR interval

(13) A 19-year-old patient admitted to the surgical casualty ward with profuse bleeding following a damage to the iliac vessels after a road traffic accident. He looks pale and carries a card confirming his blood group is B positive

Which of the following is the most appropriate blood for transfusion

(A) Transfusing O+ Blood with cross matching
(B) Transfusing B+ blood without cross matching
(C) Transfusing AB+ blood without cross matching
(D) Transfusing B+ blood with cross matching
(E) Transfusing O+ blood without cross matching

(14) Von Willebrand disease is diagnosed in a patient. Which of the following laboratory findings is not compatible with the diagnosis?

(A) Prolonged BT
(B) Prolonged CT
(C) Prolonged APTT
(D) Prolonged PT/INR
(E) Normal platelet count

(15)18-year-old girl has ingested organophosphate with the intention of committing suicide.

What are the features of involvement of nicotinic cholinergic receptors?

(A) Constriction of pupils
(B) Pulse rate of 50 /min
(C) Axillary sweating
(D) Respiratory muscle paralysis
(E) Diarrhea

(16)50-year-old man presented with syncope was found to have a complete heart block.

Which of the following is not compatible for the diagnosis?

(A) Heart rate of 40/min
(B) Appearance of P wave every 72/min in the ECG
(C) Evidence of atrioventricular dissociation in the ECG
(D) Irregular radial pulse
(E) Cannon waves in jugular venous pulse

(17)A 20-year-old woman who has no hemolytic disease gave birth to a healthy neonate who developed deep jaundice within 24 hours after birth. It was diagnosed as hemolytic disease of the new born.

Which of the following is inappropriate with the causative factor of it?

(A) The mother should be Rh-
(B) The father should be Rh+
(C) This could be her first child
(D) Delivering a Rh+ baby in a previous pregnancy increases the risk of this presentation
(E) Transfusion of Rh incompatible blood before pregnancy can be a causative factor

(18)20-year-old boy presented with shortness of breath on exertion. Features of icterus & anemia also present.

What is not present?

(A) RBC lifespan of 110 days
(B) Reticulocyte count of 6%
(C) Spherical shaped cells
(D) Increased urobilinogen in urine
(E) Increased serum conjugated bilirubin level

(19) A 55-year-old man is brought to the emergency department with fever, chills, and confusion for the past 12 hours. He has a history of diabetes mellitus and recently had surgery for a diabetic foot ulcer. On examination, he is febrile (39.2°C), hypotensive (BP 78/44 mmHg), and tachycardic (HR 124 bpm). His respiratory rate is 26 breaths/min and oxygen saturation is 93% on room air. He has warm extremities with bounding pulses. Laboratory tests show elevated white blood cell count, high serum lactate, and metabolic acidosis. Blood cultures are pending.

Which of the following is the most likely type of shock in this patient?

(A) Hypovolemic shock
(B) Cardiogenic shock
(C) Obstructive shock
(D) Septic shock
(E) Neurogenic shock

(20) A 68-year-old man is admitted to the ICU following an acute hemorrhagic stroke. Over the past hour, the nurse reports a sudden decline in the patient's level of consciousness. On assessment, his blood pressure has risen to 190/100 mmHg, heart rate has dropped to 48 bpm, and respiratory pattern is irregular with periods of apnea. His pupils are unequal and sluggishly reactive. A repeat CT scan shows increased midline shift and worsening cerebral edema.

Which of the following best explains the patient's current clinical findings?

(A) Autonomic dysregulation from spinal cord injury
(B) Brainstem ischemia triggering systemic vasodilation
(C) Increased intracranial pressure causing Cushing reflex
(D) Central pontine demyelination leading to respiratory arrest
(E) Increased sympathetic activity due to pain response

CAT-1 (BATCH 2) MOCK MCQ ANSWERS

(1)

(A) **F** - Filariasis causes lymphatic obstruction, not increased hydrostatic pressure. This leads to non-pitting lymphedema, not typical fluid shift from pressure.
(B) **F** – Chronic liver disease primarily causes decreased oncotic pressure due to low albumin, not increased capillary permeability.
(C) **T** – In heart failure, venous congestion leads to increased hydrostatic pressure in capillaries, causing fluid to move into interstitial spaces (edema).
(D) **T** – Renal failure leads to fluid retention due to impaired excretion, increasing total body water, contributing to edema.
(E) **T** – Protein loss enteropathy results in loss of albumin, reducing plasma oncotic pressure and promoting edema formation.

(2)

(A) **F** – Interstitial fluid and plasma have very similar osmotic pressures due to free movement of water and small solutes, but plasma has slightly higher oncotic (colloid osmotic) pressure due to proteins like albumin.
(B) **T** – Newborns have a higher percentage of total body water (about 70–75%) compared to older children and adults.
(C) **T** – Plasma volume makes up about 25% of the extracellular fluid (ECF); the remaining 75% is interstitial fluid.
(D) **F** – Inulin is used to measure extracellular fluid (ECF) volume, not total body water. Total body water is measured using substances like heavy water (D_2O) or antipyrine.
(E) **T** – Increased sodium loss leads to water loss from the extracellular fluid, causing a reduction in ECF volume.

(3)

(A) **T** – Total Iron Binding Capacity (TIBC) is increased in iron deficiency anemia because the body increases transferrin production to bind more available iron.
(B) **T** – Hematocrit decreases in iron deficiency anemia because of the reduced number of red blood cells and low hemoglobin concentration.
(C) **F** – Mean corpuscular volume (MCV) decreases in iron deficiency anemia because red blood cells are smaller (microcytic), not larger.
(D) **T** – Percentage saturation of transferrin is decreased in iron deficiency anemia because transferrin binds to less iron due to insufficient iron stores.
(E) **T** – Extramedullary erythropoiesis can occur in severe cases of iron deficiency anemia, where the bone marrow is unable to meet the demand for red blood cell production.

(4)

(A) **T –** Chickenpox infection leads to the development of acquired (adaptive) immunity through the formation of antibodies after exposure to the virus.
(B) **T –** Giving Rhogam to an Rh-negative mother stimulates acquired immunity by preventing the mother from producing antibodies against Rh-positive blood cells from a Rh-positive baby.
(C) **T –** Passing antibodies from mother in breast milk provides passive immunity acquired immunity. The baby receives pre-formed antibodies, but it does not produce them itself.
(D) **T –** Antigen given as an injection (such as in vaccines) stimulates the acquired immune system to produce a specific immune response (antibodies and memory cells).
(E) **T –** Crossing the maternal antibody through the placenta provides passive acquired immunity, as the fetus is not actively producing its own antibodies.

(5)

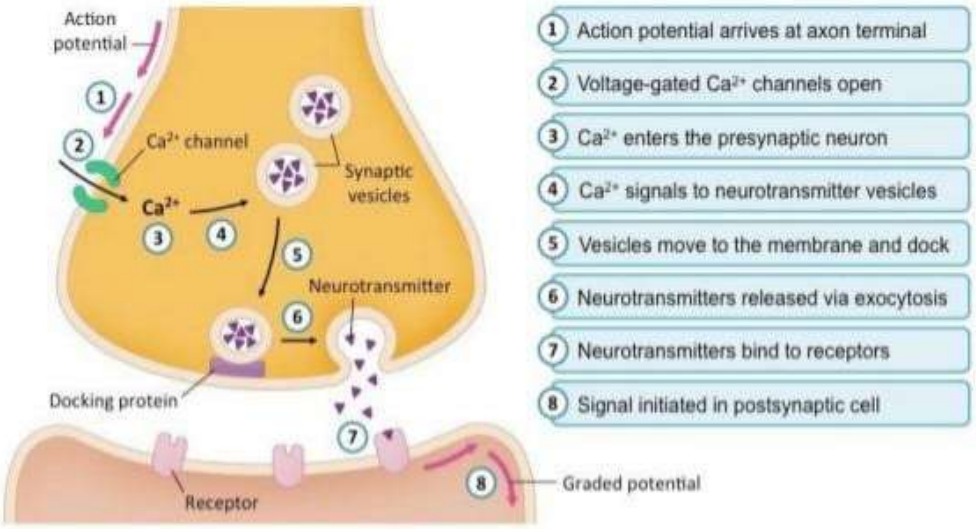
(A) **F** – Resting membrane potential (RMP) is an electronic equilibrium where ion movements are balanced.
(B) **T** – Na^+/K^+ ATPase helps establish and maintain the resting membrane potential by pumping 3 Na^+ ions out and 2 K^+ ions in, creating ion concentration gradients.
(C) **F** – The RMP is not mainly determined by Na^+ concentrations but primarily by K+ concentrations, as the membrane is more permeable to K^+ ions at rest.
(D) **T** – At rest, there are more K^+ channels open than Na^+ channels, which makes the membrane more permeable to K^+.
(E) **F** – The membrane is more permeable to K^+ than Na^+ at rest, which is why the RMP is closer to the equilibrium potential of K^+ rather than Na^+.

(6)

(A) **F** – Troponin is not present in smooth muscle. Instead, smooth muscle uses calmodulin to regulate contraction in the presence of calcium.
(B) **T** – In smooth muscle, the primary source of Ca2+ for contraction is from the extracellular fluid (through calcium channels), in addition to release from the sarcoplasmic reticulum.
(C) **T** – Relaxation time is largely determined by the intracellular Ca2+ concentration. The removal of calcium from the cytoplasm allows the muscle to relax.
(D) **T** – Smooth muscles can undergo atrophy when they are denervated because they rely on neural input to maintain function, and the loss of nerve supply can lead to muscle shrinkage.
(E) **T** – Striations are not visible in smooth muscle because the arrangement of actin and myosin filaments is not as regular as in skeletal muscle, but actin and myosin are still present in smooth muscle, just not in a striated pattern.

(7)

(A) F
(B) F
(C) F
(D) F
(E) T



(8)

(A) **F** – The PR interval is the time from the beginning of the P wave to the beginning of the QRS complex, not from the P wave to the R wave.
(B) **F** – The T wave represents ventricular repolarization, not atrial depolarization. Atrial depolarization is represented by the P wave.
(C) **T** – A cardiac axis of 30° is considered normal. The normal axis typically ranges from -30° to +90°.
(D) **F** – A prolonged ST segment is not typically seen in 1st degree heart block. 1st degree heart block is characterized by a prolonged PR interval, but not the ST segment.
(E) **T** – The P wave is inverted in lead aVR because the electrical impulse moves away from the positive electrode in this lead.

(9)

(A) **F** – The 2nd heart sound (S2) is due to the closure of the aortic and pulmonary valves, not the AV valves. The closure of the AV valves (mitral and tricuspid) causes the 1st heart sound (S1).

(B) **T** – The 2nd heart sound (S2) is split during inspiration due to a delay in the closure of the pulmonary valve relative to the aortic valve (due to increased venous return).

(C) **F** – Murmurs due to mitral stenosis are typically heard during diastole (not systole), as blood flows through the narrowed mitral valve during diastole.

(D) **T** – The 4th heart sound (S4) can be physiological, especially in athletes or young individuals, though it is often pathologic in older adults due to conditions like hypertrophy or stiffening of the ventricles.

(E) **F** – Atrial systole typically results in the 4th heart sound (S4), not the 3rd heart sound (S3). The 3rd heart sound is often associated with ventricular filling during early diastole, especially in conditions like heart failure.

(10)

(A) **T** – In sepsis, peripheries can be warm to the touch due to vasodilation and increased blood flow to the skin, often seen in the early stages of septic shock.

(B) **F** – Baroreceptor activation is increased during shock as the body attempts to compensate for the low blood pressure, triggering mechanisms to raise blood pressure (like increasing heart rate and vasoconstriction).

(C) **T** – Cardiac tamponade can lead to cardiogenic shock due to the compression of the heart, which impairs its ability to pump effectively.

(D) **T** – Heart failure can indeed be a cause of pulmonary edema due to increased pulmonary venous pressure when the left ventricle fails to pump blood effectively, leading to fluid leakage into the lungs.

(E) **F** – In shock, sympathetic (synaptic) activation is generally increased as part of the body's compensatory response to maintain blood pressure and perfusion to vital organs.

(11)Answer-B

Myasthenia Gravis is an autoimmune disorder characterized by the production of autoantibodies against nicotinic acetylcholine receptors (AChRs) at the postsynaptic membrane of the neuromuscular junction. This leads to impaired neuromuscular transmission, resulting in fluctuating skeletal muscle weakness that worsens with exertion (fatigability) and improves with rest.

(12)Answer B

In the early stage of myocardial infarction (MI), the most characteristic ECG finding is ST segment elevation, indicating acute transmural ischemia. Other changes like T wave inversion or Q waves appear later.

(13)Answer B

The patient is B+, so B+ blood is the most compatible and ideal choice for transfusion.
Cross-matching is usually recommended to avoid adverse reactions, but in an emergency situation, B+ blood can be transfused without cross-matching as it is a direct match to the patient's blood type.
O+ blood (option E) can also be used in emergencies, but B+ blood is the preferred choice since it's a more precise match to the patient's blood group.

(14)Answer D

Von Willebrand disease primarily affects platelet function and factor VIII activity, leading to prolonged bleeding time (BT), prolonged APTT, but typically normal PT/INR because the extrinsic pathway (PT) is unaffected.
Prolonged PT/INR is not characteristic of Von Willebrand disease.

(15)Answer D

Organophosphate poisoning inhibits Acetylcholine esterase leading to accumulation of Ach
Nicotinic cholinergic receptor involvement in organophosphate poisoning leads to muscle paralysis, including respiratory muscle paralysis, due to overstimulation of the receptors at the neuromuscular junction.
Other features, such as pupillary constriction (A) and sweating (C), are more associated with muscarinic receptor activation.
Pulse rate of 50/min (B) and diarrhoea (E) are also muscarinic effects.

(16)Answer D

Complete heart block (third-degree AV block) results in atrial and ventricular dissociation, meaning the atria and ventricles beat independently.
Irregular radial pulse is not typical in complete heart block. Instead, the pulse is often regular but slow (due to the ventricular escape rhythm).
A heart rate of 40/min (A), P waves at 72/min (B), atrioventricular dissociation (C), and cannon waves (E) (large, abnormal waves in the jugular venous pulse due to atrial contraction against a closed tricuspid valve) are all consistent with complete heart block.

(17)Answer C

Haemolytic disease of the newborn (HDN) due to Rh incompatibility typically occurs after a sensitizing event, which often happens in a second or subsequent pregnancy with an Rh-positive fetus, following previous exposure (e.g., from a prior pregnancy with an Rh-positive baby).
The first pregnancy is usually not affected because Rh antibodies are not typically produced until after the first exposure to Rh-positive blood (usually during delivery or after a miscarriage).
The other options (A, B, D, and E) are all consistent with Rh incompatibility being a causative factor.

(18)Answer E

In hemolytic anemia, such as hereditary spherocytosis, there is increased RBC destruction leading to a reduced RBC lifespan (typically 10-20 days, not 110 days). The excess unconjugated bilirubin is produced as a result of hemolysis, and the liver conjugates it for excretion. Increased conjugated bilirubin is not typical in this condition; if it occurs, it suggests liver dysfunction or cholestasis. Therefore, increased conjugated bilirubin is not compatible with typical hemolytic anemia like hereditary spherocytosis, where unconjugated bilirubin would be more elevated.

(19)Answer D. Septic shock

This patient presents with classic signs of septic shock: fever, hypotension, tachycardia, elevated lactate, and signs of infection. Warm extremities and bounding pulses in early septic shock reflect peripheral vasodilation and increased cardiac output, distinguishing it from other types of shock that typically present with cold, clammy skin due to vasoconstriction.

(20)Answer C. Increased intracranial pressure causing Cushing reflex

This patient is exhibiting Cushing's triad—hypertension, bradycardia, and irregular respiration—which is a physiological response to increased intracranial pressure (ICP). As ICP rises, it compromises cerebral perfusion. To maintain cerebral blood flow, the body increases systemic arterial pressure. The baroreceptors respond to this hypertension with reflex bradycardia, while pressure on the brainstem disrupts respiratory centers, leading to irregular breathing. These findings indicate impending herniation, requiring immediate intervention.

CAT-1 (BATCH 2) MOCK ESSAY

(1)A 22-year-old male presents to the emergency department with complaints of sudden-onset palpitations. He reports no chest pain or shortness of breath. His vital signs reveal a heart rate of 180 bpm, regular rhythm, and normal blood pressure. A 12-lead ECG confirms the diagnosis of supraventricular tachycardia (SVT). The attending physician asks the patient to exhale forcefully against a closed 50cc syringe as an initial intervention.

(1.1) Identify the physiological maneuver being performed and define it. (10 marks)

(1.2) Explain how this maneuver can lead to the termination of SVT Describing the phases of this maneuver and the cardiovascular changes and role of the autonomic nervous system. (50 marks)

(1.3) Draw a labeled diagram of a normal ECG and explain the Physiological basis for Each component of the ECG Wave. (40 marks)

(2)A 52-year-old man presents to the clinic with complaints of fatigue, shortness of breath on exertion, and numbness in his hands and feet. On examination, he appears pale and has a smooth, swollen tongue (glossitis). Neurological examination reveals decreased vibration and position sense. His blood tests show a hemoglobin level of 9.0 g/dL (normal: 13.5–17.5 g/dL), a mean corpuscular volume (MCV) of 115 FL (normal: 76–96 FL). A peripheral blood smear shows macrocytic, oval-shaped red blood cells and hyper segmented neutrophils.

(2.1) What is the probable clinical diagnosis? (10 marks)

(2.2) What neurological complication has he developed due to the above nutritional deficiency? (10 marks)

(2.3) Explain the physiological basis of the anaemia and neurological manifestations in this patient. (50 marks)

(2.4) Write three clinical findings and three laboratory (haematological/biochemical) findings that support your diagnosis. (20 marks)

(2.5) State one blood test to confirm your diagnosis. (10 marks)

CAT-1 (BATCH 2) MOCK ESSAY ANSWERS

(1) A 22-year-old male presents to the emergency department with complaints of sudden-onset palpitations. He reports no chest pain or shortness of breath. His vital signs reveal a heart rate of 180 bpm, regular rhythm, and normal blood pressure. A 12-lead ECG confirms the diagnosis of supraventricular tachycardia (SVT). The attending physician asks the patient to exhale forcefully against a closed 50cc syringe as an initial intervention.

(1.1) Identify the physiological maneuver being performed and define it. (10 marks)

Point	Marks
Correctly identifies the manoeuvre as the Valsalva manoeuvre	5
Correct definition: Forced expiration against a closed glottis (or closed airway), increasing intrathoracic pressure	5

(1.2) Explain how this maneuver can lead to the termination of SVT Describing the phases of this maneuver and the cardiovascular changes and role of the autonomic nervous system. (50 marks)

Phase I (10 Marks)

Point	Marks
Beginning of forced expiration	2
Intrathoracic pressure increases	3
Compression of thoracic aorta	2
Brief rise in arterial blood pressure	3

Phase II (15 Marks)

Point	Marks
Sustained raised intrathoracic pressure reduces venous return	4
Stroke volume decreases	3
Arterial blood pressure falls	3
Baroreceptor firing decreases	2
Sympathetic activity increases and heart rate rises	3

Phase III (5 Marks)

Point	Marks
Release of strain	2
Intrathoracic pressure suddenly falls	2
Brief fall in arterial pressure	1

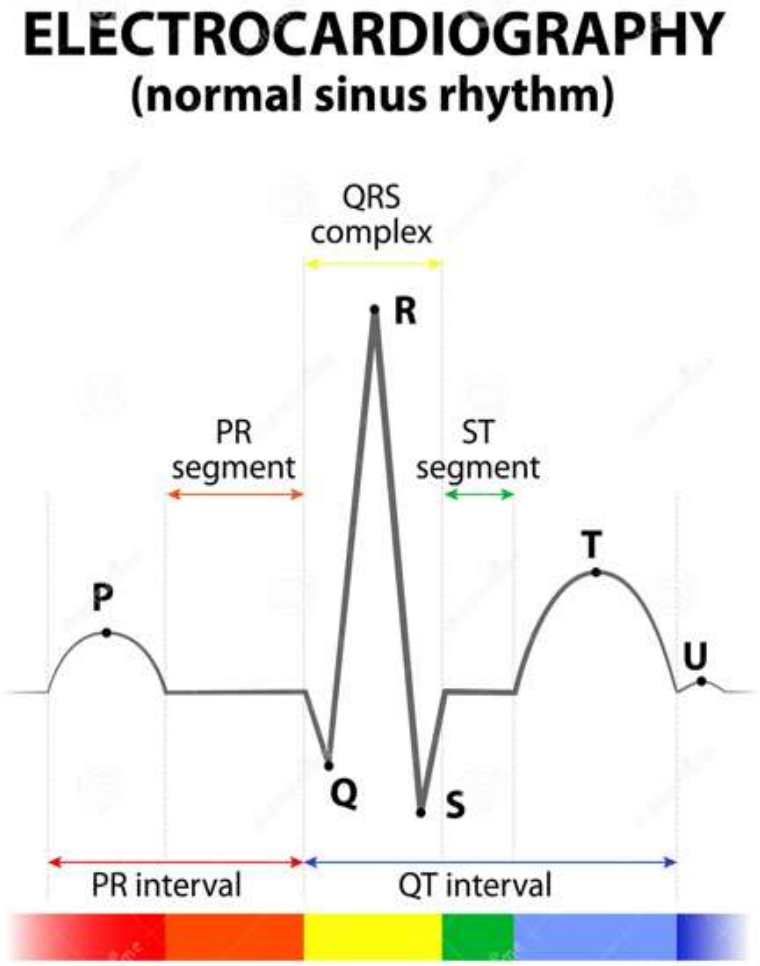
Phase IV (15 Marks)

Point	Marks
Venous return rapidly increases	3
Cardiac output increases	3
Blood pressure overshoots above normal	3
Baroreceptors are strongly stimulated	3
Increased vagal (parasympathetic) discharge and reduced sympathetic activity	3

Mechanism of SVT Termination (5 Marks)

Point	Marks
Increased vagal tone slows AV nodal conduction	2
AV nodal refractory period increases	2
Interrupts AV nodal re-entry circuit and restores sinus rhythm	1

(1.3) Draw a labeled diagram of a normal ECG and explain the Physiological basis for Each component of the ECG Wave. (40 marks)



A. Labelled ECG Diagram (15 Marks)
The diagram should include:

Component	Marks
Correct ECG waveform	3
P wave labelled	2
QRS complex labelled	3
T wave labelled	2
PR interval labelled	2
ST segment labelled	2
QT interval labelled	1

B. Physiological Basis of ECG Components (25 Marks)

Component	Physiological Basis	Marks
P wave	Atrial depolarization	4
PR interval	Conduction from atria through AV node (includes AV nodal delay)	4
QRS complex	Ventricular depolarization	5
ST segment	Ventricles completely depolarized (plateau phase)	4
T wave	Ventricular repolarization	5
QT interval	Total duration of ventricular depolarization and repolarization	3

(2) A 52-year-old man presents to the clinic with complaints of fatigue, shortness of breath on exertion, and numbness in his hands and feet. On examination, he appears pale and has a smooth, swollen tongue (glossitis). Neurological examination reveals decreased vibration and position sense. His blood tests show a hemoglobin level of 9.0 g/dL (normal: 13.5–17.5 g/dL), a mean corpuscular volume (MCV) of 115 FL (normal: 76–96 FL). A peripheral blood smear shows macrocytic, oval-shaped red blood cells and hyper segmented neutrophils.

(2.1) What is the probable clinical diagnosis? (10 marks)

Point	Marks
Megaloblastic anaemia identified	5
Vitamin B_{12} deficiency (or pernicious anaemia) specified	5

(2.2) What neurological complication has he developed due to the above nutritional deficiency? (10 marks)

Point	Marks
Subacute combined degeneration identified	6
Involvement of posterior columns and/or lateral corticospinal tracts mentioned	4

(2.3) Explain the physiological basis of the anaemia and neurological manifestations in this patient. (50 marks)

A. Physiological Basis of Anaemia (25 Marks)

Point	Marks
Vitamin B_{12} is essential for DNA synthesis	5
Defective DNA synthesis impairs nuclear maturation	5
Nuclear-cytoplasmic asynchrony develops	4
Ineffective erythropoiesis occurs	4
Macrocytic (megaloblastic) red cells are produced	4
Reduced erythrocyte production causes anaemia	3

B. Physiological Basis of Neurological Manifestations (25 Marks)

Point	Marks
Vitamin B_{12} is required for normal myelin synthesis/maintenance	5
Deficiency causes demyelination	5
Posterior columns are affected	5
Lateral corticospinal tracts may also be affected	4
Loss of vibration and position sense results	3
Peripheral neuropathy/paraesthesia may occur	3

(2.4) Write three clinical findings and three laboratory (haematological/biochemical) findings that support your diagnosis. (20 marks)

Clinical Findings (10 Marks)

Award 3 marks each (maximum 9 marks) plus 1 mark for any additional correct finding.

Any three:

Finding	Marks
Pallor	3
Fatigue	3
Shortness of breath on exertion	3
Glossitis	3
Numbness/paraesthesia	3
Loss of vibration sense	3
Loss of position sense	3

Laboratory Findings (10 Marks)
Award 3 marks each (maximum 9 marks) plus 1 mark for any additional correct finding.
Any three:

Finding	Marks
Low haemoglobin	3
Elevated MCV (>100 fL)	3
Macrocytic oval red blood cells	3
Hypersegmented neutrophils	3
Low serum vitamin B_{12}	3
Elevated methylmalonic acid	3
Elevated homocysteine	3

(2.5) State one blood test to confirm your diagnosis. (10 marks)

Point	Marks
Serum vitamin B_{12} assay correctly identified	10

CAT-1 (BATCH 2) MOCK OSPE

(1)Live Station

(1.1) Demonstrate the of palpation of the cardiac apex

(1.2) Give One cause for deviation of cardiac Apex

(2)

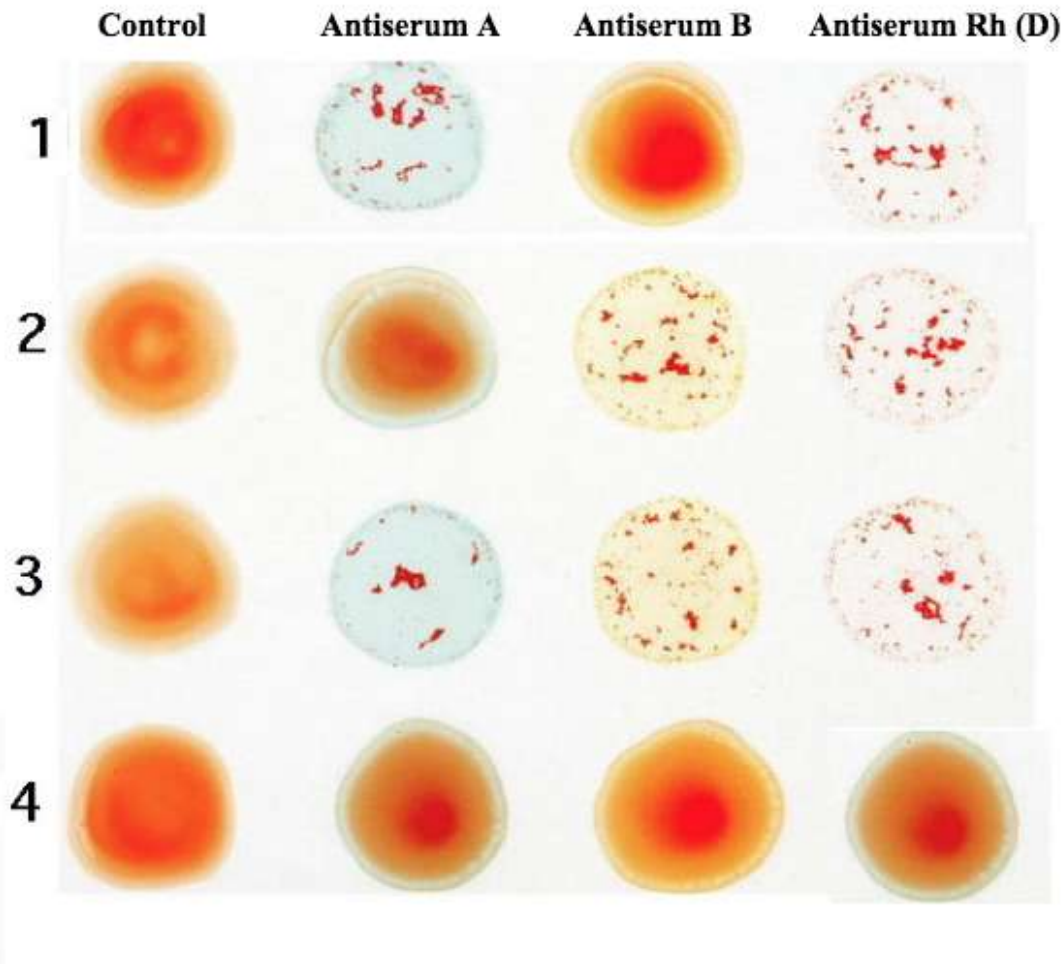


(2.1) Identify the clinical sign?

(2.2) Write two causes for above sign?

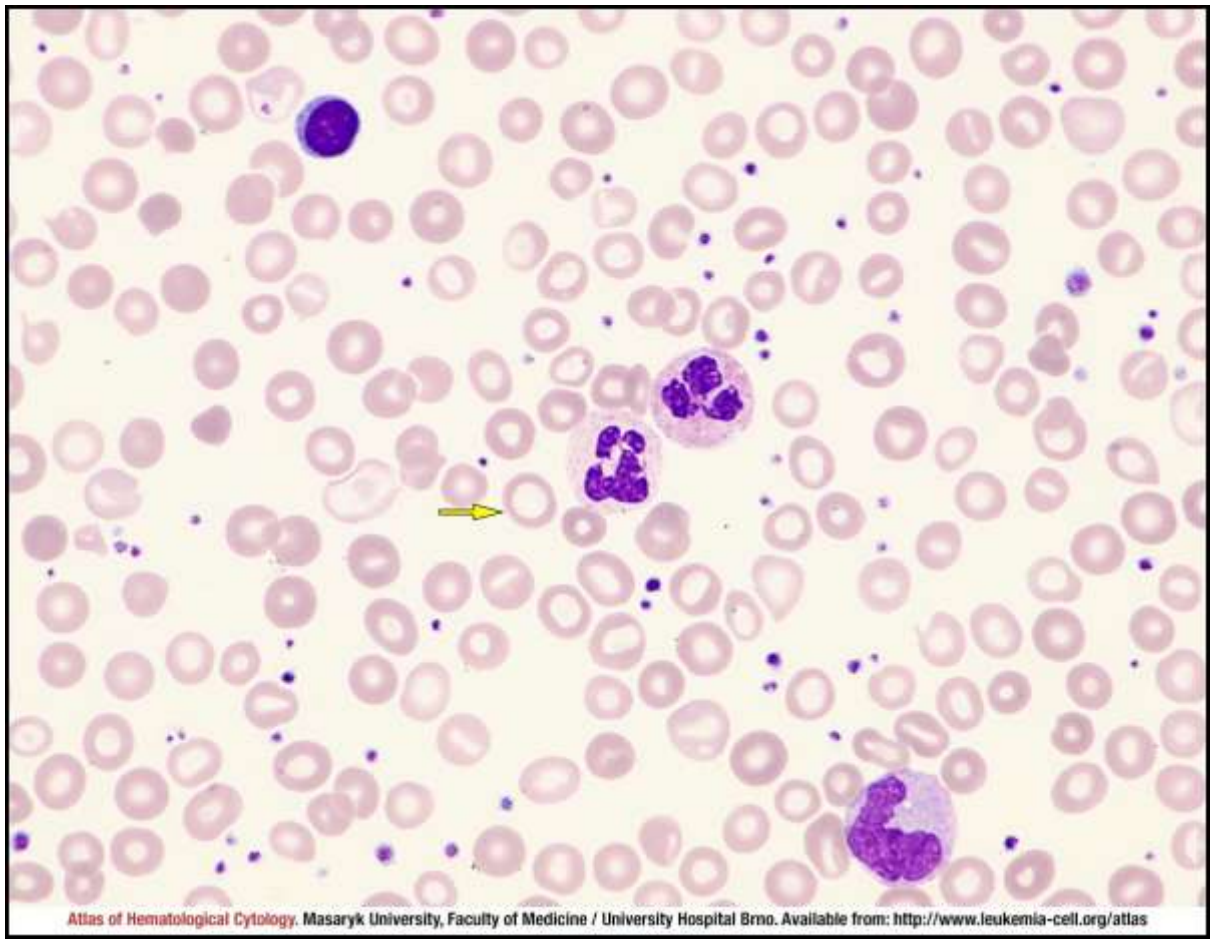
(2.3) Write one complication of above condition

(3)Identify the blood groups



1 –
2 –
3 –
4 –

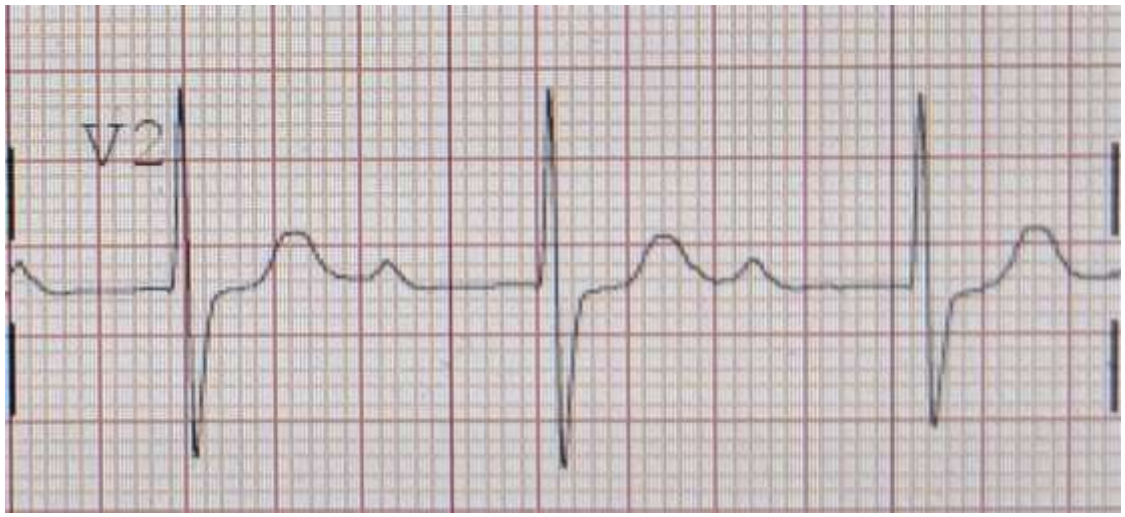
(4)



(4.1) Identify the blood picture

(4.2) Write 2 different characteristic features seen in the blood picture that supports your diagnosis?

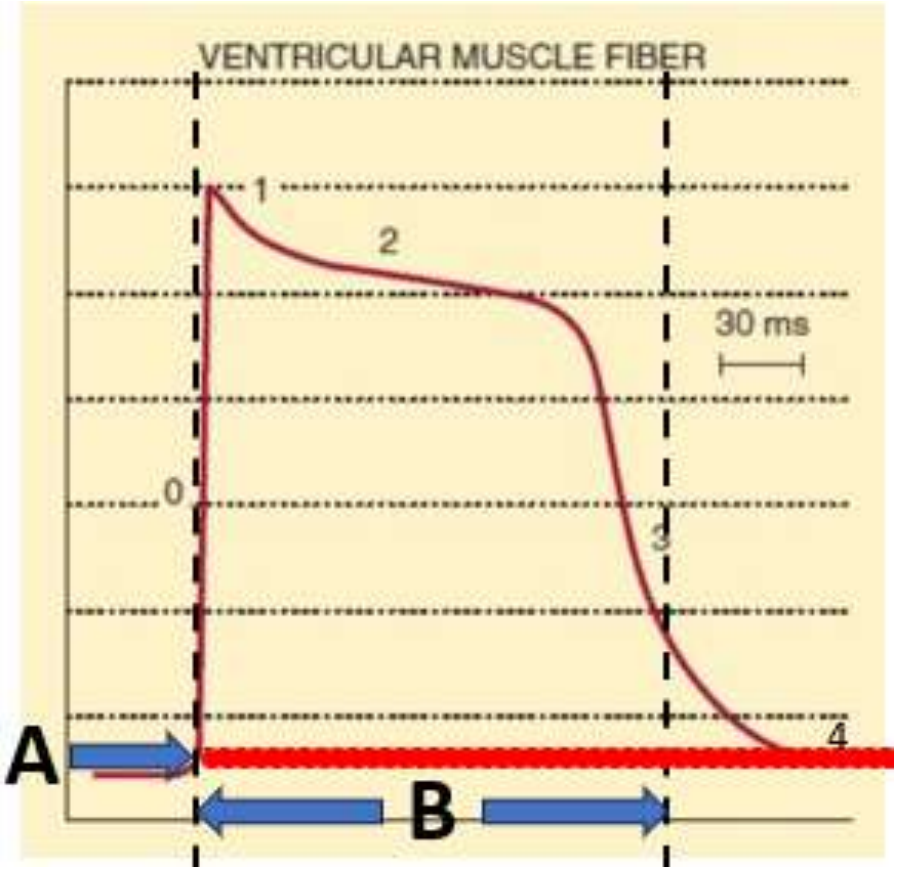
(5)



(5.1) Calculate the heart rate

(5.2) 2)Identify the ECG diagnosis?

(6)



(6.1) Identify the graph

(6.2) Name A and B

(6.3) Write the causes for each phase

0 –

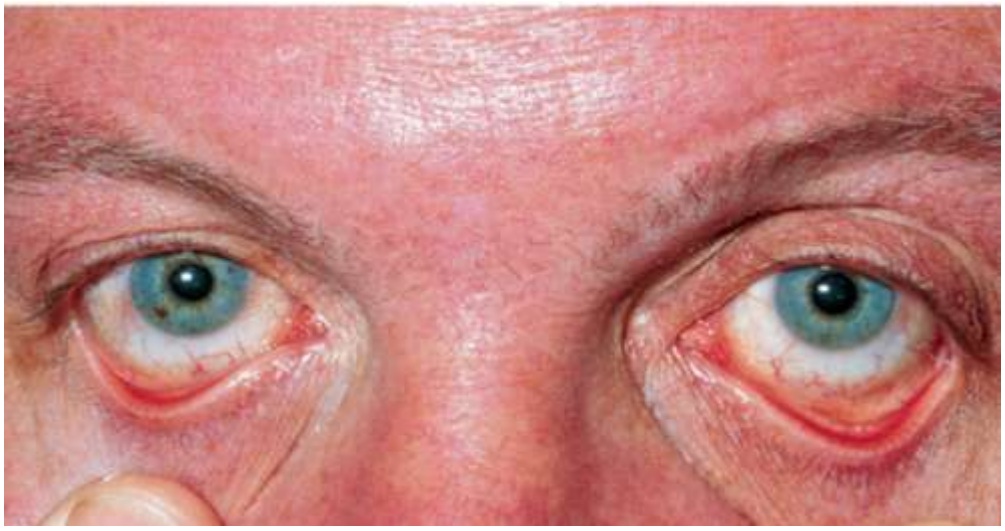
1 –

2 –

3 –

4 –

(7)

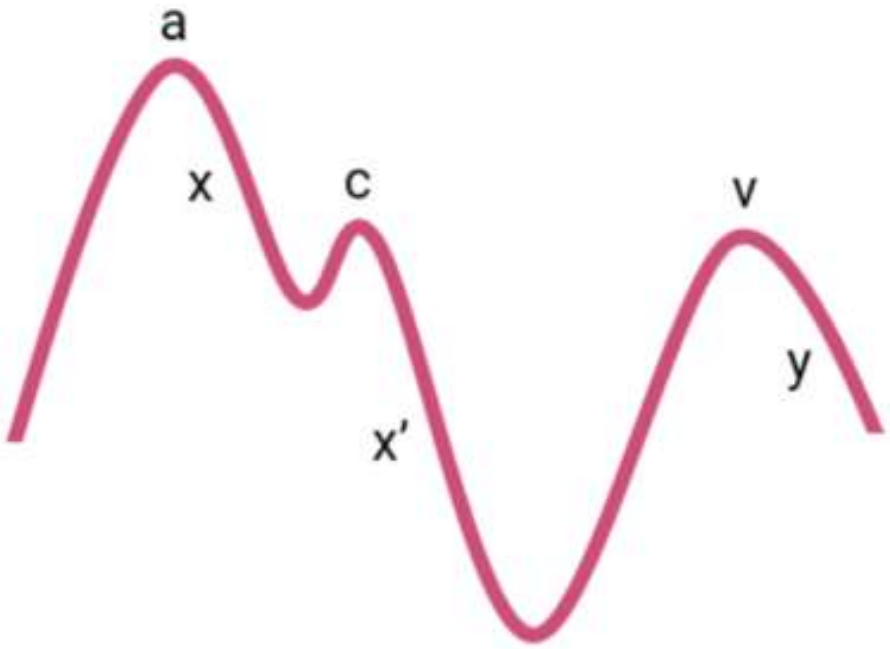




(7.1) Identify the clinical sign shown here

(7.2) Write one cause causing this sign?

(8)



(8.1) Identify the diagram

(8.2) Write causes for

Wave a –

Wave c –

Wave v –

(8.3) Write a cause for large a wave?

(9)

A



B



C



D



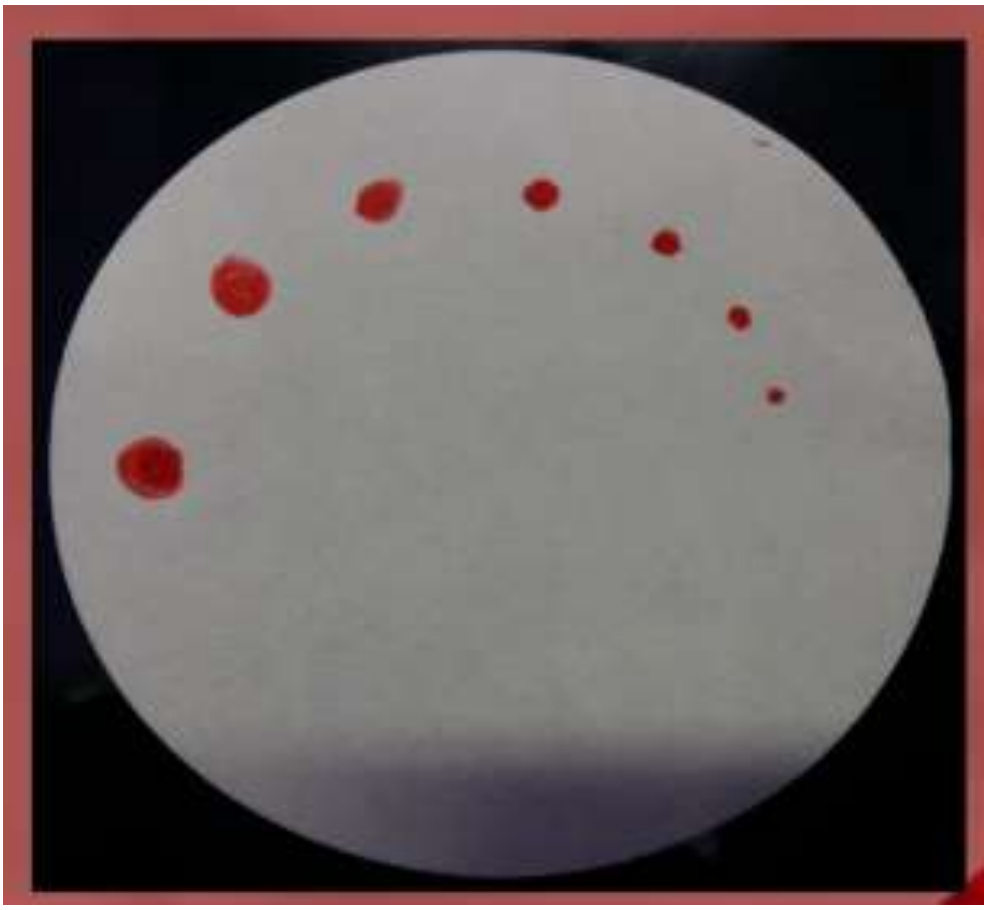
E



(9.1) Categorize mentioned IV fluids according to their osmolarity

(9.2) What would be the choice of IV fluid in a patient with severe Hyponatremia?

(10)



(10.1) What is the test has been performed, shown in the picture?

(10.2) Write 02 conditions which will give rise to prolonged test results?

CAT-1 (BATCH 2) MOCK OSPE ANSWERS

(1)Live Station

(2)

(2.1) Chronic venous insufficiency (varicose veins with venous ulcer).

(2.2) Deep vein thrombosis (post-thrombotic syndrome)
Incompetent venous valves

(2.3) Venous ulcer

(3)

1 – A
2 – B
3 – AB
4 – O

(4)

(4.1) Iron deficiency anaemia

(4.2) Microcytic red blood cells
Hypochromic red blood cells

(5)

(5.1) 75 bpm

(5.2) First degree heart block

(6)

(6.1) Ventricular muscle action potential

(6.2) A – Absolute refractory period
B – Relative refractory period

(6.3) Phase 0: Rapid Na^+ influx
Phase 1: Transient K^+ efflux
Phase 2: Ca^{2+} influx balanced by K^+ efflux (plateau)
Phase 3: K^+ efflux (repolarization)
Phase 4: Resting membrane potential maintained by K^+ permeability

(7)

(7.1) Exophthalmos (proptosis)

(7.2) Graves' disease (thyrotoxicosis)

(8)

(8.1) Jugular venous pulse (JVP)

(8.2) a wave: Atrial contraction
c wave: Bulging of tricuspid valve during ventricular systole

v wave: Venous filling of right atrium against closed tricuspid valve

(8.3) Tricuspid stenosis (acceptable: pulmonary hypertension)

(9)

(9.1) Categorize according to osmolarity

(9.2) Isotonic: A, B, C
Hypotonic: E
Hypertonic: D

(9.3) 3% Hypertonic saline

(10)

(10.1) Bleeding time

(10.2) Thrombocytopenia
von Willebrand disease

2024/2025 (3rd Batch)
CAT-1 Mock Exam

CAT-1 (BATCH 3) MOCK MCQS

MULTIPLE CHOICE QUESTIONS
Time: 1 hour

This paper consists of 10 True or False type questions and 10 Single Best Answer type questions.

(1)True or False regarding body fluid compartments of the body?

(A) Extracellular fluid constitutes of 1/3 of total body water
(B) The total body water is 40% of the weight
(C) The major cation in intercellular fluid is Na^+
(D) Majority of the extracellular fluid consists of plasma
(E) Total body water can be calculated using radioactive water (^3H_2O)

(2)Causes for haemolytic anaemia includes,

(A) Hereditary spherocytosis
(B) Vitamin B12 deficiency
(C) G6PD deficiency
(D) Beta Thalassemia major
(E) Disseminated intravascular coagulation

(3)Membrane transport processes that require specific protein to transport substances across the cell membrane includes,

(A) Simple diffusion
(B) Primary active transport
(C) Secondary active transport
(D) Facilitated diffusion
(E) Pinocytosis

(4)True or False regarding the ECG pattern?

(A) Each P wave is followed by a QRS complex in sinus rhythm
(B) Sinus bradycardia is seen during sleep
(C) Leads II, III, aVF represents the anterior leads
(D) Progressive prolongation of PR interval is seen in Mobitz type II block
(E) Atrial fibrillation is characterized by the saw-tooth appearance

(5)Systolic murmurs in the heart include,

(A) Mitral stenosis
(B) Aortic stenosis
(C) Mitral regurgitation
(D) Ventricular septal defect
(E) Aortic regurgitation

(6)True or False regarding the resting membrane potential (RMP)?

(A) It is the membrane potential of a cell when it is at the unexcited state
(B) All cell types have a universal RMP
(C) It requires energy to maintain
(D) Makes the cell negative compared to extracellular fluid
(E) Maintained by non-diffusible ions

(7)True or False regarding thermoregulation?

(A) During swimming, heat is mainly lost by radiation
(B) Thermoregulatory center is located in the posterior hypothalamus
(C) The body temperature is lowest in the morning
(D) Mouth is the best place to measure core temperature
(E) Evaporation of sweat is an important mode of heat loss of farmers in the dry zone

(8)True or False regarding the neuromuscular junction?

(A) Acetylcholine binds to nicotinic receptors
(B) Choline esterase synthesizes acetylcholine
(C) Ligand-gated Na^+ channels are present in presynaptic membrane
(D) Voltage-gated Ca^{2+} channels are present in the post synaptic membrane
(E) SNARE proteins are involved with docking of presynaptic acetylcholine vesicles

(9)Factors causing vasoconstriction is/are,

(A) Endothelin-1
(B) Nitric oxide
(C) Angiotensin II
(D) Increased local temperature
(E) Thromboxane A_2

(10)True or False regarding coronary circulation?

(A) Blood flow remains constant over a wide range of perfusion pressures
(B) Blood flow to coronary arteries is greatest during systole
(C) Sympathetic stimulation to the heart increases coronary blood flow
(D) Majority of myocardial infarctions occur in the subendocardial portion of the left ventricle
(E) Adenosine causes vasoconstriction

Question number 11 to 20 are Single Best Response (SBR) type. Select the best response to each question.

(11) A 60-year-old man diagnosed with chronic obstructive pulmonary disease, this time presented with shortness of breath, cough and wheezing. His arterial blood gas report is as follows

- **pH – 7.32 (7.35-7.45)**
- **$PaCO_2$ – 65 mmHg (35-45 mmHg)**
- **HCO_3^- – 32 mmol/l (22-26 mmol/l)**
- **PaO_2 – 55 mmHg (75-100 mmHg)**

What is the primary disorder?

(A) Metabolic acidosis with partial respiratory compensation
(B) Metabolic alkalosis with partial respiratory compensation
(C) Respiratory acidosis with partial metabolic compensation
(D) Respiratory alkalosis with partial metabolic compensation
(E) Respiratory acidosis with complete metabolic compensation

(12) Which of the following is wrong about the cardiac cycle?

(A) The duration of a single cardiac cycle is 0.8 seconds
(B) AV valves open due to atrial systole
(C) First heart sound is produced due to the AV valve closure
(D) Isovolumetric contraction of the ventricles begins at the onset of QRS complex
(E) Closure of the semilunar valves produces the second heart sound

(13) A 26-year-old man is brought to the hospital after a motor traffic accident. He has lost a lot of blood and needs an urgent blood transfusion. His blood group has not been determined yet, but the doctors cannot wait for the results.

Which type of blood should be given until his blood group is known?

(A) A positive blood
(B) B positive blood
(C) AB positive blood
(D) O negative blood
(E) O positive blood

(14) A 16-year-old boy comes to the clinic with a high fever with cough for three days duration. A full blood count was done.

Which of the following would indicate that the patient is having a bacterial infection?

(A) WBC – 15 000/mm^3
(B) RBC – 5.2 million/mm^3
(C) Hb – 15 g/dl
(D) Neutrophils – 85%
(E) Lymphocytes – 10%

(15) A 30-year-old woman complains of muscle weakness that becomes worse towards the evening. She says it is harder to keep her eyes open after working for long hours. Her condition improves after resting.

Which of the following best describes the defect in neurotransmission in this patient?

(A) Decreased release of acetylcholine from nerve endings
(B) Destruction of acetylcholine receptors at the neuromuscular junction
(C) Increased breakdown of acetylcholine by acetylcholinesterase
(D) Defective release of dopamine from presynaptic neuron
(E) Blockage of GABA receptors in the motor cortex

(16) Which of the following statements about the autonomic nervous system is correct?

(A) Both sympathetic and parasympathetic postganglionic neurons release acetylcholine
(B) The sympathetic preganglionic neuron releases noradrenaline
(C) The parasympathetic postganglionic neuron releases acetylcholine onto muscarinic receptors
(D) The parasympathetic postganglionic neuron releases noradrenaline onto adrenergic receptors
(E) The sympathetic postganglionic neuron releases acetylcholine onto nicotinic receptors in target organs

(17) A patient with frequent nosebleeds and prolonged bleeding time is found to have a deficiency of von Willebrand factor.

Which of the following steps in haemostasis is most directly affected by this deficiency?

(A) Activation of factor X in the coagulation cascade
(B) Platelet adhesion to the subendothelial collagen
(C) Conversion of fibrinogen to fibrin
(D) Activation of thrombin
(E) Platelet aggregation via fibrinogen bridges

(18) During skeletal muscle contraction, depolarization of the muscle fiber membrane triggers the release of calcium ions.

Which of the following events occur immediately after depolarization of the transverse (T) tubule?

(A) Opening of voltage-gated sodium channels in the sarcolemma
(B) Binding of calcium to troponin C
(C) Cross-bridge formation between actin and myosin
(D) Reuptake of calcium into the sarcoplasmic reticulum
(E) Release of calcium from the sarcoplasmic reticulum

(19) Which of the following statements regarding the jugular venous pressure (JVP) is correct?

(A) The 'v' wave of the JVP corresponds to the atrial filling against a closed tricuspid valve
(B) JVP reflects the pressure in the left atrium
(C) The normal JVP is about 8-10 cm above the sternal angle
(D) The 'a' wave of the JVP corresponds to closure of the tricuspid valve
(E) A raised JVP is a feature of left-sided heart failure

(20) A 45-year-old man who lives in a high mountain area is found to have an increased haematocrit and haemoglobin concentration. His erythropoietin level is also elevated.

Which of the following best explains the reason for his increased red blood cell count?

(A) Increased destruction of red blood cells stimulates bone marrow to produce more
(B) Chronic low oxygen levels stimulate increased secretion of erythropoietin from the kidneys
(C) Mutation in the JAK2 gene causes uncontrolled red cell production
(D) Iron deficiency leads to compensatory increase in red cell mass
(E) Dehydration concentrates the red cells in the blood

CAT-1 (BATCH 3) MOCK MCQ ANSWERS

(1)

(A) **T**
(B) **F** – around ~60%
(C) **F** – K^+ is the major intracellular cation
(D) **F** – plasma is only 20% of the extracellular fluids. Interstitial fluid consists of 80% of the ECF
(E) **T**

(2)

(A) **T** - membranopathy
(B) **F** – causes megaloblastic anaemia
(C) **T** – enzymopathy
(D) **T** – haemoglobinopathy
(E) **T** – acquired cause for haemolysis

(3)

(A) **F** – lipid soluble substances diffuse through the lipid bilayer
(B) **T** – carrier protein
(C) **T** – transport of a substance against concentration gradiance
(D) **T** – with help of channel or carrier proteins
(E) **F** – cell membrane folds, no special proteins required

(4)

(A) **T**
(B) **T**
(C) **F** – represents the inferior leads. Anterior leads are V3, V4
(D) **F** – seen in Mobitz type I
(E) **F** – seen in atrial flutter

(5)

(A) **F** – mid diastolic murmur
(B) **T** – ejection systolic murmur
(C) **T** – pansystolic murmur
(D) **T** – pansystolic murmur
(E) **F**– early diastolic murmur

(6)

(A) **T**
(B) **F** – neuron: -70 mV, muscle: -90 mV
(C) **T** – Na^+-K^+ ATPase pump contributes
(D) **T**
(E) **T** – Donnan effect

(7)

(A) **F** – mainly convection
(B) **F** – anterior hypothalamus
(C) **T**
(D) **F** – rectum is the best place. The temperature of the mouth can change due to chewing, eating etc.
(E) **T** – as body temperature and the environmental temperature is the same, sweat evaporation is the only method

(8)

(A) **T** – as well as muscuranic receptors
(B) **F** – breaks down acetylcholine into acetate and choline
(C) **F** – postsynaptic membrane
(D) **F** – presynaptic membrane
(E) **T** – SNAP 25, Syntaxin, Synaptobrevin

(9)

(A) **T**
(B) **F**
(C) **T**
(D) **F**
(E) **T**

(10)

(A) **T** – also known as autoregulation of blood flow. Also seen in brain and kidneys
(B) **T** – during systole, coronary vessels are squeezed, reducing blood flow to the heart. The flow is greatest during diastole due to recoil of aorta
(C) **T** – increased contractility causes increased demand
(D) **T** – subendocardial portion receives poor blood flow and the left ventricle has a higher workload
(E) **F** – local cause for vasodilation

(11) Answer – C

The pH is <7.35 meaning acidosis. This is a COPD patient and his $PaCO_2$ is high which means this is a respiratory acidosis. The HCO_3^- is high, which means there is a metabolic compensation but it is only partial as the pH is still low. So, this is a respiratory acidosis with partial metabolic compensation

(12)Answer - B

The AV valves initially close as the ventricular pressure is higher than the atrial pressure. Once the ventricles have emptied and the isovolumetric relaxation of the ventricles occur, the ventricular pressure begins to drop. When it is lower than the atrial pressures, the AV valves open and the rapid ventricular filling phase begins. Once the pressure gradience starts to reduce, the ventricular filling slows down. Then the SA node depolarizes starting a new cardiac cycle and causing atrial systole.

(13)Answer – D

This patient seems to be in severe haemorrhagic shock and needs urgent transfusion. As we are unaware of both the blood group and the rhesus status of this patient, we must give blood which does not contain A or B antigen and is Rh negative. Blood group O negative, which is also known as the universal donor type, fits this description.

(14)Answer – D

During an acute bacterial infection, our bodies innate immune system activates first. The cellular barrier of the innate immune system consists of natural killer cells, macrophages and neutrophils. They are involved with secreting bactericidal factors (NK cells) and phagocytosis (neutrophils and macrophages) of the bacterial cells. So, initially, the number of neutrophils in the blood is increased (neutrophilia). The total WBC is increased during acute bacterial infection but it is not specific to a bacterial etiology. The haemoglobin levels and the RBC count is usually not affected in a bacterial infection

(15)Answer – B

This patient is suffering from Myasthenia Gravis, which has the characteristic pattern of progressively reduced muscle strength with repeated use of the muscle and recovery of muscle strength following a period of rest. It occurs due to antibody formation against acetylcholine nicotinic postsynaptic receptors of NMJ.

(16)Answer – C

The autonomic neurons are either cholinergic or noradrenergic. The autonomic neurons that are cholinergic are (1) all preganglionic neurons, (2) all parasympathetic postganglionic neurons, (3) sympathetic postganglionic neurons that innervate sweat glands, and (4) sympathetic postganglionic neurons that end on blood vessels in some skeletal muscles and produce vasodilation when stimulated. The remaining postganglionic neurons are noradrenergic. The adrenal medulla is basically a sympathetic ganglion which secretes noradrenaline and adrenaline directly into the blood stream. Nicotinic receptors are found in the autonomic ganglia at the synapses between the pre-ganglionic and post-ganglionic neurons of both the sympathetic and parasympathetic systems. Muscarinic receptors are found on all effector cells that are stimulated by the postganglionic cholinergic neurons of either the parasympathetic nervous system or the sympathetic system.

(17)Answer – B

Von Willibrand factor plays a key role in primary haemostasis. It helps the platelets attach to the exposed collagen in damaged blood vessels by linking to the GpIb receptors on platelet membranes. It also carries factor VIII which is used in the intrinsic pathway of the clotting cascade. So, von Willibrand deficiency leads to impaired platelet plug formation leading to increased bleeding time and impaired intrinsic pathway leading to increased APTT.

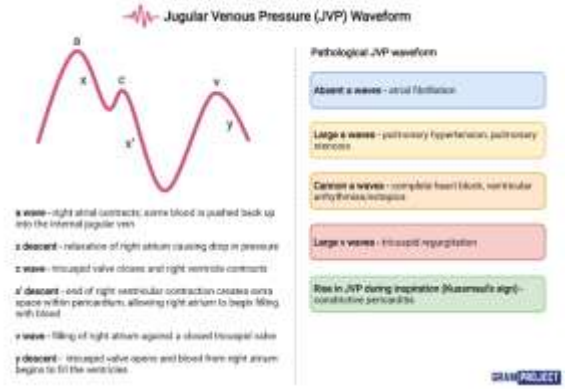
(18)Answer – E

Excitation-contraction coupling is the process by which depolarization of the muscle fiber initiates contraction. The steps are as follows

- Action potential travels along the sarcolemma and down to the T-tubules
- Depolarization of the T-tubules activates dihydropyridine receptors (DHPRs), which interacts with ryanodine receptors (RyR1) on the sarcoplasmic reticulum (SR)
- This causes calcium release from SR which binds to the troponin C which shifts tropomyosin allowing actin-myosin cross-bridge formation
- ADP releases from the myosin head and power stroke occurs
- ATP binds to the myosin head detaching it from the actin fibers. ATP hydrolyze and the myosin fiber "re-cocks" itself

The process continues as long as cytosolic Ca^{2+} is high. Opening of the voltage-gated sodium channels occur when the action potential reaches the motor endplate.

(19)Answer – A



The JVP represents the right atrial pressure, not the left.
The normal JVP is about 4 cm above the sternal angle.
Raised JVP is a feature of right heart failure, not left.

(20)Answer – B

Polycythaemia is increased red cell mass and haemoglobin concentration. It can be primary (polycythaemia vera) due to a bone marrow mutation (JAK2) with low erythropoietin (EPO) levels or secondary due to increased EPO levels from chronic hypoxia (e.g. high altitude, cardiac failure). At high altitudes, as the air has less oxygen, the kidneys detect hypoxia and release more EPO which increases the RBC production to improve oxygen delivery. This is a physiological process.

CAT-1 (BATCH 3) MOCK ESSAY

(1) Explain the physiological basis of the following observations
  (1.1) Heat stroke may develop in young healthy athletes when exercising without drinking water in hot and humid environments (50 marks)
  (1.2) Nicotinic receptor antagonists are used to paralyze skeletal muscles during abdominal surgery (50 marks)

(2) Explain the physiological basis for the following
  (2.1) Cardiac output increases in exercise (50 marks)
  (2.2) Oedema occurs in lymphatic obstruction (50 marks)

CAT-1 (BATCH 3) MOCK ESSAY ANSWERS

(1) Explain the physiological basis of the following observations

(1.1) Heat stroke may develop in young healthy athletes when exercising without drinking water in hot and humid environments (50 marks)

Point	Marks
Exercise markedly increases metabolic heat production	6
Heat is normally lost by radiation, convection, conduction and evaporation	5
Hot environment reduces heat loss by radiation/convection	5
High humidity reduces evaporation of sweat	8
Lack of water intake causes dehydration	6
Reduced plasma volume decreases sweating	5
Reduced sweating impairs evaporative cooling	5
Core body temperature rises progressively	5
Failure of thermoregulation results in heat stroke	5

(1.2) Nicotinic receptor antagonists are used to paralyze skeletal muscles during abdominal surgery (50 marks)

Point	Marks
Nicotinic (Nm) receptors are located at the neuromuscular junction	6
Acetylcholine normally binds to Nm receptors	6
Binding produces end-plate depolarization	6
Muscle action potential is generated	5
Muscle contraction follows excitation	5
Nicotinic receptor antagonists competitively block ACh receptors	8
End-plate depolarization is prevented	5
Muscle action potential cannot be generated	5
Skeletal muscle paralysis results, facilitating surgery	4

(2) Explain the physiological basis for the following

(2.1) Cardiac output increases in exercise (50 marks)

Point	Marks
Exercise increases metabolic demand	5
Sympathetic nervous system activation increases	5
Parasympathetic activity decreases	4
Heart rate increases (positive chronotropic effect)	6
Myocardial contractility increases (positive inotropic effect)	6
Venous return increases due to muscle and respiratory pumps	6
End-diastolic volume increases (Frank–Starling mechanism)	5
Stroke volume increases	5
Cardiac output (HR × SV) increases	5
Increased cardiac output meets increased tissue oxygen demand	3

(2.2) Oedema occurs in lymphatic obstruction (50 marks)

Point	Marks
Lymphatic vessels normally return excess interstitial fluid to the circulation	8
They also return plasma proteins to the blood	6
Lymphatic obstruction prevents drainage of interstitial fluid	8
Protein accumulates in the interstitial space	8
Interstitial oncotic pressure increases	6
More fluid moves from capillaries into tissues	6
Persistent accumulation of protein-rich fluid causes lymphoedema	8

CAT-1 (BATCH 3) MOCK OSPE

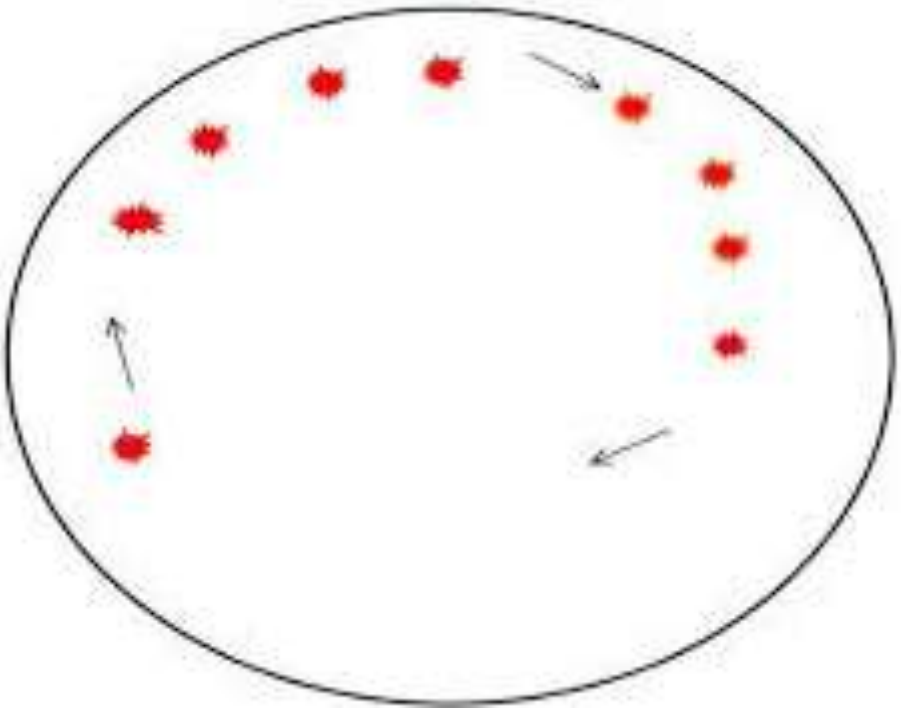
(1)



(1.1) State the clinical feature you observe (05 marks)

(1.2) What is the reason for this appearance? (05 marks)

(2)



(2.1) Identify the test (06 marks)

(2.2) State one reason for increasing the reading obtained by the given test (04 marks)

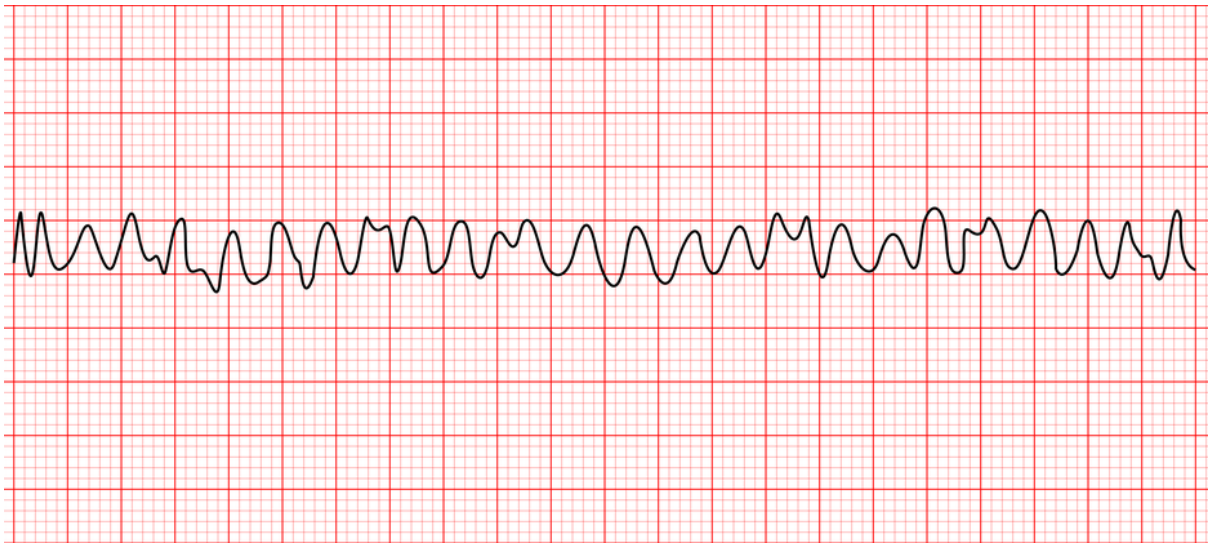
(3)

	Anti A	Anti B	Anti D
1			
2			
3			

(3.1) Identify the blood groups (06 marks)

(3.2) What is the reason for cross matching the blood samples before blood transfusion? (04 marks)

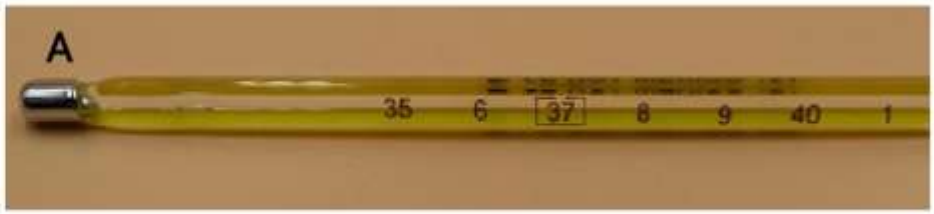
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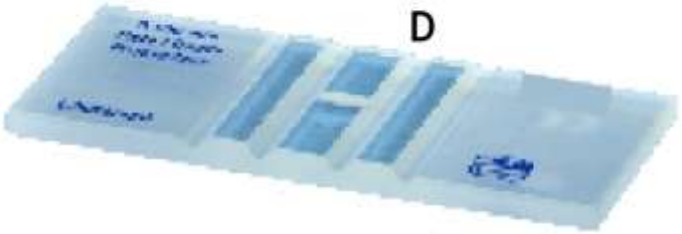
(4.1) What is this ECG pattern? (06 marks)

(4.2) What is the treatment? (04 marks)

(5)



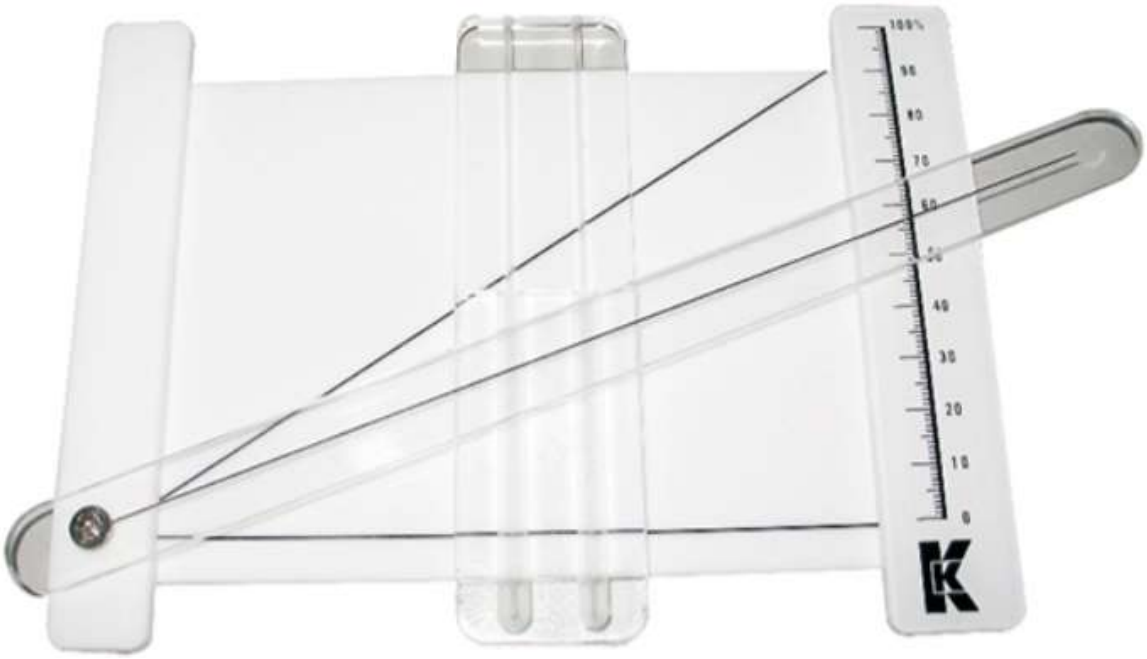






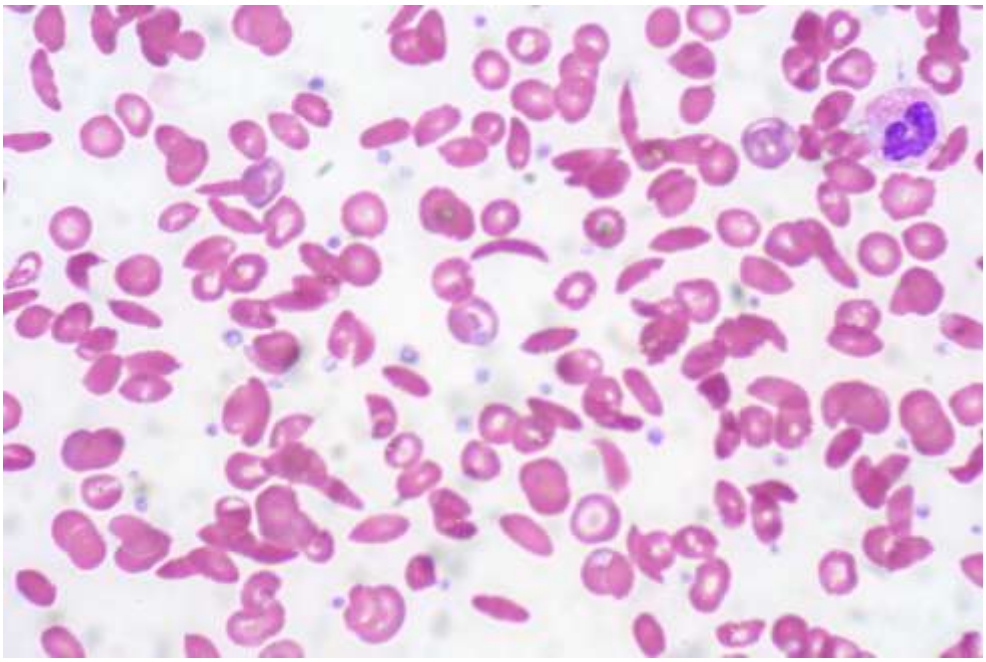
(5.1) Identify the instruments given here (05 marks)
(5.2) Name 3 sites where B can be used (03 marks)
(5.3) Give 2 uses of D (02 marks)

(6)



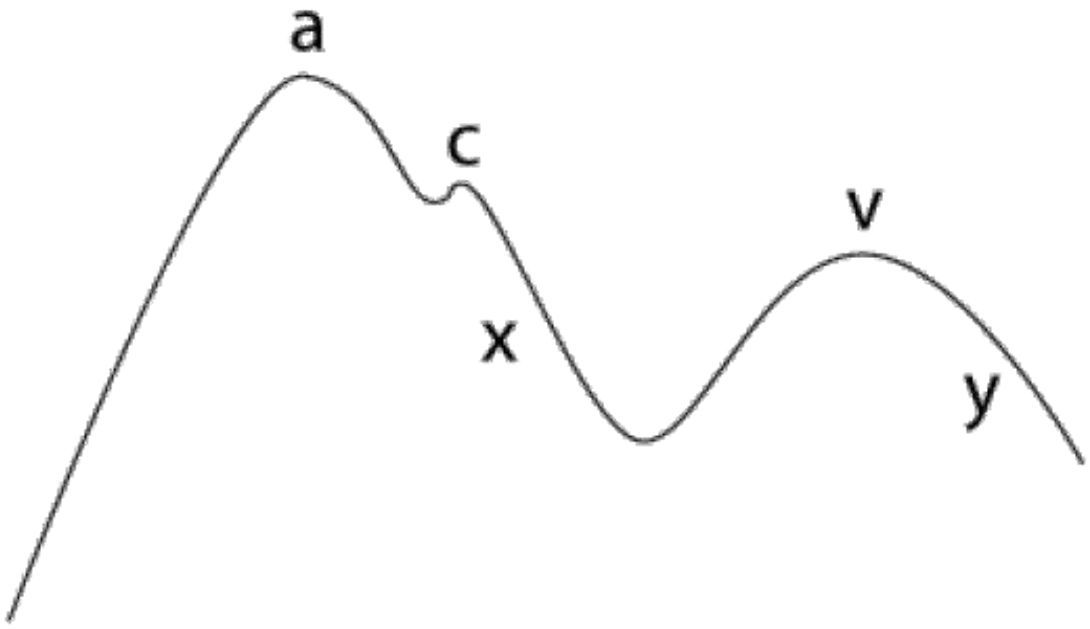
(6.1) Name this instrument (04 marks)
(6.2) What does it measure? (02 marks)
(6.3) Upon using this instrument, the reading comes out as 60%. State 2 conditions which could give this reading (04 marks)

(7)



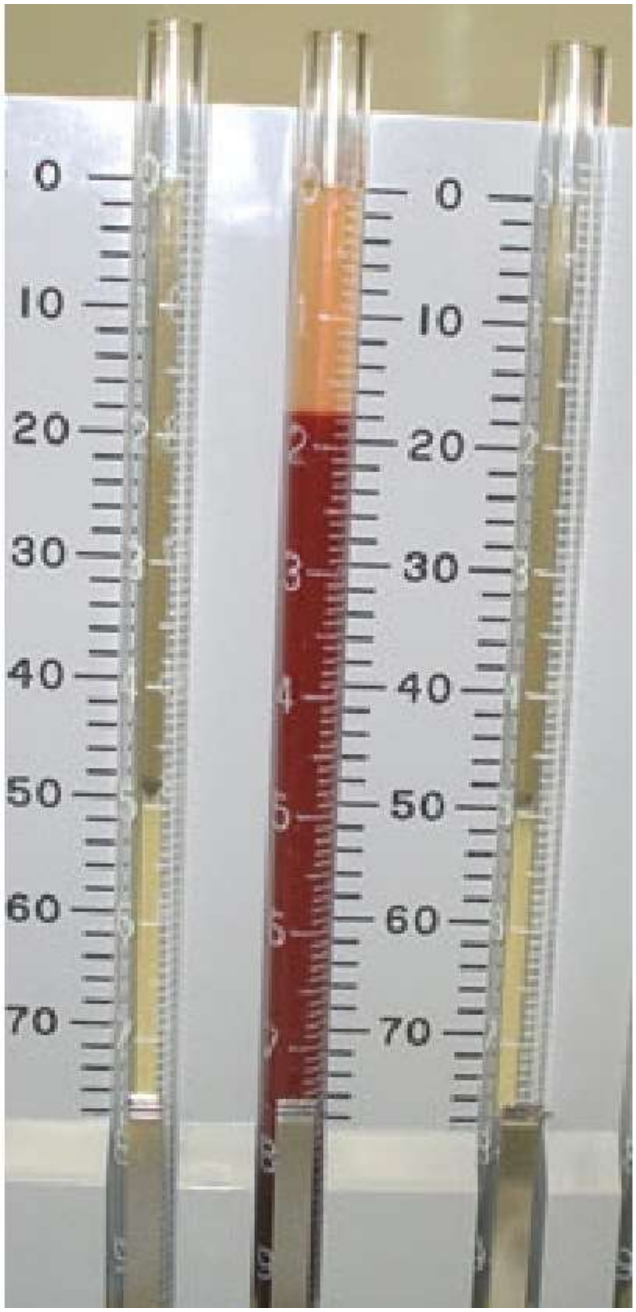
(7.1) What is this investigation called? (06 marks)
(7.2) What is the abnormality seen here? (04 marks)

(8)



(8.1) What is the curve? (02 marks)
(8.2) What do a, c and v waves represent? (06 marks)
(8.3) Which condition causes absent a wave? (02 marks)

(9)



(9.1) Identify the test (02 marks)

(9.2) Identify the apparatus used (04 marks)

(9.3) Name two conditions in which the value of the above test is increased (04 marks)

(10)Assess the radial pulse of the patient and comment on your findings (10 marks)

CAT-1 (BATCH 3) MOCK OSPE ANSWERS

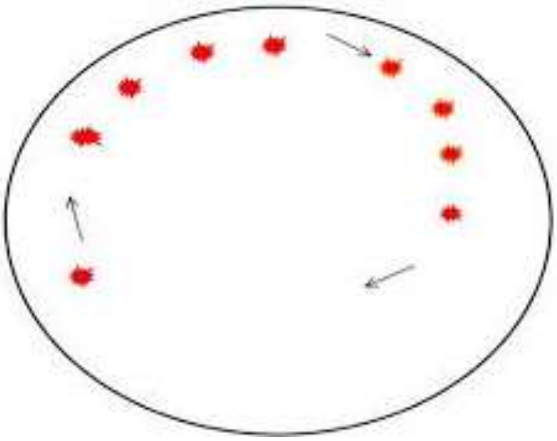
(1)



(1.1) Pale conjunctiva (05 marks)

(1.2) Anaemic condition due to low haemoglobin (05 marks)

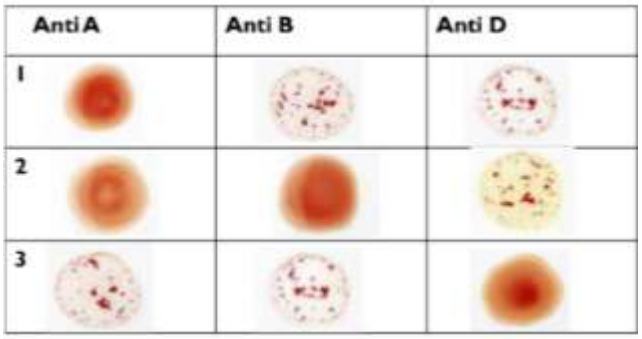
(2)



(2.1) Duke's method of measuring bleeding time (06 marks)

(2.2) Von Willebrand disease, thrombocytopenia (any one of these) (04 marks)

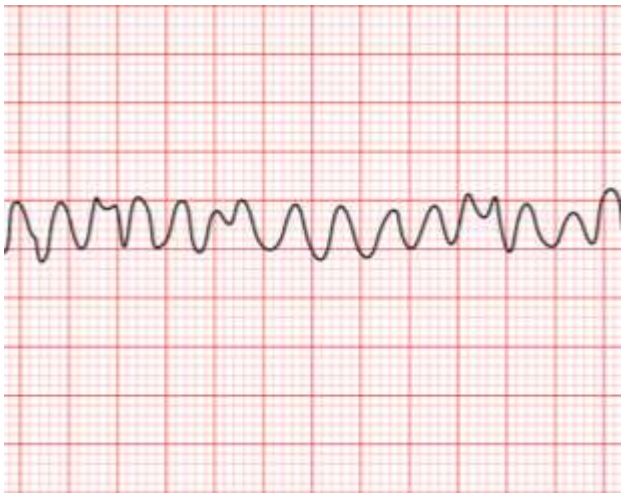
(3)



(3.1) B+, O+, AB- (2*3 = 06 marks)

(3.2) To prevent transfusion reactions (04 marks)

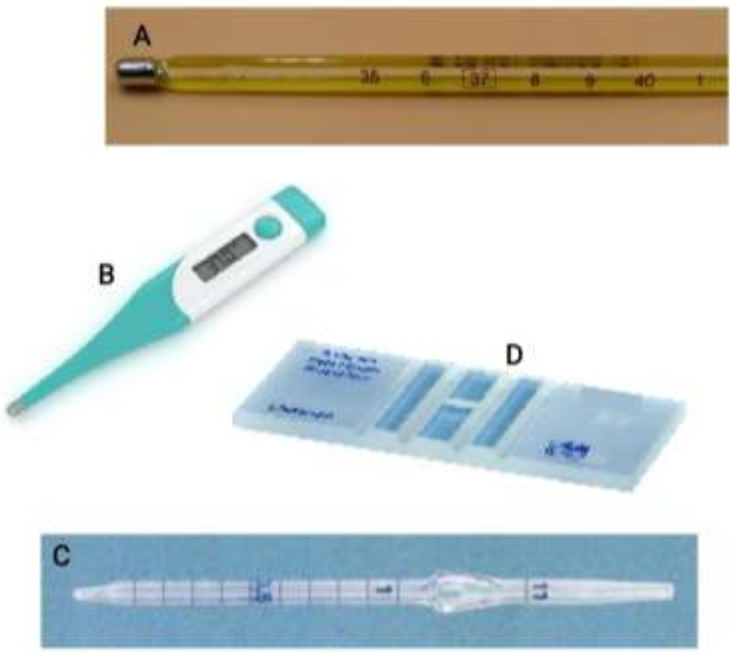
(4)



(4.1) Ventricular fibrillation (06 marks)

(4.2) Electrical defibrillation (04 marks)

(5)



(5.1) A – rectal thermometer, B – digital thermometer, C – WBC pipette, D – Neubauer chamber (1.25*4 = 05 marks)

(5.2) Under the tongue, axilla, rectum (1*3 = 03 marks)

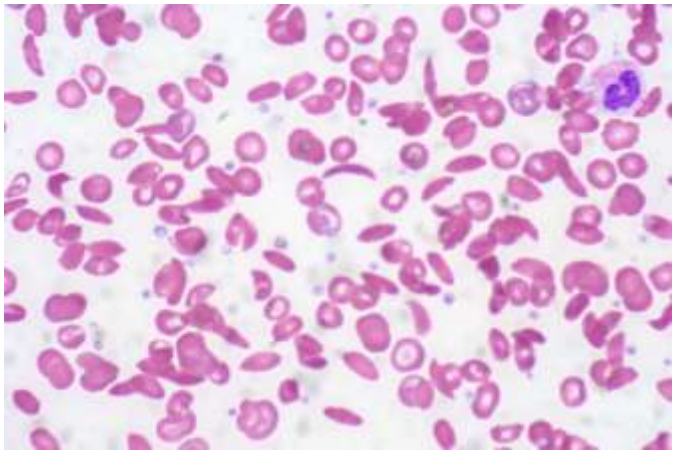
(5.3) To obtain WBC count, to obtain platelet count (1*2 = 02 marks)

(6)



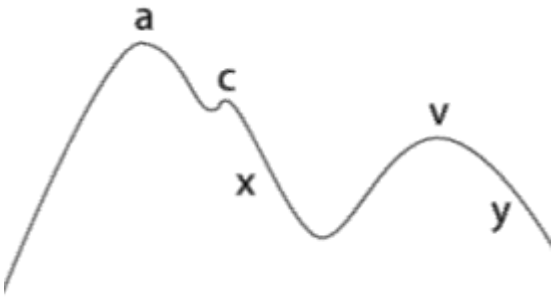
(6.1) Microhaematocrit meter (04 marks)
(6.2) PCV/haematocrit (02 marks)
(6.3) Severe dehydration, polycythemia vera, spherocytosis (any two of these) (2*2 = 04 marks)

(7)



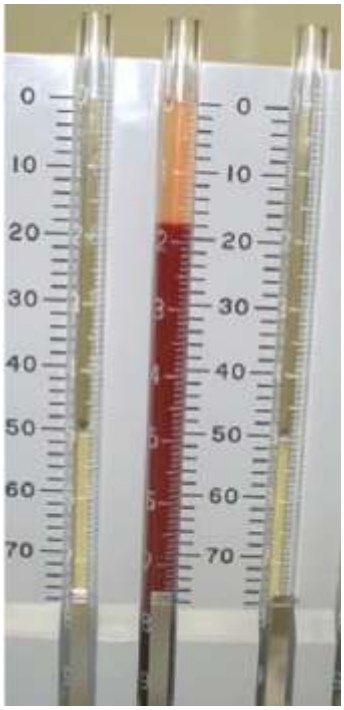
(7.1) Blood picture/blood smear (06 marks)
(7.2) Sickling of red blood cells (04 marks)

(8)



(8.1) JVP waveform (02 marks)
(8.2) a - Right atrial contraction, c – tricuspid valve closure and right ventricular contraction, v – filling of the right atrium against closed tricuspid valve (2*3 = 06 marks)
(8.3) Atrial fibrillation (02 marks)

(9)



(9.1) ESR (02 marks)

(9.2) Calibrated westergren tube (04 marks)

(9.3) Chronic inflammations and infections (TB), acute inflammations and infections, normal pregnancy (physiological), malignancies, severe anaemias (any two of these) (2*2 = 04 marks)

(10)Points given;

- Intro. And Consent (02 marks)
- Patient Positioning and Technique (04 marks)
    - Right side approach, using the index and the middle finger, count the beats up to 15/30 seconds and multiply by 4/2 or count the beats for an entire minute
- Comment on;
    - The rate (0.5 marks) (if only counted up to 15 seconds, the final rate should be a value that is dividable by 4 and if only counted up to 30 seconds, the value should be dividable by 2)
    - The rhythm (0.5 marks)
- For volume and character – use the pulse of a large vessel (e.g. carotid, femoral etc.) (01 mark)
- Thank the patient at the end (02 marks)

PHYSIOLOGY CONTINUOUS ASSESSMENT-1

2023/2024 (2nd Batch)
CAT-1
Papers & Answers

CAT-1 (BATCH 2) MCQ PAPER

Question numbers 01 to 10 are True or False type questions. Mark your answer for each of the 5 responses (A to E)

(1)Which feedback mechanisms is/are correctly matched with the given examples?

(A) Activation of the blood clotting cascade mechanism - Negative feedback
(B) Thermoregulation by sweating mechanism - Positive feedback
(C) Uterine contractions during childbirth mechanism - Positive feedback
(D) Inhibition of ADH secretion when dehydration is treated mechanism - Negative feedback
(E) Regulation of blood glucose by insulin mechanism - Positive feedback

(2)True or False regarding cell communication and transport?

(A) All the cellular receptors that mediate intercellular communication are located on the plasma membrane
(B) Cholera toxin causes diarrhea by inhibiting GTPase activity.
(C) Downregulation of receptors occurs through endocytosis.
(D) During facilitated diffusion, transported molecules get dissolved in the phospholipid bilayer of the cell membrane
(E) Na,K ATPase pump has a coupling ratio of 3:2.

(3)True or False regarding the composition of body fluid?

(A) The normal range of serum Na+ is 115-125 mmol/L.
(B) The volume of plasma constitutes 50% of extra cellular fluid.
(C) Phosphate is the chief extracellular anion.
(D) Sodium is the chief intracellular cation.
(E) Proteins are highly concentrated in intracellular fluids.

(4)True or False regarding the resting membrane potential of a nerve?

(A) Chloride influx is the main factor contributing to the negativity of membrane
(B) Intracellular proteins contribute to the positivity inside the membrane
(C) The cell membrane is more permeable to potassium than sodium.
(D) Sodium potassium pump causes more negativity inside the membrane
(E) The resting membrane potential is essential for the generation of action potentials.

(5)True or False regarding the action potential of a nerve?

(A) Voltage gated sodium channels open up when the threshold level is reached
(B) The all-or-none principle means a stronger stimulus causes a larger action potential.
(C) Repolarization occurs due to the efflux of potassium ions.
(D) They can travel in both directions along an axon.
(E) They are propagated by passive diffusion of ions along the axon.

(6)True or False regarding the Autonomic nervous system (ANS)?

(A) Long standing diabetes causes autonomic dysfunction.
(B) Beta 2 receptors are stimulated by Salbutamol.
(C) Its ultimate responsibility is to maintain homeostasis.
(D) It carries out functions without requiring a conscious effort.
(E) It comprises of three components

(7)Polycythemia is a feature in

(A) people living in high altitude.
(B) chronic cardiac failure.
(C) chronic renal failure.
(D) chronic smoking.
(E) patients on chemotherapy.

(8)Hypochromic microcytic anemia is found in

(A) Iron deficiency anemia.
(B) Beta thalassemia.
(C) Vitamin B12 defiance.
(D) Sideroblastic anemia.
(E) Lead poisoning.

(9)True or False regarding the heart sounds?

(A) Fixed splitting of the second heart sound is physiological in children.
(B) Loud first heart sound is a characteristic feature of mitral stenosis.
(C) Triple rhythm (Gallop rhythm) is usually a physiological phenomenon.
(D) Third heart sound occurs due to rapid ventricular filling.
(E) Second heart sound is best heard in the cardiac apex.

(10)A 28-year-old male met with a road traffic accident and lost about 1000 mL of blood. In this person,

(A) Venoconstriction occurs.
(B) Blood vessels in the skin are constricted.
(C) Norepinephrine concentration in blood is elevated.
(D) Rostral Ventrolateral Medulla (RVLM) generate more impulses.
(E) rate of impulse generation from the baroreceptors in the carotid sinus is increased.

Questions 11 to 20 are Single Best Response (SBR) type. Select the best response to each question.

(11) A 22-year-old athlete was brought to emergency department with a history of collapse during a marathon. He showed signs of moderate dehydration.

Which of the following mechanisms contribute for the most significant loss of body water during prolonged heavy exercise, leading to dehydration?

(A) Metabolic water.
(B) Urine.
(C) Sweating.
(D) Insensible loss through skin.
(E) Insensible loss via lungs.

(12) A 25-year-old man is brought to the Emergency Treatment Unit (ETU) after being found confused and disoriented. His friends reported that he had been drinking alcohol at a party and may have consumed a homemade alcoholic beverage of unknown composition. On examination, he is tachypneic with a respiratory rate of 28 breaths per minute. Arterial blood gas (ABG) analysis reveals the following:

- **pH: 7.10**
- **PCO_2: 20 mmHg**
- **HCO_3^-: 8 mmol/L**
- **Anion gap: 24 mmol/L (normal: 8–16 mmol/L)**

Further investigations confirm elevated serum methanol levels.

Which of the following best explains the patient's acid–base disturbance?

(A) Mixed respiratory and metabolic alkalosis.
(B) Metabolic alkalosis due to vomiting.
(C) High anion gap metabolic acidosis due to accumulation of organic acids.
(D) Normal anion gap metabolic acidosis due to bicarbonate loss.
(E) Respiratory acidosis due to aspirate of vomitus.

(13) A 58-year-old man with chronic kidney disease presents to the emergency department with complaints of muscle weakness and palpitations. An ECG shows peaked T waves. Blood tests reveal a serum potassium level of 6.8 mmol/L (normal: 3.5–5.0 mmol/L).

Which of the following best explains the effect of hyperkalemia on the resting membrane potential of his neurons and muscle cells?

(A) It causes hyperpolarization, making cells less excitable.
(B) It increases the threshold potential, reducing the likelihood of depolarization.
(C) It reduces the negativity of membrane potential, bringing it closer to threshold.
(D) It enhances sodium influx, making action potentials more frequent.
(E) It increases the permeability of potassium channels, stabilizing the membrane potential.

(14) A 60-year-old woman with a history of hypertension is prescribed a calcium channel blocker to control her blood pressure. Two weeks later, her blood pressure has decreased significantly.

Which of the following best explains how calcium channel blockers lower blood pressure through their action on vascular smooth muscle?

(A) They inhibit sympathetic nerve activity, reducing peripheral resistance.
(B) They block sodium-potassium ATPase, reducing smooth muscle excitability
(C) They inhibit calcium entry into smooth muscle cells, leading to relaxation of arteriolar walls
(D) They promote nitric oxide release from endothelial cells, causing vasodilation
(E) They increase intracellular calcium concentration, in vascular smooth muscle cells by enhancing vasoconstriction

(15) Parasympathetic stimulation slows down the heart rate. One of the mechanisms involved in this slowing down is hyperpolarization of the SA nodal cell membrane.

What is the most likely mechanism responsible for hyperpolarization?

(A) Increase in Cl- conductance.
(B) Decrease in Na + conductance.
(C) Increase in the K + conductance.
(D) Activation of M 2 receptors.
(E) Slowing of opening of Ca 2+ channels.

(16) Direct stimulation of α 1 receptors by catecholamines causes vasoconstriction. On the contrary, increased serum catecholamines causes coronary vasodilatation.

What is the best explanation for this coronary vasodilatation?

(A) Increased cardiac output pushes coronary blood vessels outwards increasing their diameter.
(B) Increased cardiac chronotropic and inotropic effects produces potent vasodilator metabolites.
(C) Actions of circulating norepinephrine and norepinephrine released from nerve endings in blood vessels are different.
(D) In this situation parasympathetic effects are more powerful than sympathetic effects.
(E) α 1 receptor on coronary blood vessels are a different subset of receptors.

(17) Many changes to fetal circulation occur at birth. One such change is the closure of foramen ovale.

Which of the following change that occurs at birth causes closure of foramen ovale?

(A) Activation of prostaglandin F 2α .
(B) Discontinuation of the placental circulation.
(C) Closure of ductus venosus.
(D) Closure of ductus arteriosus.
(E) Increase in the left atrial pressure.

(18) A 45-year-old woman presents with spontaneous facial muscle spasms of the left side of the face which causes severe distress to the patient. There were no other symptoms. She was given botulinum toxin injection to the facial muscles which improved the distressing muscle spasms.

Which of the following best describes the mechanism of action of botulinum toxin at the neuromuscular junction?

(A) It destroys motor end plates, leading to irreversible denervation.
(B) It inhibits synaptic vesicle fusion, preventing acetylcholine release.
(C) It prevents acetylcholine synthesis by inhibiting choline uptake.
(D) It increases acetylcholine release by enhancing calcium influx.
(E) It blocks acetylcholine receptors on the postsynaptic membrane.

(19) There are different types of cardiovascular regulatory mechanisms, namely, local regulation, systemic regulation by hormones and systemic regulation by nervous system.

What is the factor that is attempted to be maintained constant by the systemic regulation by the nervous system?

(A) Blood pressure
(B) Cardiac output
(C) Heart rate
(D) Peripheral resistance
(E) Stroke volume

(20) Cardiac muscle cannot be tetanized. What feature in the cardiac muscle cells makes it not possible to tetanize?

(A) Having a plateau phase in the action potential.
(B) AV nodal delay.
(C) Re-cocking of myosin heads is required before the next contraction.
(D) Cytosolic Ca2+ must be pumped back before the next contraction.
(E) Intracellular ATP stores have to be replenished before next contraction

CAT-1 (BATCH 2) MCQ PAPER ANSWERS

(1)FFTTF

(2)FTTFT

(3)FFFFT

(4)FFTTT

(5)TFTTF

(6)TTTTT

(7)TTFTF

(8)TTFTT

(9)FTFTF

(10)TTTTF

(11)D

(12)B

(13)E

(14)C

(15)D

(16)C

(17)E

(18)D

(19)A

(20)C

CAT-1 (BATCH 2) STRUCTURED ESSAY (SEQ) PAPER

(1)Tissue fluid is the fluid that surrounds and bathes the body's cell, playing a vital role in the exchange of nutrients, gases, and waste products between blood and tissues.

(1.1) With the help of a labelled diagram describe the forces governing the formation of tissue fluid at the capillary level. (40 marks)

(1.2) Explain the physiological basis for the development of generalized edema in the following conditions:

(1.2.1) Nephrotic syndrome (25 marks)

(1.2.2) Congestive cardiac failure (35 marks)

(2)Explain the physiological basis of the following observations.

(2.1) Competitive neuromuscular junction blocking agents are used to facilitate endotracheal intubation and provide muscle relaxation during abdominal surgery. (40 marks)

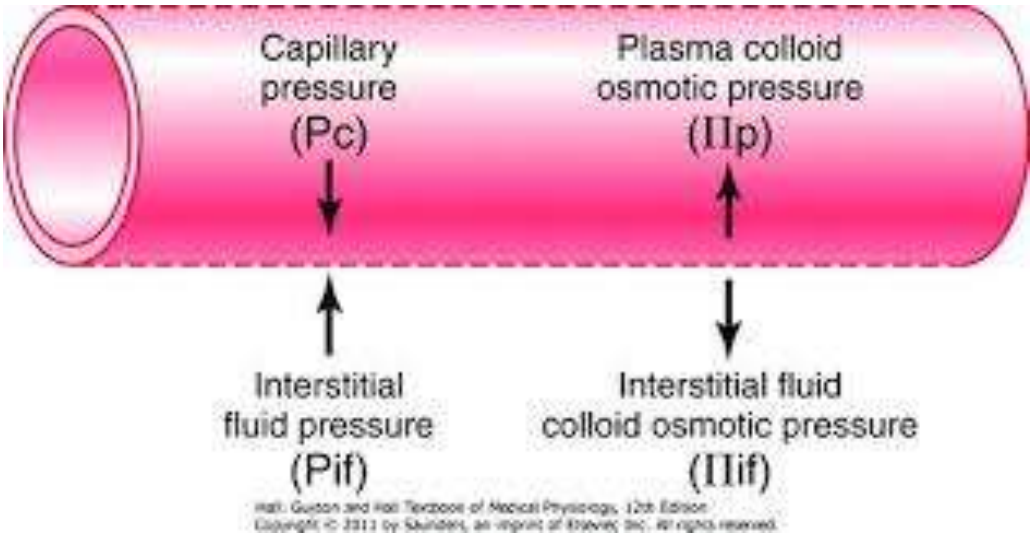
(2.2) Action potential propagation is faster in myelinated nerves than in unmyelinated nerves (30 marks)

(2.3) Organophosphates causes respiratory muscle paralysis by neuromuscular junction block (30 marks)

CAT-1 (BATCH 2) SEQ PAPER ANSWERS

(1)Tissue fluid is the fluid that surrounds and bathes the body's cell, playing a vital role in the exchange of nutrients, gases, and waste products between blood and tissues.

(1.1) With the help of a labelled diagram describe the forces governing the formation of tissue fluid at the capillary level. (40 marks)



A. Labelled Diagram (15 Marks)

The diagram should include:

Component	Marks
Capillary and interstitial space correctly drawn	3
Capillary hydrostatic pressure (Pc)	3
Plasma colloid osmotic pressure (πc)	3
Interstitial hydrostatic pressure (Pi)	2
Interstitial oncotic pressure (πi)	2
Direction of filtration/reabsorption arrows	2

B. Starling Forces (25 Marks)

Point	Marks
Capillary hydrostatic pressure favors filtration	5
Plasma colloid osmotic pressure favors reabsorption	5
Interstitial hydrostatic pressure opposes filtration	4
Interstitial oncotic pressure favors filtration	4
Net filtration occurs mainly at arterial end	3
Reabsorption occurs mainly at venous end (or excess fluid removed by lymphatics)	4

(1.2) Explain the physiological basis for the development of generalized edema in the following conditions:

(1.2.1) Nephrotic syndrome (25 marks)

Point	Marks
Increased glomerular permeability causes proteinuria	5
Loss of plasma albumin (hypoalbuminaemia)	5
Plasma colloid osmotic pressure decreases	5
Reduced reabsorption/increased filtration at capillaries	4
Fluid accumulates in the interstitial space causing oedema	4
Secondary sodium and water retention (RAAS activation) aggravates oedema	2

(1.2.2) Congestive cardiac failure (35 marks)

Point	Marks
Cardiac pumping function decreases	5
Venous pressure increases	5
Capillary hydrostatic pressure increases	6
Increased capillary filtration occurs	5
Reduced renal perfusion activates RAAS	5
Sodium and water retention increase blood volume	4
Increased blood volume further raises venous pressure	3
Generalized oedema develops	2

(2)Explain the physiological basis of the following observations.

(2.1) Competitive neuromuscular junction blocking agents are used to facilitate endotracheal intubation and provide muscle relaxation during abdominal surgery. (40 marks)

Point	Marks
Neuromuscular junction contains nicotinic (Nm) acetylcholine receptors	5
Acetylcholine normally binds to Nm receptors	5
End-plate depolarization is produced	4
Muscle action potential is generated	4
Competitive neuromuscular blockers compete with ACh for Nm receptors	8
ACh cannot bind to receptors	4
End-plate potential fails to reach threshold	4
Muscle action potential and contraction do not occur, producing skeletal muscle relaxation/paralysis	6

(2.2) Action potential propagation is faster in myelinated nerves than in unmyelinated nerves (30 marks)

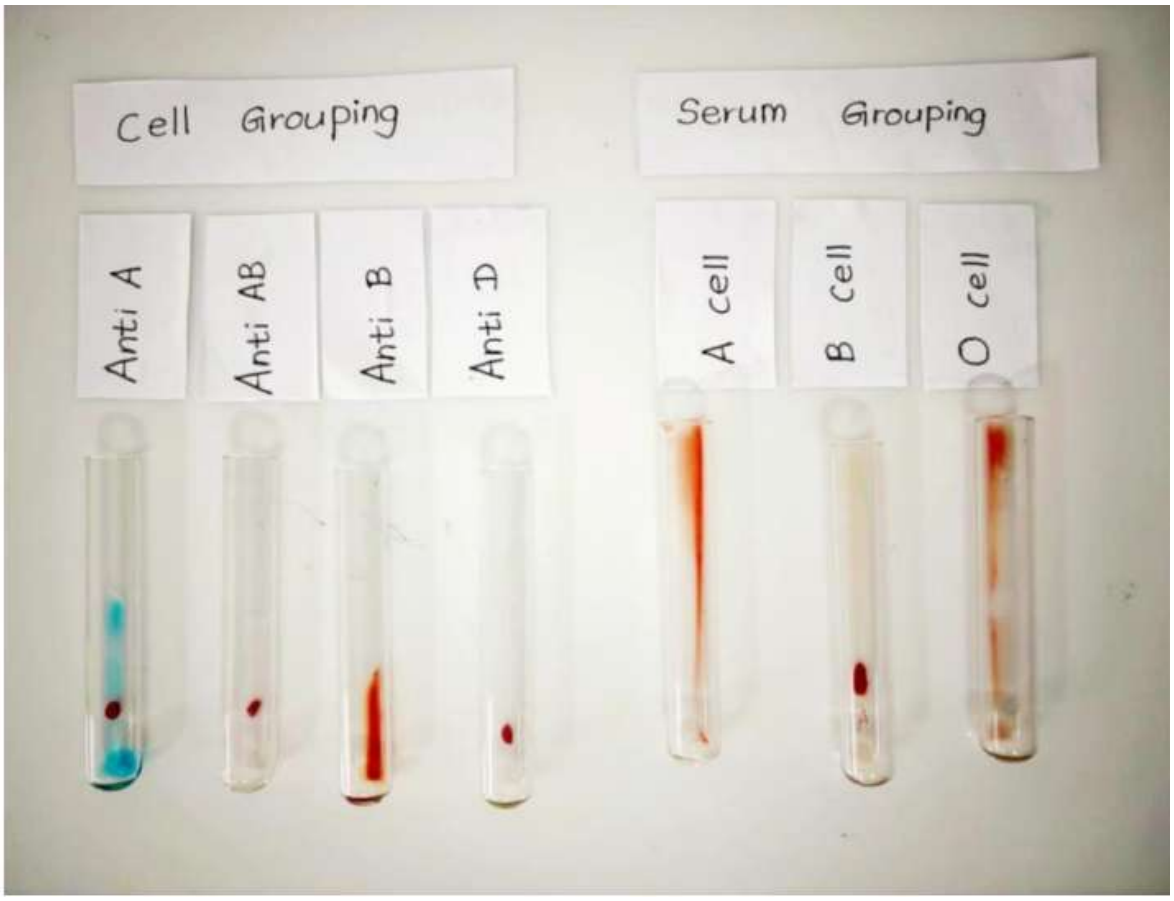
Point	Marks
Myelin sheath acts as an electrical insulator	5
Voltage-gated Na^+ channels concentrated at nodes of Ranvier	5
Action potentials generated only at nodes	5
Impulse "jumps" from node to node (saltatory conduction)	7
Less ion movement across membrane	3
Faster and more energy-efficient conduction	5

(2.3) Organophosphates causes respiratory muscle paralysis by neuromuscular junction block (30 marks)

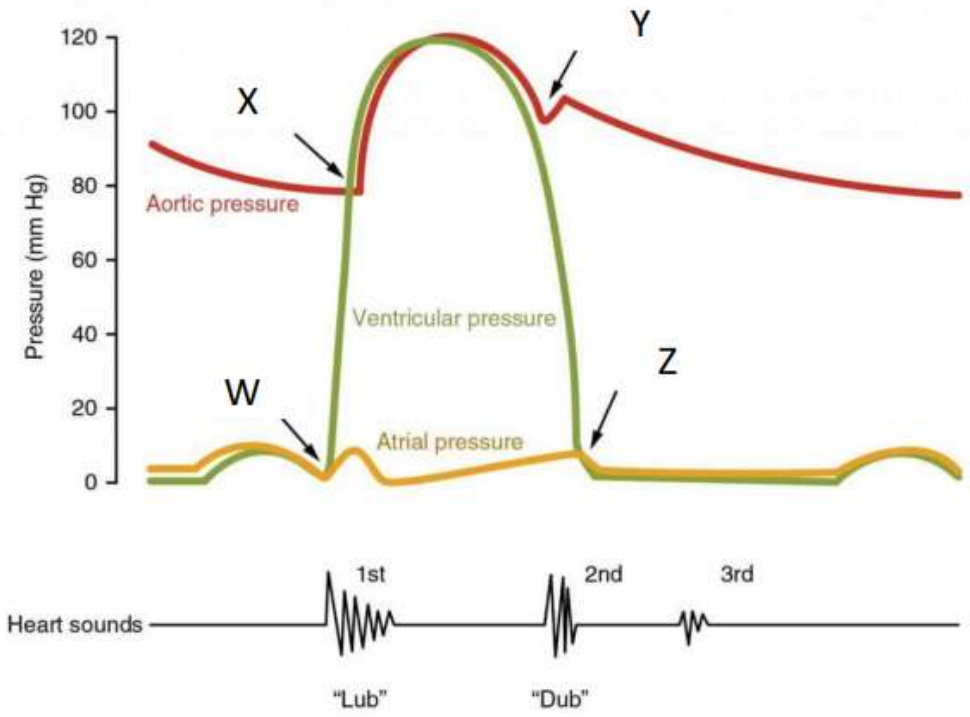
Point	Marks
Organophosphates irreversibly inhibit acetylcholinesterase	6
Acetylcholine accumulates in the synaptic cleft	5
Persistent stimulation of nicotinic receptors occurs	5
Continuous depolarization of the motor end plate	5
Voltage-gated Na^+ channels become inactivated (depolarizing block)	5
Neuromuscular transmission fails, causing respiratory muscle paralysis	4

CAT-1 (BATCH 2) OSPE QUESTIONS

(1)Interpret the ABO and Rh D Blood group from the grouping results given below.



(2)The graph shows pressure changes during a cardiac cycle



Name the events that take place at

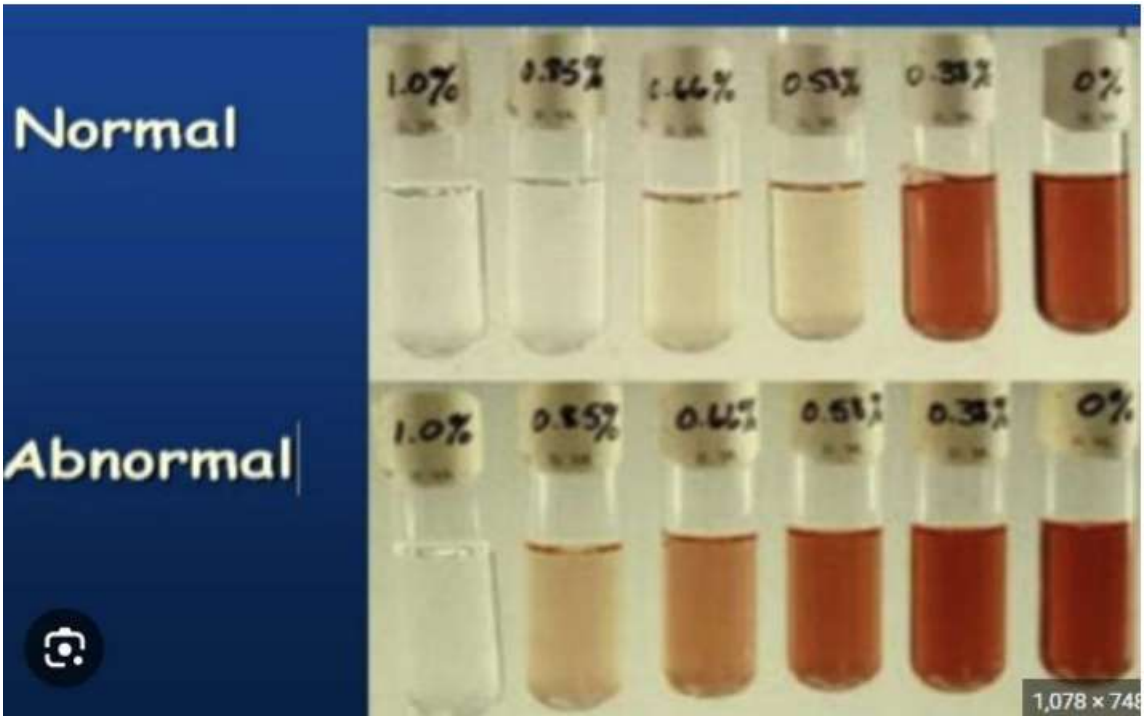
(2.1) X

(2.2) Y

(2.3) W

(2.4) Z

(3)Given below is a photograph of a laboratory test used to identify a hematological abnormality.



(3.1) What is the name of this test?

(3.2) Name two conditions that can show abnormal results in this test.

(3.3) What is the solution used in this test?

(4)

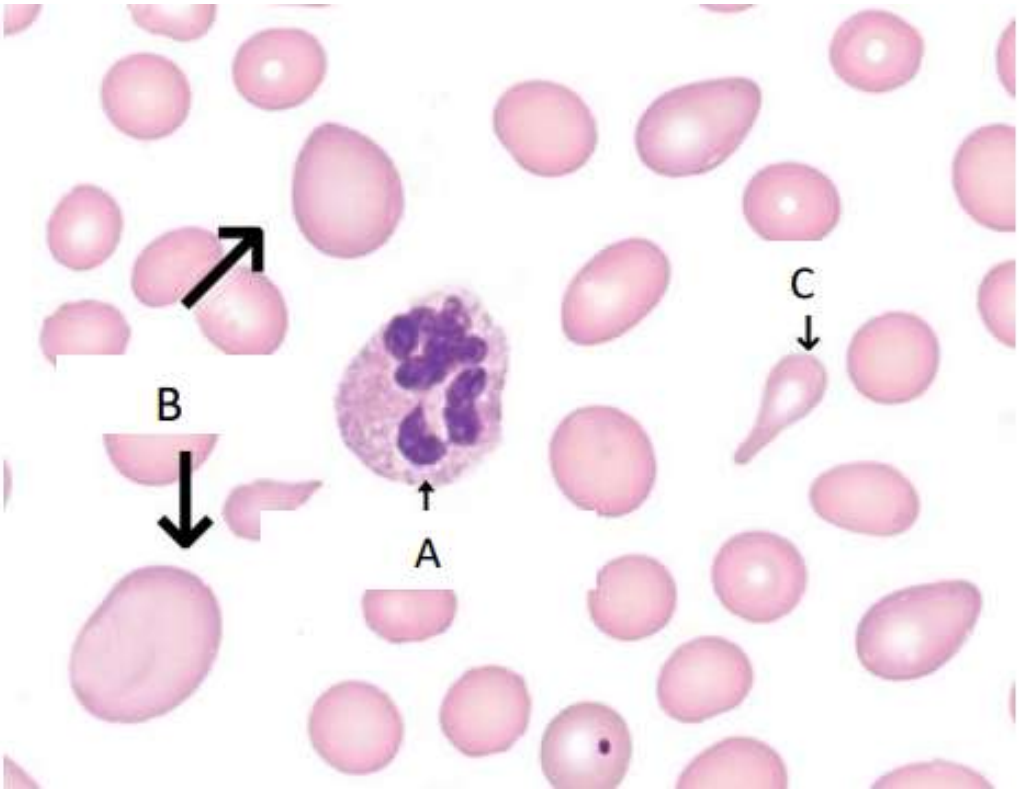


(4.1) State one abnormality seen in the right eye of this patient. (3 marks)

(4.2) State two other clinical features which may be present in this patient. (4 marks)

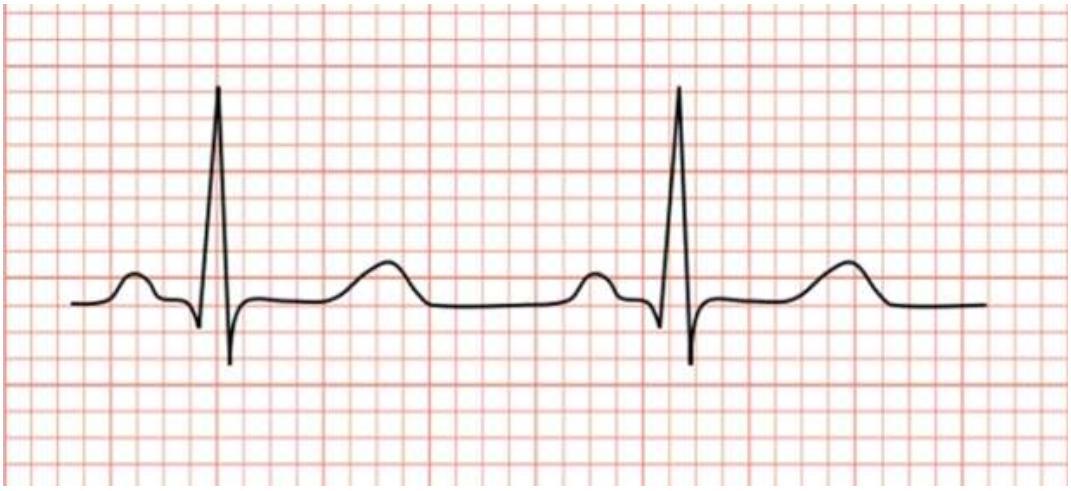
(4.3) State the most likely neurological disorder present in this patient. (3 marks)

(5)A 50- year- old female presented with history of fatigue lasting for 2 months. This image below showed her blood film.



(5.1) Identify A, B, and C
(5.2) What is the hematological diagnosis?
(5.3) Name two causes for your answer in 5.2

(6)Please calculate the following in this stranded ECG



(6.1) PR interval in milliseconds
(6.2) Heart rate in the ECG
(6.3) Height of the R wave in millivolts

(7)A 45 -year – old male with type 1 diabetes mellitus was admitted with severe fatigue and weakness and shortness of breath for 3 days.

ABG;

- pH 7.25 (7.35-7.45)
- PCO_2 - 24 mmHg (35-45)
- PO_2 -98 mmHg
- HCO_3^- - 12 mmol/L (22-26)
- Blood glucose 450 mg/dL

Serum Electrolytes

- Na^+ - 135mmol/L (135-145)
- K^+ - 5.2 mmol/L (4.5-5.5
- Cl^- - 95 mmol/L

(7.1) What is the acid base abnormality of this patient? (03 marks)

(7.2) Calculate the anion gap (04 marks)

(7.3) What is the most likely cause for these metabolic abnormalities? (03 marks)

(8)

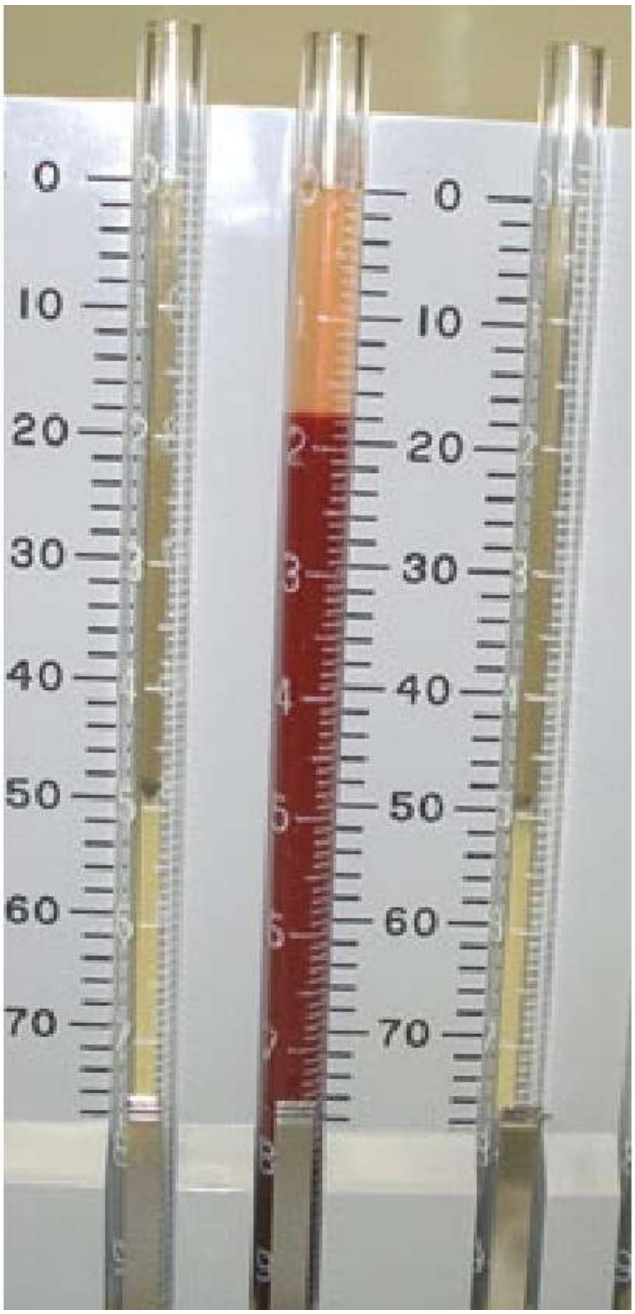


(8.1) Identify the physical sign. (04 marks)

(8.2) Name two possible causes. (04 marks)

(8.3) Name one biochemical test you would perform for this patient (02 marks)

(9)



(9.1) Identify the instrument (03 marks)

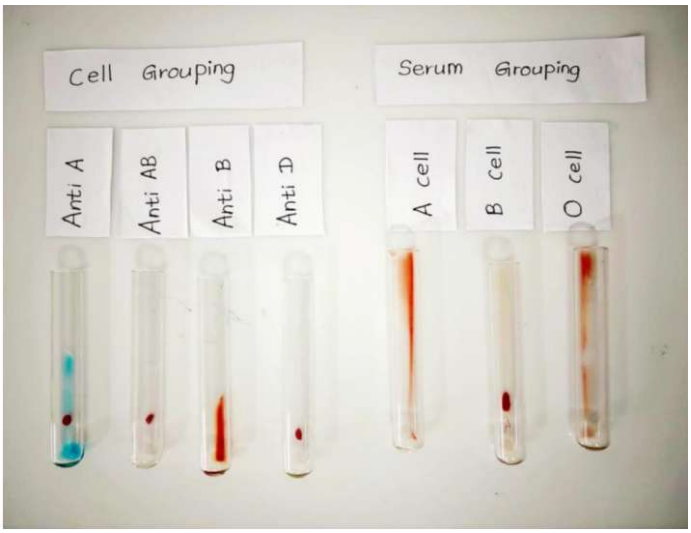
(9.2) Name one clinical use of this instrument. (03 marks)

(9.3) List two precautions should be taken when using this instrument to ensure accuracy and safety. (04 marks)

(10)Live station - Measure the systolic and diastolic blood pressure

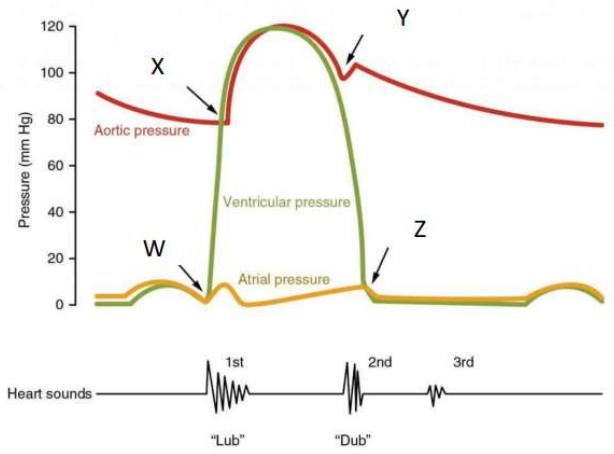
CAT-1 (BATCH 2) OSPE ANSWERS

(1)



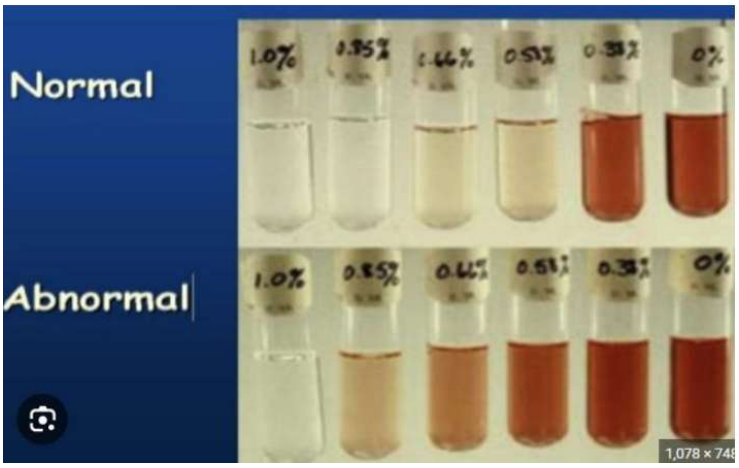
Blood Group A (05 marks)
Rh D Positive (05 marks)
5*2 = 10 marks

(2)



(2.1) Semilunar valves open
(2.2) Semilunar valves closure
(2.3) AV valve closure
(2.4) AV valve closure
2.5*4 = 10 marks

(3)



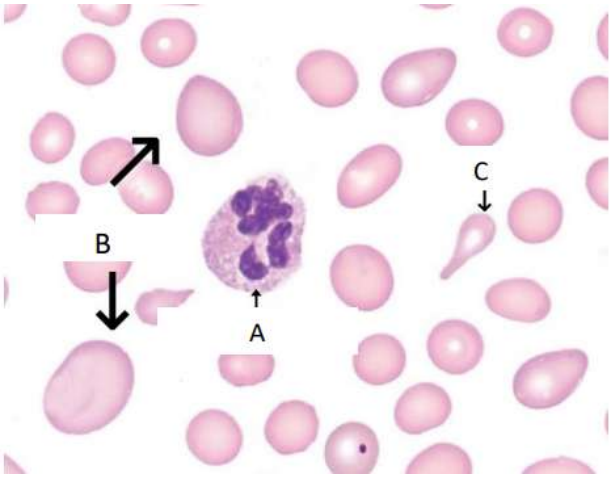
(3.1) Osmotic fragility test (04 marks)
(3.2) Hereditary spherocytosis, sickle cell anemia, thalassemia (02*2 = 04 marks)
(3.3) NaCl/saline (02 marks)

(4)



(4.1) Ptosis/drooping of the eyelid (03 marks)
(4.2) Fatiguability, double vision, difficulty in swallowing (02*2 = 04 marks)
(4.3) Myasthenia gravis (03 marks)

(5)

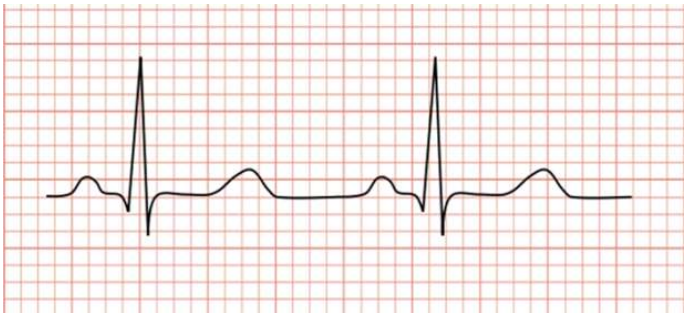


(5.1) A – hyper segmented neutrophil, B – macroovalocytes/large, round cell, C – tear drop cells (01*3 = 03 marks)

(5.2) Megaloblastic anemia (03 marks)

(5.3) Vitamin B12 deficiency, Folate deficiency (02*2 = 04 marks)

(6)



(6.1) 4*40 ms = 160 ms (03 marks)

(6.2) 1500/17 = 88 bpm or 300/4 = 75 bpm (04 marks)

(6.3) 10 mm = 1 mV or 0.1*9 = 0.9 mV or 0.8 mV (03 marks)

(7)ABG;

- pH 7.25 (7.35-7.45)
- PCO_2 - 24 mmHg (35-45)
- PO_2 -98 mmHg
- HCO_3^- - 12 mmol/L (22-26)
- Blood glucose 450 mg/dL

Serum Electrolytes

- Na^+ - 135mmol/L (135-145)
- K^+ - 5.2 mmol/L (4.5-5.5
- Cl^- - 95 mmol/L

(7.1) Metabolic acidosis (02 marks) with respiratory compensation (01 marks)

(7.2) Anion gap = $[Na^+ + K^+] – [Cl^- + HCO_3^-]$ = [135+5.2]-[95+15] = 140.2-107 = 33.2 (04 marks)

(7.3) Diabetes ketoacidosis (03 marks)

(8)

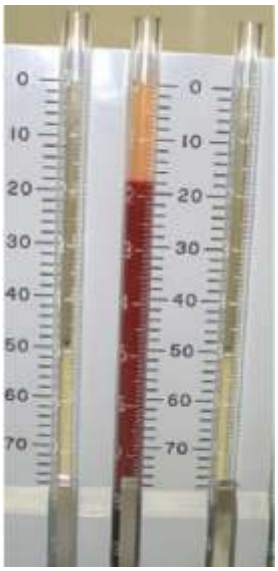


(8.1) Pitting edema of both legs/bilateral pitting edema (04 marks)

(8.2) Right heart/congestive heart failure, nephrotic syndrome, cirrhosis/CLCD (02*2 = 04 marks)

(8.3) Serum proteins with albumin, serum creatinine/BU/TSH (02 marks)

(9)



(9.1) Westergren Tube (03 marks)

(9.2) For measuring ESR (03 marks)

(9.3) Place the tube vertically in a stand, avoid air bubbles in the column, keep the setup away from direct sunlight, filled exactly to the 200 mm mark (02*2 = 04 marks)

(10)Live station – hearing assessment with tuning fork

2024/2025 (3rd Batch)
CAT-1
Papers & Answers

CAT-1 (BATCH 3) MCQ PAPER

Question numbers 01 to 10 are True or False type questions. Mark your answer for each of the 5 responses (A to E)

(1)True or False regarding the feedback mechanisms operating in the body?

(A) A negative feedback mechanism regulates gastric acid secretion.
(B) A positive feedback mechanism operates during blood clotting.
(C) Negative feedback mechanisms disrupt homeostasis.
(D) Positive feedback mechanisms amplify the output signal.
(E) Positive feedback mechanisms occur more frequently than negative feedback mechanisms in the body.

(2)True of False regarding hydrogen ion (H^+) homeostasis?

(A) Anion gap is increased in diabetic ketoacidosis.
(B) Bicarbonate is an important buffer in the extracellular fluid.
(C) Paralysis of respiratory muscles causes respiratory alkalosis.
(D) Severe diarrhoea causes metabolic acidosis.
(E) Voluntary hyperventilation causes metabolic alkalosis.

(3)True or False regarding formation of the tissue fluid?

(A) About 15% of tissue fluid drains via lymphatics.
(B) Hydrostatic pressure forces fluid out at the arterial end of capillaries.
(C) Oncotic pressure draws fluid back into the venous end of capillaries.
(D) Significant amount is formed by capillaries in the pulmonary circulation.
(E) Tissue fluid formation is high in metabolically active tissues.

(4)True or False regarding the resting membrane potential of a nerve?

(A) Intracellular proteins contribute to the negativity in the inner side of the membrane.
(B) It is maintained by voltage-gated calcium channels.
(C) K^+ efflux is the main factor contributing to the negativity inside the membrane.
(D) Membrane is more permeable to Na^+ than to K^+ at rest.
(E) Sodium-potassium pump generates more positivity in the inner side of the membrane.

(5)True or False regarding the autonomic nervous system (ANS)

(A) ANS motor pathways consist of two neurons between the CNS and the effector organ.
(B) It is important for maintaining homeostasis.
(C) Parasympathetic ganglia are located far from their target organs.
(D) Sympathetic division is described as thoracolumbar in origin.
(E) The adrenal medulla functions as a modified parasympathetic ganglion.

(6)True or False regarding skeletal muscle physiology

(A) Calcium is released from the sarcoplasmic reticulum via ryanodine receptors.
(B) Dihydropyridine (DHP) receptors act as voltage sensors in skeletal muscle.
(C) During summation, repeated stimulation before relaxation increases the developed tension.
(D) The contractile response of skeletal muscle has a refractory period equal to the duration of action potential.
(E) T-tubules transmit action potential into the interior of the muscle fibre.

(7)True or False regarding platelets?

(A) Platelets are formed by fragmentation of megakaryocytes in the bone marrow.
(B) Platelets are granulated cell bodies.
(C) Platelets have a lifespan of about 3 months.
(D) Production is stimulated by thrombopoietin.
(E) Splenectomy leads to a decrease in platelet count.

(8)True or False regarding the innate immunity?

(A) Chemokines attract phagocytic cells to sites of infection.
(B) Complement system is activated.
(C) Immune memory is produced.
(D) Natural Killer cells contribute to it.
(E) Response is antigen specific.

(9)True or False regarding clinical uses of the ECG?

(A) Detection of myocardial ischemia.
(B) Diagnosis of cardiac arrhythmias.
(C) Diagnosis of cardiac chambers hypertrophy.
(D) Identification of conduction abnormalities (e.g., heart block).
(E) Measurement of cardiac output.

(10)Match the type of shock with the correct example/condition

(A) Cardiogenic shock – Myocardial infarction.
(B) Distributive shock – Pulmonary embolism.
(C) Hypovolaemic shock – Severe vomiting and diarrhea.
(D) Neurogenic shock – Spinal cord injury.
(E) Obstructive shock – Cardiac tamponade.

Questions numbers 11 to 20 are Single Best Response (SBR) type. Select the best response to each question.

(11) There are different types of dehydration, namely, hypotonic, hypertonic and isotonic dehydration.

Which of the following statement best describes the physiological changes that occur in isotonic dehydration?

(A) Loss of sodium counter-balanced by retention of potassium.
(B) Loss of sodium only, causing decreased plasma osmolality.
(C) Loss of water and electrolytes, without a change in plasma osmolality.
(D) Loss of water exceeding sodium loss, leading to increased plasma osmolality.
(E) Loss of water only, leading to increased plasma osmolality.

(12) A 55-year-old man presents with progressive abdominal swelling and puffiness of the face for the past one month. He also notices swelling of both ankles, especially in the evening. On examination, he has bilateral pitting oedema and ascites.
Laboratory investigations show low serum albumin levels.

Which of the following mechanisms is the most likely cause of his generalized oedema?

(A) Decreased plasma oncotic pressure.
(B) Increased capillary hydrostatic pressure.
(C) Increased capillary permeability.
(D) Lymphatic obstruction.
(E) Sodium retention.

(13) A 32-year-old woman presents with progressive muscle weakness for 3 months. She reports difficulty in climbing stairs, which worsens towards the end of the day. She also complains about drooping of her eyelids in the evening. On examination, there is bilateral ptosis and fatigable weakness of proximal muscles. Myasthenia Gravis was suspected.

Which of the following is the most likely physiological defect at the neuromuscular junction in this patient?

(A) Autoimmune destruction of postsynaptic nicotinic cholinergic receptors.
(B) Autoimmune destruction of voltage-gated calcium channels in the nerve endings.
(C) Decreased release of acetylcholine from the presynaptic terminal.
(D) Decreased sensitivity of nicotinic receptors to acetylcholine.
(E) Overactivity of acetylcholinesterase activity in the synaptic cleft.

(14) A 25-year-old man is brought to the emergency department after collapsing while running a marathon on a hot day. He is confused, his skin is hot and dry, and his core body temperature is 40°C. On examination, there is no sweating.

Which of the following physiological mechanisms is most likely impaired, leading to his condition?

(A) Countercurrent heat exchange in deep blood vessels.
(B) Cutaneous vasodilatation reducing heat loss.
(C) Evaporative heat loss due to sweat secretion.
(D) Heat production in the liver.
(E) Insulation provided by subcutaneous fat.

(15)Red cell formation in the bone marrow is controlled by different mechanisms.

Which of the following factors plays the most important physiological role in stimulating erythropoiesis?

(A) Increased blood thyroid hormones concentration.
(B) Increased methemoglobin level in blood.
(C) Increased plasma androgen concentration.
(D) Reduced RBC count.
(E) Reduced renal oxygen delivery.

(16)A 7-year-old boy is brought to the clinic with recurrent swelling of his knees and elbows after minor trauma. His mother reports that he often develops large bruises and prolonged bleeding after small cuts. There is a family history of a similar condition in a maternal uncle. Laboratory investigations show:
Normal platelet count Normal bleeding time
Prolonged activated partial thromboplastin time (aPTT) Normal prothrombin time (PT)

Which of the following is the most likely underlying physiological defect in this patient?

(A) Deficiency of factor VIII.
(B) Deficiency of factor XIII.
(C) Increased fibrinolysis causing early clot breakdown.
(D) Vitamin K deficiency.
(E) von Willebrand factor deficiency.

(17)At the end of the repolarization phase of cardiac pacemaker cells, membrane begins to depolarize automatically.

Which of the following ion channels is responsible for the initial part of this depolarization?

(A) Funny channels.
(B) K^+ channels.
(C) Ligand-gated Na^+ channels.
(D) Long-lasting Ca^{2+} channels.
(E) Transient Ca^{2+} channels.

(18)A 52-year-old man presents for a routine medical check-up. He has no significant symptoms but is found to have persistently elevated blood pressure (160/100 mmHg) on repeated measurements. Laboratory investigations reveal normal renal function. Further assessment shows increased plasma renin activity and elevated aldosterone levels.

Which of the following is the most likely physiological mechanism contributing to his hypertension?

(A) Atherosclerosis.
(B) Decreased serum K^+ concentration.
(C) Increased cardiac output due to enhanced sympathetic activity.
(D) Increased responsiveness of vascular smooth muscle to vasoconstrictors.
(E) Increased total peripheral resistance due to arteriolar constriction.

(19) According to standard evidence, different errors can increase blood pressure by varying amounts.

Which of the following factors is most likely to cause the greatest inaccuracy (largest increase) in blood pressure measurement?

(A) A full bladder.
(B) An unsupported arm.
(C) Crossing the legs.
(D) Placing the cuff over thick clothing.
(E) Talking during the measurement.

(20) A 65-year-old man presents with progressive shortness of breath and episodes of dizziness on exertion.
On examination, he has a slow-rising pulse and an ejection systolic murmur best heard at the right upper sternal border, radiating to the carotid arteries.

Which of the following is the most likely physiological mechanism responsible for this murmur?

(A) Backflow of blood from the aorta into the left ventricle during diastole.
(B) Increased flow across a normal pulmonary valve during ventricular systole.
(C) Increased flow across the normal aortic valve during ventricular systole.
(D) Turbulent flow across a narrowed aortic valve during ventricular systole.
(E) Turbulent flow across a narrowed pulmonary valve during ventricular systole.

CAT-1 (BATCH 3) MCQ PAPER ANSWERS

(1)TTFTF

(2)TTFTF

(3)TTTFT

(4)TFTFF

(5)TTFTF

(6)TTTFT

(7)TTFTF

(8)TTFTF

(9)TTTTF

(10)TFTTT

(11)C

(12)A

(13)A

(14)C

(15)E

(16)A

(17)A

(18)E

(19)D

(20)D

CAT-1 (BATCH 3) STRUCTURED ESSAY (SEQ) PAPER

(1) A 5-year-old child presents with a history of profuse diarrhea, which was treated at home only with plain water. The child appears lethargic, has sunken eyes, and shows reduced skin turgor. Laboratory values reveal low plasma osmolality and hyponatremia.

(1.1) Define hypotonic dehydration (10 marks)

(1.2) Explain how this child developed hyponatremic dehydration (15 marks)

(1.3) Using labelled diagrams, describe the changes in extra cellular fluid (ECF) and Intra cellular fluid (ICF) volumes and osmolarity in this child. (20 marks)

(1.4) Describe the physiological compensatory mechanisms that occur in hypotonic dehydration (35 marks)

(1.5) Outline the principles of fluid management in this child. (20 marks)

(2) A 60-year-old man with long-standing hypertension presents with exertional dyspnea. Echocardiography reveals increased end-systolic volume and reduced stroke volume.

(2.1) Define the term stroke volume. (10 marks)

(2.2) State three (03) factors that will determine the stroke volume (15 marks)

(2.3) What is the relationship between the stroke volume and the cardiac output (15 marks)

(2.4) Describe the changes that occur in the stroke volume and the cardiac output in following conditions.

(2.4.1) Pregnancy (10 marks)

(2.4.2) Anaemia (10 marks)

(2.4.3) Exercise (10 marks)

(2.5) State the equation to calculate the ejection fraction of the left ventricle? (15 marks)

(2.6) Name three (03) conditions in which cardiac output is reduced (15 marks)

CAT-1 (BATCH 3) SEQ PAPER ANSWERS

(1) A 5-year-old child presents with a history of profuse diarrhea, which was treated at home only with plain water. The child appears lethargic, has sunken eyes, and shows reduced skin turgor. Laboratory values reveal low plasma osmolality and hyponatremia.

(1.1) Define hypotonic dehydration (10 marks)

Hypotonic (hyponatraemic) dehydration is a form of dehydration in which sodium loss exceeds water loss, resulting in a decrease in extracellular fluid osmolality and a serum sodium concentration below 135 mmol/L.

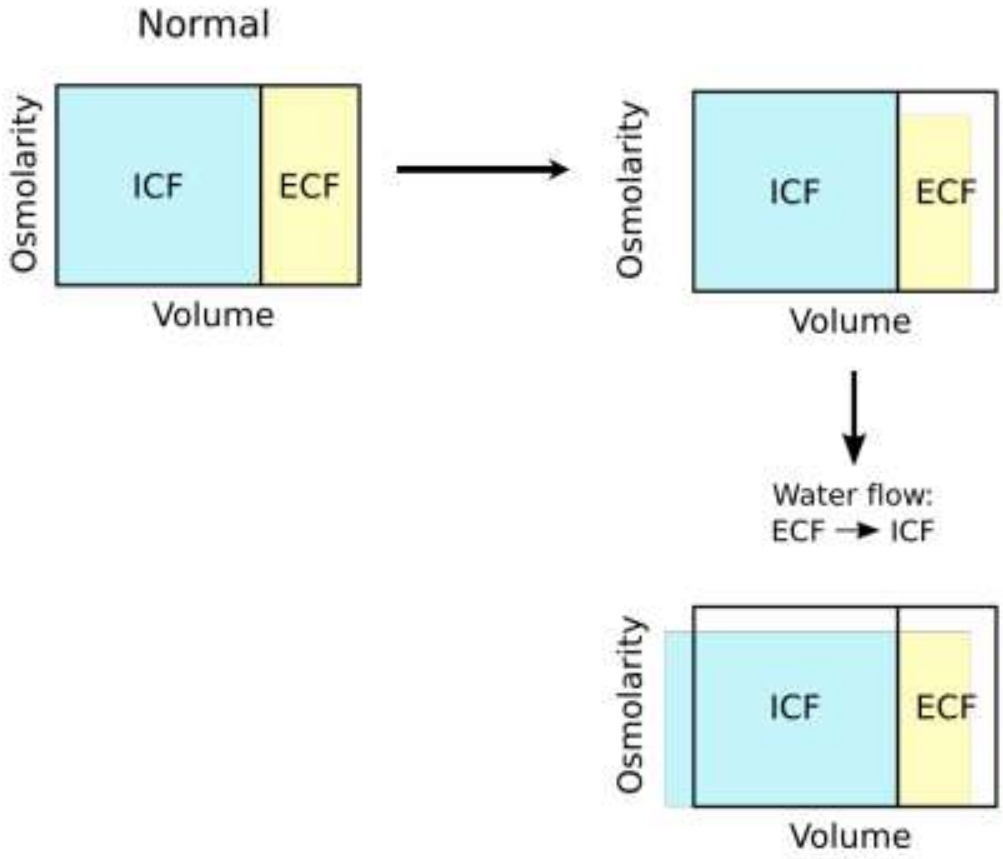
Mark Allocation:

Point	Marks
Correctly defines dehydration with sodium loss exceeding water loss	5
Mentions decreased ECF osmolality and/or hyponatraemia (Na^+ <135 mmol/L)	5

(1.2) Explain how this child developed hyponatremic dehydration (15 marks)

Point	Marks
Diarrhoea causes loss of sodium-rich extracellular fluid	5
Replacement with plain water alone dilutes extracellular sodium	4
Plasma sodium concentration falls (hyponatraemia)	3
Plasma/ECF osmolality decreases, resulting in hypotonic dehydration	3

(1.3) Using labelled diagrams, describe the changes in extra cellular fluid (ECF) and Intra cellular fluid (ICF) volumes and osmolarity in this child. (20 marks)



A. Labelled Diagrams (10 Marks)

Component	Marks
Correct ECF diagram	3
Correct ICF diagram	3
Arrows indicating water movement from ECF to ICF	2
Appropriate labels (volume and osmolarity changes)	2

B. Physiological Changes (10 Marks)

Point	Marks
ECF volume decreases	2
ECF osmolarity decreases	2
Water moves from ECF into ICF	2
ICF volume increases	2
ICF osmolarity becomes equal to reduced ECF osmolarity	2

(1.4) Describe the physiological compensatory mechanisms that occur in hypotonic dehydration (35 marks)

Point	Marks
Hypovolaemia reduces arterial pressure	4
Baroreceptor firing decreases	3
Sympathetic nervous system activated	4
Tachycardia and peripheral vasoconstriction occur	5
Renin secretion increases	4
Activation of the renin–angiotensin–aldosterone system (RAAS)	5
Aldosterone increases renal Na^+ reabsorption	4
ADH secretion may increase due to hypovolaemia despite low osmolality	3
Thirst mechanism stimulated	3

(1.5) Outline the principles of fluid management in this child. (20 marks)

Point	Marks
Assess severity of dehydration	3
Restore circulating volume with isotonic IV fluids (e.g., 0.9% saline or Ringer's lactate)	5
Correct hyponatraemia gradually (avoid rapid correction)	4
Replace ongoing fluid and electrolyte losses	3
Continue maintenance fluids with appropriate electrolyte composition	3
Monitor clinical status, serum electrolytes and urine output	2

(2)A 60-year-old man with long-standing hypertension presents with exertional dyspnea. Echocardiography reveals increased end-systolic volume and reduced stroke volume.

(2.1) Define the term stroke volume. (10 marks)

Stroke volume is the volume of blood ejected by one ventricle during each heartbeat (ventricular systole).

Point	Marks
Defines stroke volume as the volume ejected by one ventricle	6
Specifies that it is ejected during each systole/heartbeat	4

(2.2) State three (03) factors that will determine the stroke volume (15 marks)

Factor	Marks
Preload	5
Contractility	5
Afterload	5

(2.3) What is the relationship between the stroke volume and the cardiac output (15 marks)

Cardiac Output = Stroke Volume × Heart Rate

Point	Marks
Correct formula stated	8
Explains that cardiac output is directly proportional to stroke volume (if heart rate remains constant)	7

(2.4) Describe the changes that occur in the stroke volume and the cardiac output in following conditions.

(2.4.1) Pregnancy (10 marks)

Point	Marks
Stroke volume increases	4
Cardiac output increases	4
Increased blood volume/venous return contributes	2

(2.4.2) Anaemia (10 marks)

Point	Marks
Stroke volume increases	4
Cardiac output increases	4
Compensatory response to maintain oxygen delivery (↑ HR/↓ blood viscosity)	2

(2.4.3) Exercise (10 marks)

Point	Marks
Stroke volume increases	4
Cardiac output increases markedly	4
Due to increased sympathetic activity, venous return and contractility	2

(2.5) State the equation to calculate the ejection fraction of the left ventricle? (15 marks)

$$Ejection\ Fraction\ (EF) = \frac{Stroke\ Volume}{End - Diastolic\ Volume} \times 100\%$$

Point	Marks
Correct formula	15

(2.6) Name three (03) conditions in which cardiac output is reduced (15 marks)

Any three (05 marks each):

- Heart failure (congestive cardiac failure)
- Myocardial infarction
- Hypovolaemic shock
- Cardiac tamponade
- Severe valvular heart disease
- Cardiomyopathy
- Severe bradycardia

CAT-1 (BATCH 3) OSPE QUESTIONS

(1)Descriptive statistics

Fasting blood glucose levels (mg/dL) of eight (08) students were measured during a practical physiology class.

The values obtained were:

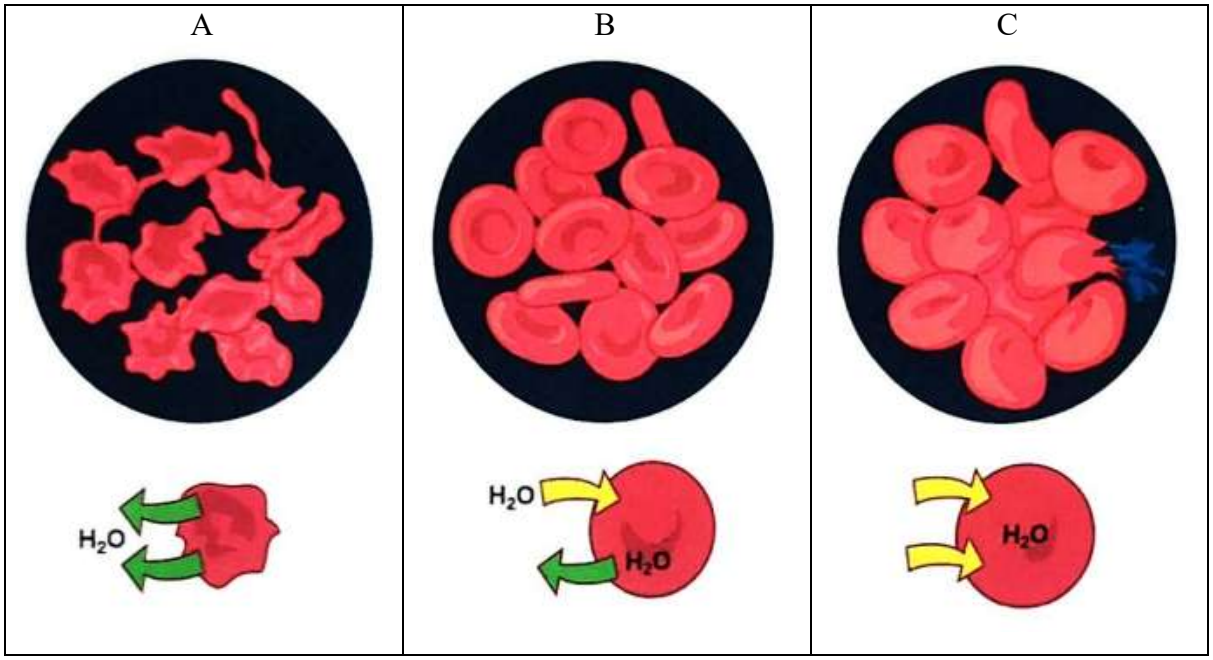
68, 72, 70, 72, 76, 72, 68, 80

(1.1) What is the mode of the dataset? (04 marks)

(1.2) What is the range of blood glucose level? (03 marks)

(1.3) State one reason why standard deviation is preferred over range as a measure of dispersion. (03 marks)

(2)Effect of Tonicity on Red Blood Cells

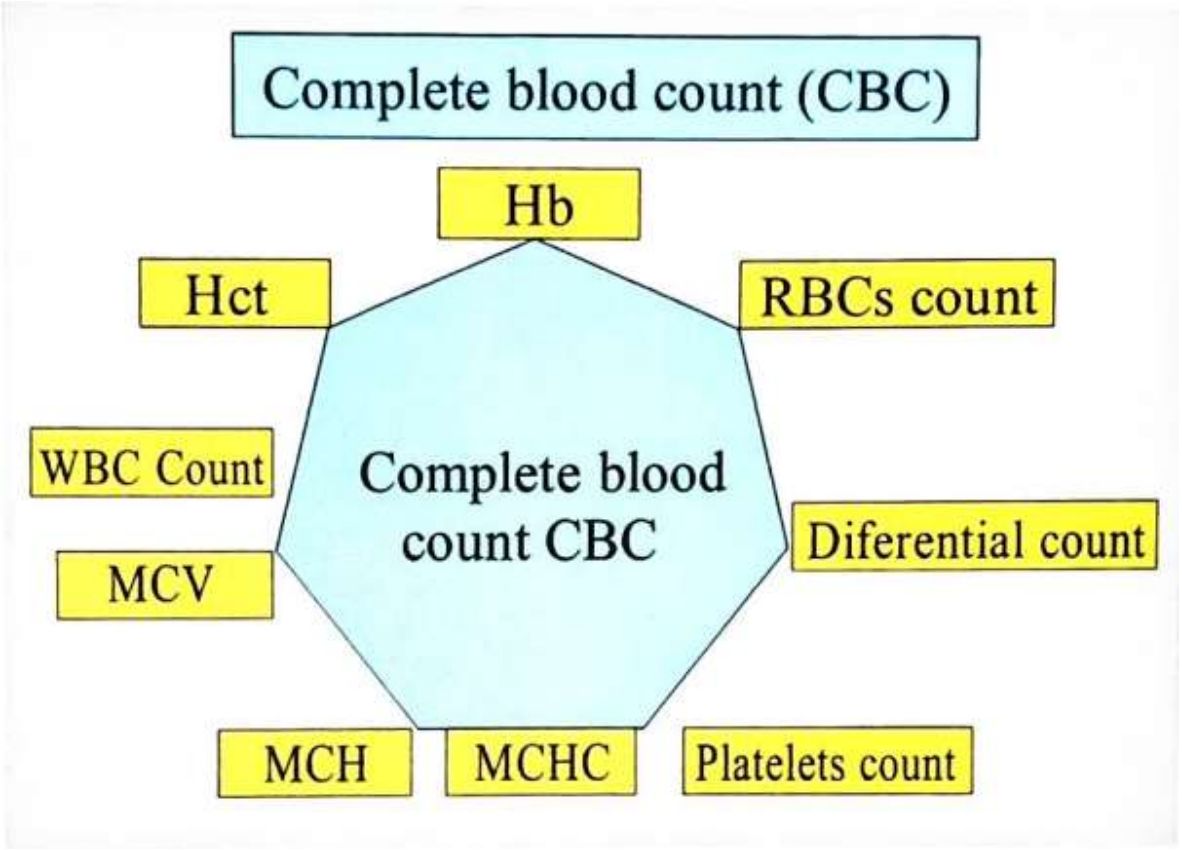


(2.1) Identify the tonicity of solution in A, B, and C. (03 marks)

(2.2) Name one example for each solution mentioned in 2.1 (03 marks)

(2.3) State the physiological principle responsible for the changes shown in the diagram. (04 marks)

(3)Components of a complete blood count (CBC/FBC)



(3.1) Name two directly measured parameters (03 marks)

(3.2) Name two calculated parameters (03 marks)

(3.3) State two clinical conditions in which hematocrit (Hct) is increased. (04 marks)

(4)A blood film (blood picture)

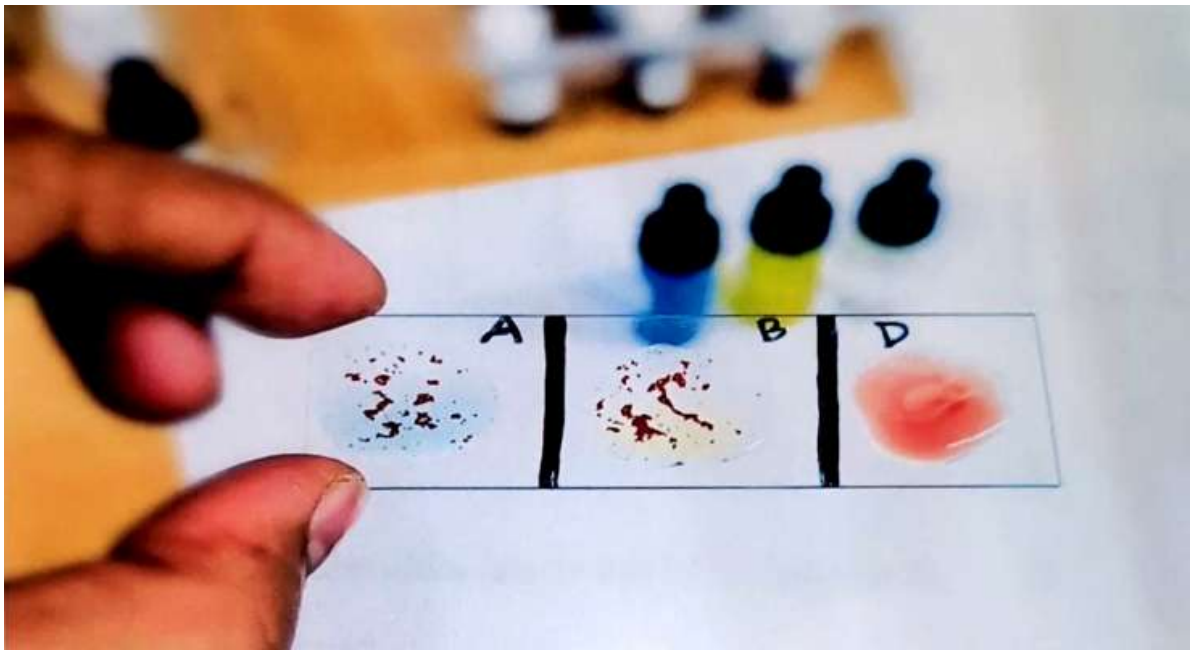


(4.1) Identify two types of abnormal red cells (04 marks)

(4.2) What is the most likely haematological diagnosis? (04 marks)

(4.3) State one complication of this condition. (02 marks)

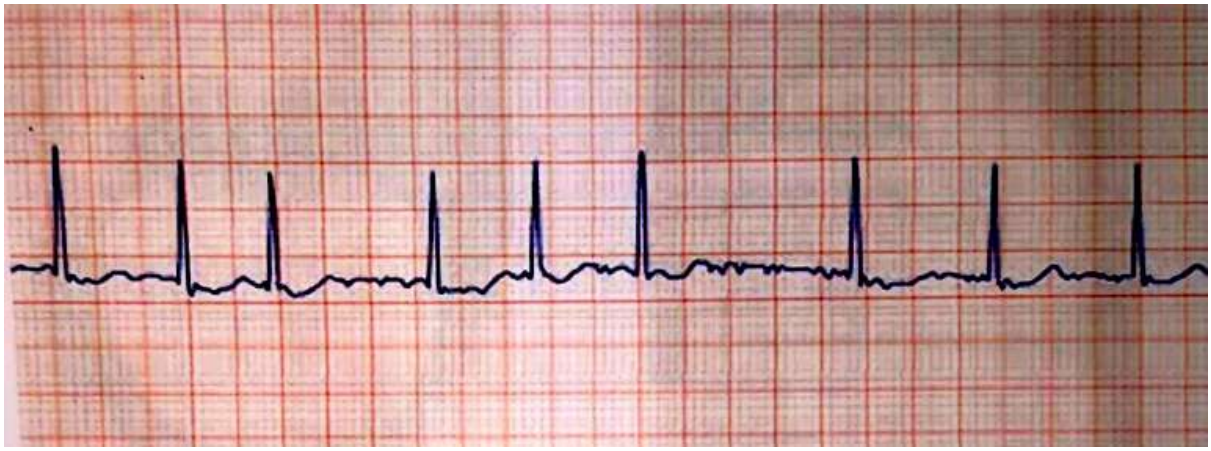
(5)Blood grouping



(5.1) Identify the blood group (06 marks)

(5.2) Name two blood groups that can be safely donated to this individual. (04 marks)

(6)An ECG



(6.1) List two abnormalities seen in this ECG rhythm strip. (04 marks)

(6.2) What is the ECG diagnosis? (03 marks)

(6.3) Name one abnormality of the pulse that may be present in this patient. (03 marks)

(7)A patient with a physical sign



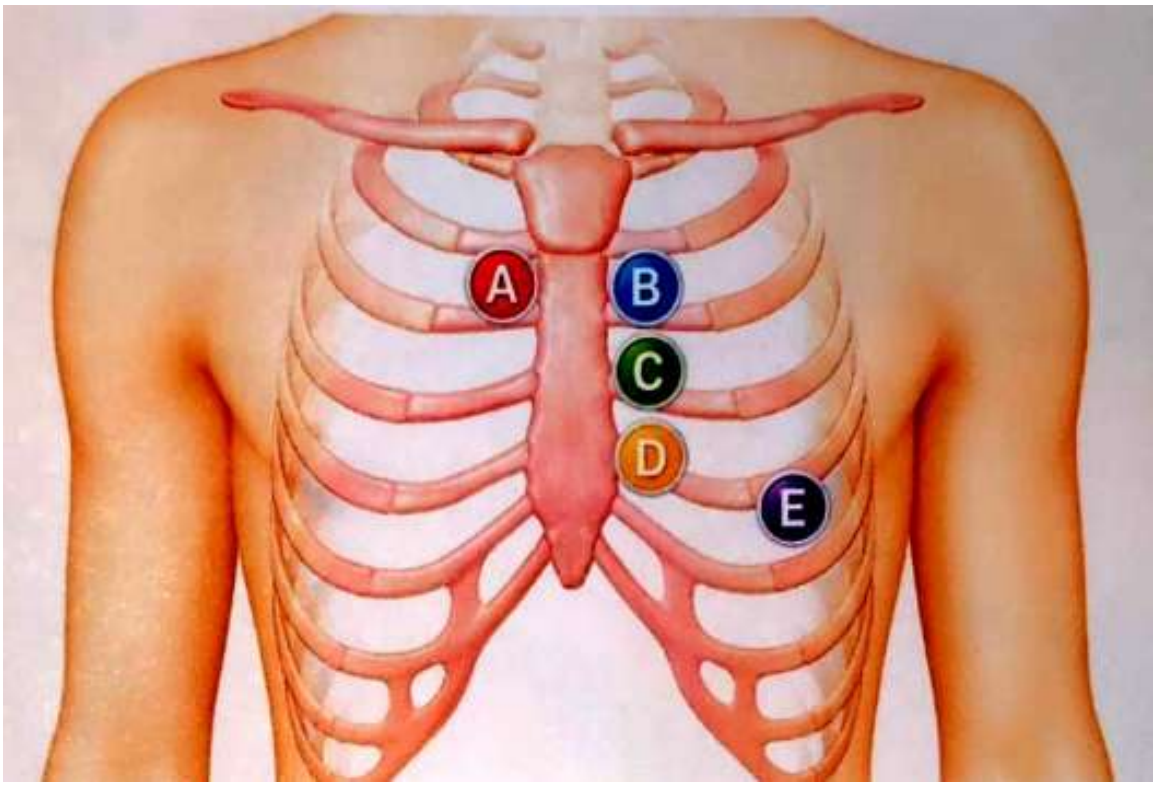
65-year-old male presents with per rectal bleeding, progressive shortness of breath on exertion and fatigability of two-month duration.

(7.1) Identify the physical sign (03 marks)

(7.2) Name two features in his blood picture (04 marks)

(7.3) State one blood investigation to confirm the diagnosis (03 marks)

(8)Precordial auscultatory areas



(8.1) Identify the areas B, C, D and E (04 marks)

(8.2) Match the following murmurs with areas where it is best heard

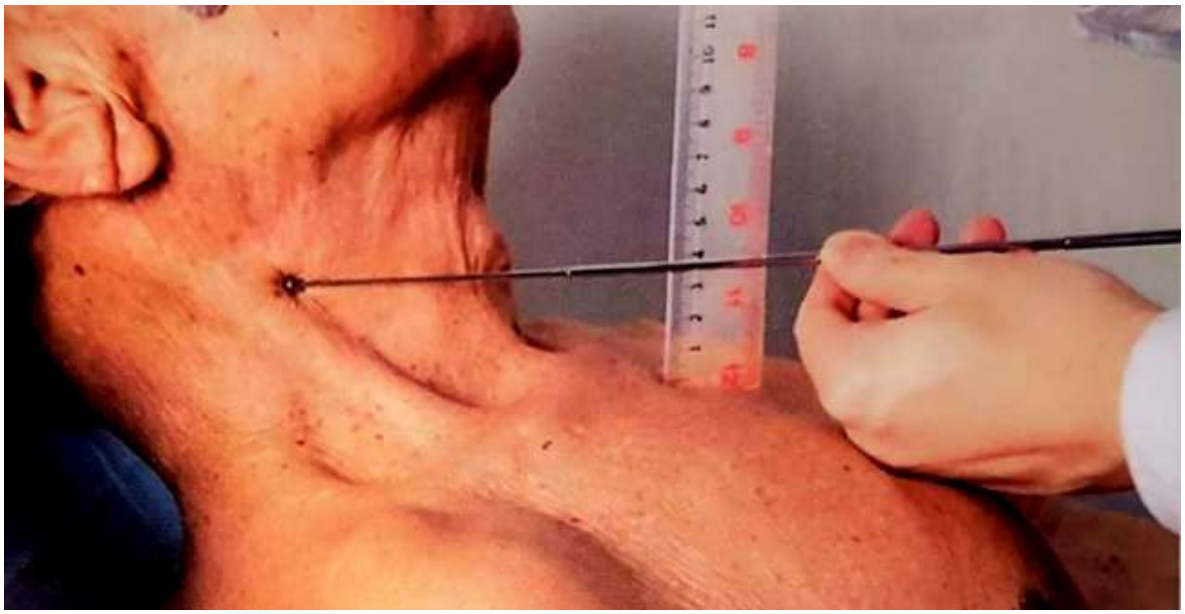
(8.2.1)Ejection systolic murmur

(8.2.2)Mid diastolic murmur

(8.2.3)Pansystolic systolic murmur

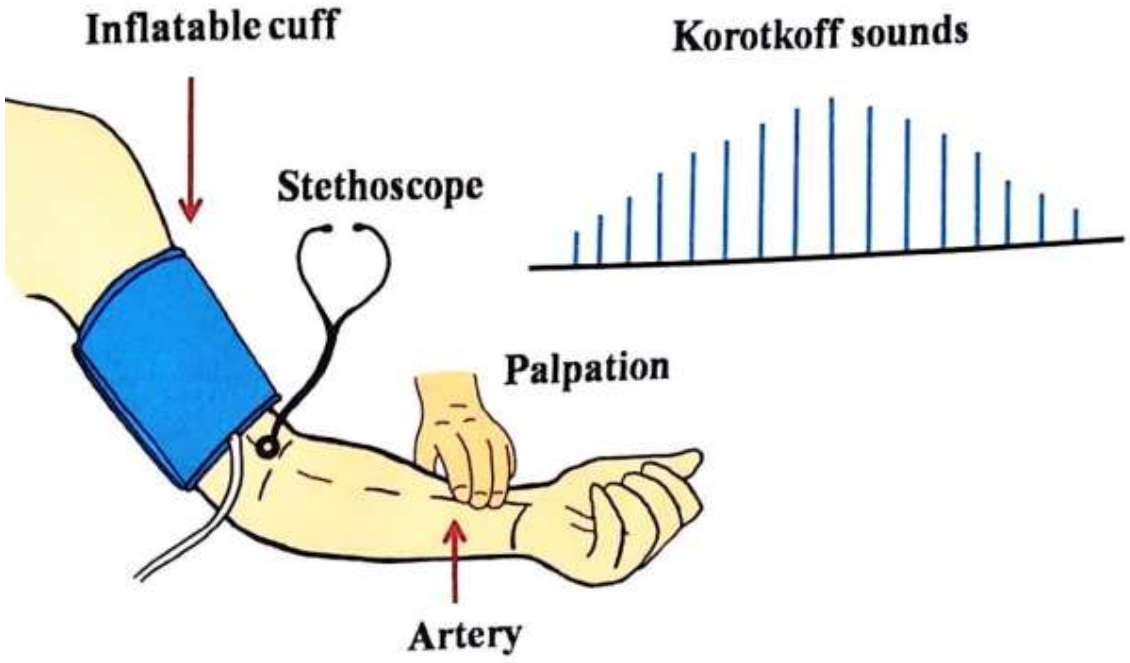
(8.2.4)Early diastolic murmur (06 marks)

(9)Part of CVS examination



(9.1) What is being tested in this examination? (03 marks)
(9.2) List three steps to follow during this examination. (03 marks)
(9.3) Name two conditions in which a high reading is obtained. (04 marks)

(10)Blood pressure measurement



(10.1) Name the instrument used to measure arterial blood pressure. (03 marks)
(10.2) List three important steps that should be followed to obtain an accurate blood pressure measurement. (03 marks)
(10.3) Name the Korotkoff sound that corresponds:
(10.3.1)Systolic blood pressure (04 marks)
(10.3.2)Diastolic blood pressure (04 marks)

CAT-1 (BATCH 3) OSPE ANSWERS

(1)

Fasting blood glucose levels (mg/dL) of eight (08) students were measured during a practical physiology class.

The values obtained were:

68, 72, 70, 72, 76, 72, 68, 80

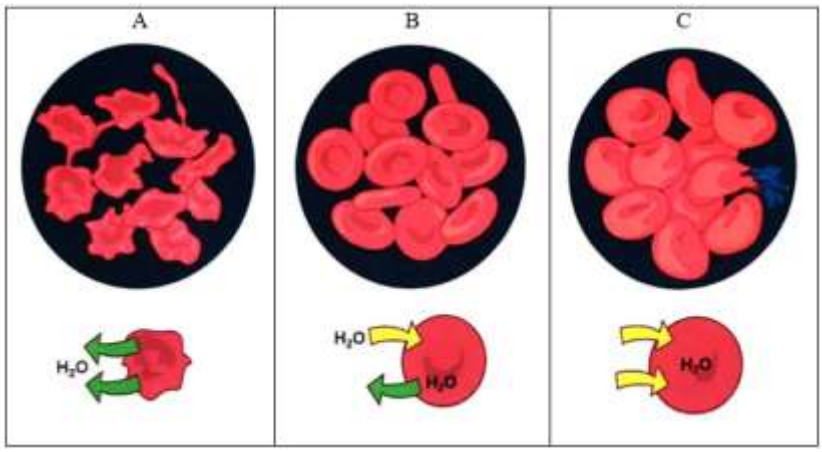
(1.1) Mode 72 (4 marks)

(1.2) Range maximum-minimum value 80-68=12 (3 marks)

(1.3) Standard deviation is preferred because it uses all data values, whereas range depends only on the maximum and minimum values. (3 marks)

Range is greatly affected by extreme values

(2)



(2.1) A Hypertonic B Isotonic C hypotonic (1x3= 3 marks)

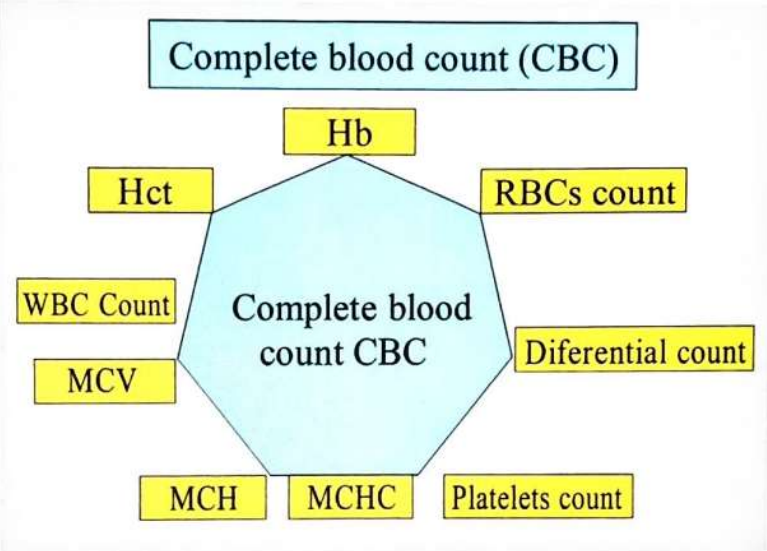
(2.2) A 3% saline /3% sodium chloride solution

B 0.9% (normal saline)

C 0.45% sodium chloride solution/ Distilled water (1x3 =3 marks)

(2.3) Osmosis (movement of water across a semi-permeable membrane from low solute concentration to high solute concentration) (4 marks)

(3)



(3.1) Directly measured parameters (1.5x2=3marks)
Any two:
Hemoglobin (Hb)/Red blood cell (RBC) count/Hematocrit (Hct)/Platelet count
Differential white blood cell count

(3.2) Calculated parameters (1.5x2=3marks)
Any two:
Mean corpuscular volume (MCV)/Mean corpuscular hemoglobin (MCH)
Mean corpuscular hemoglobin concentration (MCHC)

(3.3) Clinical condition with increased hematocrit
Any two:
Polycythemia vera/Dehydration/Chronic hypoxia/Living at high altitude (2x2=4 marks)

(4)

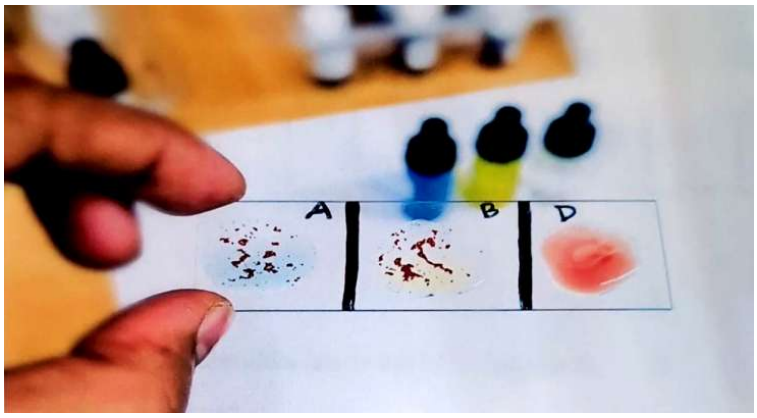


(4.1) Sickle cells and Target cells (2x2=4 marks)

(4.2) Sickle cell disease/Sickle cell anaemia (2x2=4 marks)

(4.3) Any one: Vaso-occlusive crisis/Stroke/Splenic infarction/Acute chest syndrome/Severe anaemia (2 marks)

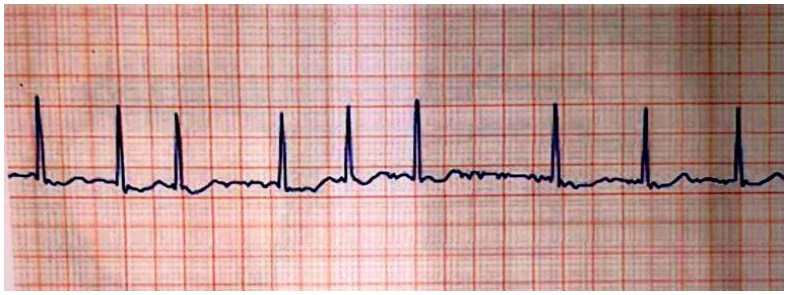
(5)



(5.1) AB negative (AB−) (6marks)

(5.2) 5.2 compatible donor groups include:
O--/ A−/B−/AB− (2x2=4marks)

(6)



(6.1) Any two:
Absence of distinct P waves
Irregularly irregular R–R intervals
Presence of fibrillatory (f) waves
Variable ventricular rate (2x2=4marks)

(6.2) Atrial fibrillation (3 marks)

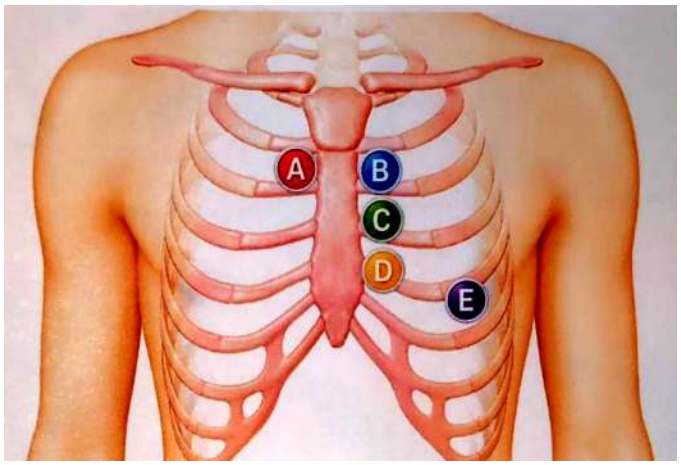
(6.3) Any one:
Irregularly irregular pulse
Pulse deficit (3 marks)

(7)



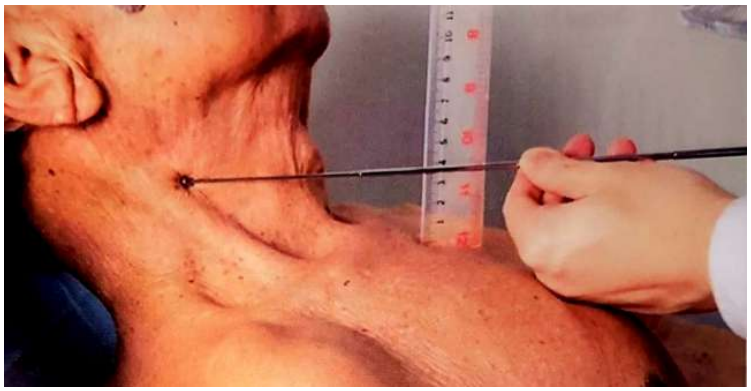
(7.1) Pallor (especially palmar pallor and pallor of the tongue) (3 marks)
(7.2) Hypochromic/microcytic RBCs/anisocytosis/poikilocytosis/target cells (2x2=4marks)
(7.3) Serum ferritin (3 marks)

(8)



(8.1) B Pulmonary C Erbs point D Tricuspid E Mitral (1x4=4 marks)
(8.2)
(8.2.1) A/B
(8.2.2) E
(8.2.3) D/E
(8.2.4) C (1.5x4 = 6 marks)

(9)



(9.1) Jugular Venous Pressure (JVP). (3 marks)

(9.2) Position the patient reclining at about 45°. (3 marks)

Turn the patient's head slightly to the opposite side and inspect the neck. head to be supported

Measure the vertical height of the jugular venous pulsation from the sternal angle.

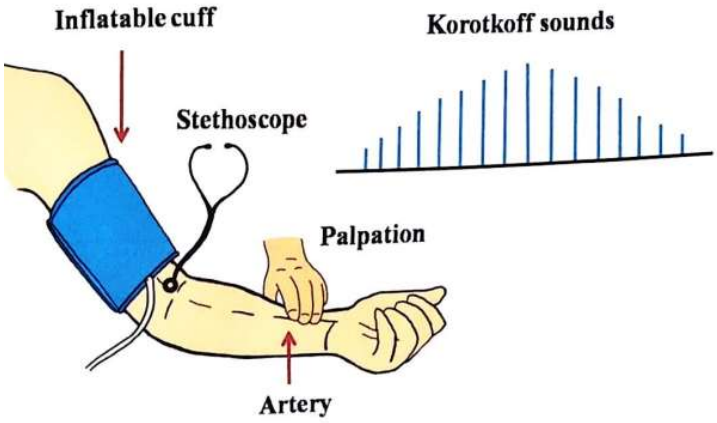
(9.3) Two conditions in which JVP is elevated:

Right-sided heart failure

Cardiac tamponade

Fluid overload (2x2 = 4 marks)

(10)



(10.1) 1Sphygmomanometer (3 marks)

(10.2) Any three of the following: (1x3=3 marks)

Patients should rest for at least 5 minutes before measurement.
Arm should be supported at heart level.
Appropriate cuff size should be used.
Patients should not talk during the procedure.
Legs should not be crossed.
Cuff should be applied on a bare arm.
Patients should be seated comfortably.

(10.3)

(10.3.1) Appearance of first Korotkoff sound (Phase I) – systolic pressure. (2 mark)

(10.3.2) Disappearance of Korotkoff sounds (Phase V) – diastolic pressure. (2 mark)



MESSAGE OF THE DEAN

As the Dean of the Uva Wellassa Medical Faculty, I am delighted to present "Mastering Physiology – Semester 1 – Book – II (2026): A Comprehensive Guide to MCQs, Essays, and OSPEs." This publication represents a significant achievement in our ongoing commitment to enhancing the quality of medical education and supporting student learning.

In the ever-evolving discipline of medicine, a thorough knowledge of Physiology continues to be a cornerstone of academic and professional success. This guide has been thoughtfully designed to serve as a comprehensive learning resource, covering a wide range of assessment formats, including MCQs, essays, and OSPEs, while providing detailed explanations and model answers to reinforce understanding.

The primary aim of this book is to equip students with the knowledge and skills necessary to excel in examinations and deepen their comprehension of physiological principles. We believe that this guide will become a trusted companion throughout your academic journey, helping to build confidence, improve clarity, and establish a strong foundation for learning.

I extend my heartfelt gratitude to the faculty members and contributors whose dedication, expertise, and hard work made this publication possible. It is our sincere hope that you will find this guide both informative and inspiring as you advance through your medical studies.

I wish you every success in your academic endeavors and in your future career as a medical professional.

Sincerely,
Senior Professor Muditha Vidanapathirana,
MBBS (Col), DLM, MD, MA (SJP), FFFLM (UK)
Dean,
Faculty of Medicine,
Uva Wellassa University of Sri Lanka

Rs. 1500/-

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