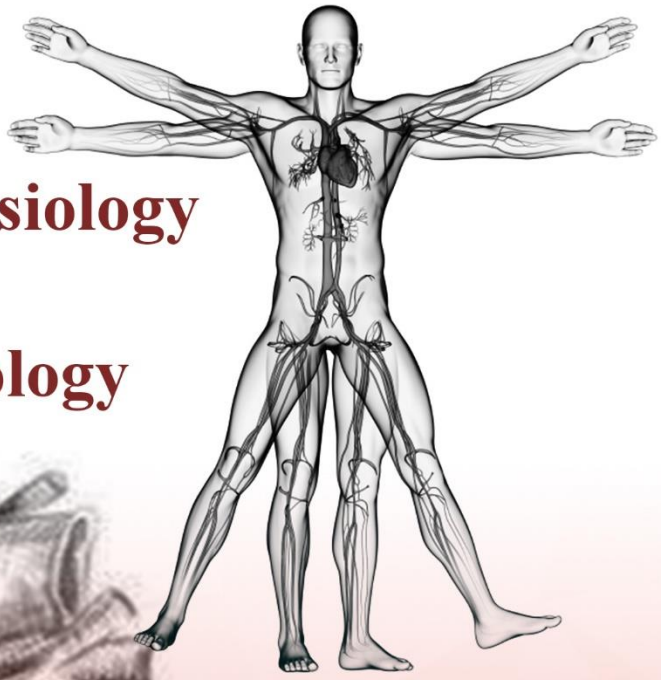
MASTERING PHYSIOLOGY
A Comprehensive Guide to MCQs, Essays, and OSPEs



- Body fluids
- Nerve and muscle physiology
- Blood and immunity
- Cardiovascular physiology

Published by,
Department of Physiology
Faculty of Medicine
Uva Wellassa University

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- **Body fluids, nerve, and muscle physiology**
- **Blood and immunity**
- **Cardiovascular physiology**

Authored by:

Department of Physiology

Faculty of Medicine

Uva Wellassa University

Mastering Physiology

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Contributors to Excellence

A concept of:
Founder Dean, Snr. Prof. Muditha Vidanapathirana

Authors:

Dr. Bandusiri Rathnayake

Consultant Physician, Senior Lecturer (Grade I)
MBBS (Ruhuna), MD (Medicine), FCCP (SL), FACP (USA)

Dr. Dhammika Halahakoon

Consultant Neurologist, Senior Lecturer (Grade I)
MBBS, MD Medicine (Col), MRCP-UK, FRCP-London

Dr. K.P. Anuththara Sewwandi

Lecturer (Probationary),
MBBS University of Peradeniya

Dr. P.A. Tashini T. Nandasena

Temporary Demonstrator, Department of Physiology

Snr. Prof. Muditha Vidanapathirana

Head of the Department of Forensic Medicine

Edited and compiled by

Dr. R. M. Kalma G. Rathnayake, Temporary Demonstrator, Department of Biochemistry

Cover design by

Dr. R. M. Kalma G. Rathnayake, Temporary Demonstrator, Department of Biochemistry

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Message from the Vice Chancellor

Dear Students,

It is with great pleasure that I extend my heartfelt congratulations and sincere appreciation to the Faculty of Medicine, Uva Wellassa University of Sri Lanka including Senior Professor Muditha Vidanapathirana, the Founder Dean of the Faculty of Medicine, for this remarkable initiative of publishing “Mastering Physiology: A Comprehensive Guide to MCQs, Essays & OSPEs”.

This book is an invaluable resource, offering immense benefits not only to MBBS undergraduates of Uva Wellassa University but also to medical students across the country.

I encourage you to take full advantage of the excellent resources developed by the Faculty of Medicine to enhance your academic journey. Resources such as this guide can make your studies more effective, efficient, and rewarding.

Wishing you all the very best in your academic and professional pursuits.

Senior Professor Kolitha B. Wijesekara
B.Sc. (Hon.) (Peradeniya), M.Phil. (Peradeniya), Dr. Sc. Agr. (Gottingen, Germany), M.Biol.
Vice Chancellor
Uva Wellassa University
06.01.2025



Message from the Dean

As the Founder Dean of the Uva Wellassa Medical Faulty, it is with great pride and enthusiasm that I present to you “Mastering Physiology: A Comprehensive Guide to MCQs, Essays, and OSPEs.” This publication represents a significant milestone in our ongoing commitment to enhancing the educational experience for our students.

In the ever-evolving field of medicine, a thorough understanding of Physiology is foundational to your future success. This guide has been meticulously crafted to provide you with a comprehensive resource that not only covers a wide range of question formats MCQs, essays, and OSPEs but also offers detailed answers and explanations to reinforce your learning.

Our aim with this book is to equip you with the tools necessary to excel in your examinations and to deepen your grasp of anatomical concepts. We believe that this guide will serve as an invaluable asset in your academic journey, offering clarity, confidence, and a robust framework for your studies.

I extend my heartfelt gratitude to the faculty members and contributors who have dedicated their expertise and effort to make this resource possible. It is our hope that you will find this guide to be a source of support and inspiration as you navigate your medical education.

Wishing you every success in your studies and future medical career.

Sincerely,

Senior Professor Muditha Vidanapathirana,
Founder Dean,
Faculty of Medicine,
Uva Wellassa University

PHYSIOLOGY MCQ (T/F & SBA) QUESTIONS

1. **Body fluids, nerve, and muscle physiology**

2. **Blood and Immunity**

3. **Cardiovascular Physiology**

Body fluids, nerve, and muscle physiology

Question 01

Which would favor increased fluid filtration across the capillary wall?

A. Increase in capillary colloid osmotic pressure.
B. Increase in interstitial fluid hydrostatic pressure.
C. Increase capillary hydrostatic pressure.
D. Decrease capillary permeability.
E. Decrease in circulating blood volume.

Question 02

Which of the following is /are true regarding body fluid compartments in a healthy adult?

A. Half of the total body water is in ECF.
B. Nerve cell membrane is less permeable to K+ than Na+ during the resting stage.
C. Plasma proteins are the main buffers in ECC.
D. Phosphate is the main anion in ICF.
E. The plasma pH ranges from 7.35-7.45.

Question 03

A healthy hydrated adult patient was rapidly infused with a 5% dextrose solution. Which of the following are the changes in the body fluid?

A. Volume of ICF increases more than ECF.
B. Plasma glucose concentration is increased.
C. Increased levels of intravascular compartment than interstitial compartment.
D. Fall of his body fluid osmolarity.
E. Rise of urine output.

Question 04

Which of the following is /are true regarding cell active transport systems?

A. The substance is transported against a concentration gradient.
B. It allows the movement of Na+ from intracellular fluid to extracellular fluid.
C. It involves the use of ATP for the process.
D. H, K ATPase transport system used in the renal tubules.
E. It allows to transport of two substances simultaneously.

Question 05

Which of the following is/are true regarding diffusion across the cell membrane?

A. O2 and CO2 in alveoli are transported by simple diffusion.
B. It transports substances from high to low concentrations.
C. GLUT transporter is an example of facilitated diffusion.
D. Facilitated diffusion utilizes energy for substance transportation.
E. Transported molecules do not dissolve in the phospholipid bilayer.

Question 06

Which of the following is/are the true statements regarding resting membrane potential?

A. Inside of the cell membrane is negatively charged compared to the outside of the cell.
B. K+ leak channels are the most important factor in determining the Resting membrane potential of a cell.
C. Non-excitable tissues do not have negative resting membrane potential.
D. Permeability to Na+ is greater than K+ in a non-stimulated state.
E. RMP of a cell is close to the equilibrium potential of K+.

Question 07

Regarding the action potential of a neuron,

A. Depolarization is caused by the opening of ligand-gated Na+ channels.
B. Hyperpolarization is caused by the slow closure of voltage-gated K+ channels.
C. Hypokalaemia may lead to delayed ventricular repolarization which can contribute to cardiac arrhythmias.
D. Repolarization is caused by the K+ leaky channels.
E. The amplitude of the stimulus causes increasing of the action potential.

Question 08

Which of the following is/are true regarding the arrival of a nerve impulse at the motor end plate in the neuromuscular junction?

A. Acetylcholine binds to nicotinic cholinergic receptors in the motor end plate.
B. Acetylcholinesterase is present in high concentration at the neuromuscular junction.
C. Generation of an excitatory postsynaptic potential.
D. Neurotransmitters are released by exocytosis.
E. Opening of voltage-gated Ca2+ channels in the presynaptic membrane.

Question 09

Which of the following is/ are true regarding a patient with myasthenia gravis?

A. He has antibodies that destroy nicotinic acetylcholine receptors.
B. His muscle weakness becomes worse with repeated activity.
C. Neostigmine increases the number of nicotinic receptors in the neuromuscular junction.
D. Immunosuppressive drugs can be used to treat this patient.
E. This patient has the tendency to develop rheumatoid arthritis.

Question 10

Which of the following is/are true regarding the sarcomere of skeletal muscle?

A. T tubules enter at the A-I junctions.
B. It is the contractile unit between two Z lines.
C. I band contains thick and thin filaments.
D. In A band each myosin filament is surrounded by six actin filaments.
E. Thick and thin filaments lie parallel to the long axis of myofibrils.

Question 11

A 10-year-old boy lifts a stone off the ground using his hand. Which of the is /are true regarding mechanisms that occur during the contraction of his biceps muscle?

A. ADP released from myosin head.
B. Hydrolysis of ATP and release of inorganic phosphate.
C. Influx of Ca2+ into the muscle from the extracellular matrix.
D. Influx of Na+ ions to the motor end plate.
E. Release of acetylcholine following neural stimulation.

Question 12

Which of the following is/are true regarding smooth muscle?

A. Calcium calmodulin complex causes muscle contraction.
B. Dense bodies in the cytoplasm are bound by α-actinin to actin filaments.
C. Muscle fibers are made up of myofibrils that are arranged parallel to fiber.
D. NO is important in smooth muscle relaxation.
E. Unitary smooth muscle has connections between individual muscle cells.

Question 13

Which of the following is/are true regarding features of a multi-unit smooth muscle?

A. Each muscle fiber has its nerve supply.
B. Fine, graded contractions occur in multi-unit smooth muscle.
C. It functions as a syncytium.
D. It is found in the iris of the eye.
E. The contractions are under voluntary control.

Question 14

Which statements are true regarding homeostasis?

A. Highest excretion of the body water is from urine.
B. The main nitrogen excretion of the body is from the kidney.
C. Metabolic alkalosis is seen in prolonged vomiting.
D. Normal urea excretion in a healthy adult person is 25mg/day.
E. pH of body fluids decreases in patients with chronic kidney disease.

Question 15

Which of the following is/are true regarding acid-base balance?

A. High $PaCO_2$ indicates respiratory acidosis.
B. Increase plasma HCO_3 concentration indicate metabolic acidosis.
C. Metabolic acidosis is a result of diabetic ketoacidosis.
D. Metabolic alkalosis is caused by Conn's syndrome.
E. Respiratory alkalosis is compensated by the kidney.

Question 16

Which of the following is/are true regarding the autonomic nervous system?

A. It consists of the sympathetic and parasympathetic nervous system
B. Sympathetic neurons originate from the thoracic and lumbar segments of the spinal cord.
C. The nerve impulse conduction is slow.
D. The S2-S4 spinal cord contributes to the formation of parasympathetic neurons
E. The parasympathetic post-ganglionic fibers are longer than preganglionic fibers.

Question 17

Which of the following is /are true regarding the parasympathetic nervous system?

A. Acetylcholine is a neurotransmitter for all preganglionic fibers in the parasympathetic nervous system.
B. Bronchoconstriction is an effect of the parasympathetic nervous system.
C. Cranial outflow is involved with 3, 7,9,10 cranial nerves.
D. Lacrimal gland receives its secretomotor fibers from the ciliary ganglion.
E. Secretomotor fibers for the parotid gland pass through the otic ganglion.

Blood and Immunity

Question 18

Which of the following is/are true regarding the red blood cell?

A. The life span of RBC is 120 days.
B. Antigens are present in the red cell membrane.
C. They can alter their shape.
D. In iron deficiency, cells are hypochromic microcytic.
E. Foetal Hb has 2α and 2β chains.

Question 19

Which of the following is/are true regarding platelets?

A. Deficiency results in prolonged bleeding time.
B. They have multiple nuclei.
C. They have a 120-day lifespan.
D. They are destroyed in the spleen.
E. Thromboxane A2 stimulates their aggregation.

Question 20

A 22-year-old male presented with a cut injury on the index finger. Which of the following can be seen in him after the injury?

A. constriction of the artery is involved.
B. Factor VIII activates prothrombin.
C. Activation of the extrinsic pathway.
D. Release of tissue thromboplastin.
E. Fibrin mesh is stabilized by factor XIIIa and Ca2+.

Question 21

Which of the following are true regarding clotting factor II

A. It is synthesized in the liver.
B. It is the precursor of thrombin.
C. It is activated by factor Xa.
D. In deficiency causes prolonged APTT.
E. Levels decrease in Vitamin K deficiency.

Question 22

What is true about tissue plasminogen activator (tPA)

A. It is a fibrinolytic agent.
B. Inhibitor of tissue plasminogen activator is activated by activated protein C.
C. It inactivates activated clotting factor VIII
D. It converts plasminogen to plasmin.
E. It is a treatment for acute myocardial infarctions

Question 23

Which of the following is /are true regarding anemia?

A. Reticulocyte count increases due to hemolytic anemia.
B. Invading malignant cells in bone marrow causes anemia.
C. MCV is elevated in Iron deficiency anemia.
D. Iron deficiency anemia is a feature of a patient in 2 years after total gastrectomy.
E. Hypochromic microcytic anemia is caused by beta-thalassemia.

Question 24

Which of the following results in extravascular hemolysis?

A. Autoimmune hemolytic anemia.
B. Glucose-6-phosphate (G6PD) enzyme deficiency.
C. Hereditary spherocytosis.
D. Sickle cell disease.
E. Thalassemia

Question 25

A man is blood group B+ and his son is blood group O-. Which of the following is/are true or false regarding the father's blood group?

A. He has an anti-A antibody in his serum.
B. He has an anti-D antibody in his serum.
C. He can be transfused with O- blood in an emergency.
D. His blood can be transfused to his son.
E. blood group genotype is BODd likely in him.

Question 26

Which of the following is /are true regarding the Rh group system in blood?

A. Found in most cells in the body.
B. Consists of C, D, and E antigens.
C. Antigen D is the most antigenic in the Rh grouping system.
D. They are not glycosylated proteins.
E. Rh incompatibility arises when a Rh-negative mother carries a Rh-positive fetus.

Question 27

Which of the following cells participate in the innate immunity?

A. B cell
B. Eosinophil
C. Macrophages.
D. Neutrophils
E. NK cells.

Question 28

Which of the following is/ are true regarding cells involved in innate immune response?

A. Cells response to special antigens
B. Dendritic cells act as a bridge between innate and adaptive immunity response
C. NK cells kill microorganisms by activating macrophages.
D. Secrete antibodies
E. Secrete cytokines

Question 29

Which of the following is/ are true regarding functions of the complement system?

A. Lysis of bacteria
B. Trigger inflammation
C. Opsonization
D. Antibody dependent cell mediated cytotoxicity
E. Clearance of immune complex

Question 30

Which of the following is/are true regarding cytokines in regulating immune response?

A. They are secreted by lymphocytes and macrophages.
B. Interferons are involved in activating PMNs and macrophages for enhanced Killing.
C. IL–1, TNF alfa, and IL-6 are pro Inflammatory cytokines.
D. IL-12 activates NK cells to produce interferon-gamma.
E. IL-11 stimulates the production of acute-phase proteins.

Question 31

Which of the following is/are true regarding antibodies?

A. IgM can cross the placenta.
B. IgA promotes mucosal immunity.
C. IgE is involved in parasitic infection.
D. IgD recognizes B cell receptors.
E. IgG is involved in primary immune responses.

Question 32

Which of the following is /are true regarding immunoglobulin?

A. Antigen binding to variable regions of both heavy chains and light chains of immunoglobulin
B. Both light and heavy chains are the product of multiple genes
C. Fc region is the same for members of the same class
D. Hinge region provides flexibility
E. Heavy chain determines the immunoglobulin class

Question 33

Which of the is /are true regarding the complement system?

A. The classical pathway is activated by antigen antibody complexes.
B. Conversion of C 3 to C 3b is the most important reaction.
C. C3 convertase is different in pathways.
D. MAC belongs to the terminal pathway
E. Bacterial cell wall components are initiation components of alternative pathways.

Cardiovascular Physiology

Question 34

Which of the following are correctly paired regarding the action potential of a ventricular myocardium?

A. Phase 0 – opening of Na+ channels.
B. Phase 1 – Closure of Na+ channels.
C. Phase 2 – transient opening of Ca2+ channels.
D. Phase 3 - Closure of Ca2+ channels.
E. Phase 4 – resting membrane potential.

Question 35

Which of the following are the differences between left ventricular myocardium and SA nodal action potential?

A. Upstroke is due to sodium ion Influx
B. Presence of a plateau
C. Presence of a pre-potential
D. Repolarization is due to potassium ion influx
E. Activation of the 'h' channel

Question 36

Which of the following is/are true regarding the action potential of the SA node?

A. The action potential is due to Ca 2+ influx.
B. The 'f' channel is activated following hyperpolarization.
C. Opening of Transient Ca 2+ channel complete pre-potential.
D. The rate of discharge of the SA node and other nodal tissue is influenced by temperature and drugs
E. In vagal stimulation the slope of the pre-potential is decreased.

Question 37

Which of the following is /are true regarding events during isovolumetric contraction of the cardiac cycle?

A. All valves are in closed position.
B. Ventricles contract without volume change.
C. The ventricle pressure sharply increases above the pressure in great arteries.
D. The v wave of the JVP is seen.
E. A pan systolic murmur is heard in patients with mitral valve papillary muscles rupture.

Question 38

Which of the following is /are true regarding the cardiac cycle?

A. Diastole is longer than systole.
B. In jugular venous pressure "a" wave occurs in atrial systole.
C. The rate of emptying of the left ventricle is uniform throughout the ejection phase of the ventricular systole.

D. Most of the ventricular filling occurs during diastole.
E. Right ventricular ejection occurs before the left ventricular ejection.

Question 39

Which of the following is/ are true regarding the heart sound?

A. The first heart sound occurs due to the closure of the atria ventricular valves
B. The first heart sound is louder than the second.
C. Third heart sound is normal in many young individuals.
D. Fourth heart sounds can be heard in ventricular hypertrophy.
E. Wide splitting of the second heart sound is a likely finding in atrial spectrum defects

Question 40

Which of the following is/ are correctly paired regarding murmurs?

A. Aortic stenosis – Ejection systolic murmur
B. Mitral regurgitation – Pansystolic murmur
C. Aortic regurgitation – Mid diastole murmur
D. Ventricular septal detect – Pan systolic murmur
E. Patent ductus arteriosus – Continuous machinery murmur

PHYSIOLOGY MCQ (T/F & SBA) ANSWERS

Question 01

The correct answer is C

The question is regarding starling's forces which regulate fluid movement into and out of the capillaries. Hydrostatic and oncotic pressures within the capillary and tissue interstitium determine the net driving force for fluid movement into the capillary (reabsorption) or out of the capillary (filtration).

Increases in capillary oncotic pressure and interstitial hydrostatic pressure lead to fluid absorption across the wall.

Decreasing capillary permeability and circulating blood volume leads to reduced fluid filtration

When capillary hydrostatic pressure is high, the pressure gradient increases causing fluid filtration

Question 02

A. False

Extracellular fluid is the fluid found outside of cells. Intra-cellular fluid is the fluid within cells. ICF is about 28L (2/3 of total body water). ECF 14L (1/3 of total body water) when total volume is 42L.

B. This statement is incomplete due to a typing error. Sorry for the inconvenience.

C. False

Buffers are weak acids or bases that can minimize changes in pH by taking up or releasing H+. The major extracellular buffering system is HCO3-/H2CO3.

D. True

Phosphate is the main anion and K+ is the main cation in intracellular fluid.

Na+ is the main cation and Cl- is the main anion in extracellular fluids.

E. True.

When pH is below 7.35 plasma becomes acidosis when above 7.45 it becomes alkalosis.

Question 03

A. True

5% dextrose in water is a hypotonic solution. fluid osmolarity is reduced after adding this solution

B. True

C. True

5% dextrose in water treats hypoglycemia (low blood sugar) and dehydration.

D. True

Excess fluid is excreted through the kidneys. So urine output is increased.

E. True

As this is a hypotonic solution more fluid enter into the cells causing cell swelling.

Hypertonic solution

With the administration of hypertonic solution into the body fluids, osmolarity is increased. Then intracellular fluid comes out from the cells resulting in increasing extracellular fluid.

Isotonic solution

There are no changes in osmolarity and only extracellular fluid is increased.

Question 04

A. True

In both gastric mucosa and renal tubules.

B. False

Na, K ATPase is an example of active transport that catalyzes the hydrolysis of ATP to adenosine diphosphate (ADP) and uses the energy to extrude three Na+ from the cell and take K+ into the cell for each molecule of ATP hydrolyzed.

C. True

In Na, K ATPase is an electrogenic pump in that it moves three positive charges out of the cells for each two that moves in.

D. True

E. True

In an active transport system, it transports substances against their electrical and chemical gradients which require energy.

Question 05

A. False

Molecules travel across the membrane in the direction determined by their concentration gradient and an external source of energy is not used.

B. True
Glucose is transported by the glucose transporter, which moves glucose down its concentration gradient from the ECF to the cytoplasm of the cell.

C. True
Molecules move from areas of high concentration to areas of low concentration (down their chemical gradient) and cations move to negatively charged areas whereas anions move to positively charged areas (down their electrical gradient.) In facilitated diffusion, carrier proteins move substances in the direction of an electrochemical gradient.

D. True
Small, nonpolar molecules (O2, N2) and small uncharged polar molecules such as CO2 diffuse across the lipid membranes of cells. These molecules simply dissolve in the phospholipid bilayer, diffuse across it, and dissolve in the cytoplasm in simple diffusion.

E. True
In facilitated diffusion, transported molecules do not dissolve in the phospholipid bilayer. Instead, their passage is mediated by proteins that enable the transported molecules to cross the membrane without directly interacting with its hydrophobic interior.

Question 06

A. True
A potential difference that exists across all cell membranes is called Resting Membrane Potential (RMP). The inside is negative concerning the outside of the cell.

B. True
One of the main factors is K+ efflux which causes the negativity inside the cell membrane which determines the RMP. K+ efflux through leak channels and there are more K+ leak channels than Na+ leak channels.

C. False
Non-excitable tissues such as red blood cells, intestinal cells, fibroblasts and adipocytes have less negative RMP.

D. False
There are more K+ leak channels than Na+ leak channels. K+ permeability is 20 times more than that of Na+

E. True
Consequently, the intracellular and extracellular K + concentrations are the prime determinants of the resting membrane potential, which is therefore close to the equilibrium potential for K +

Question 07

A. False
When the threshold level is reached, voltage-gated Na+ channels open up. Since Na concentration outside is more than the inside, Na influx will occur. Positive ion coming inside increases the positivity of the membrane potential and causes depolarization.

B. True
After reaching the resting stage of the action potential, still, slow K+ channels may remain open causing further hyperpolarization.

C. True
If the extracellular level of K+ is decreased (Hypokalaemia), the membrane potential is reduced and the neuron is hyperpolarized. This may lead to delayed ventricular repolarisation which can contribute to cardiac arrhythmias.
If the extracellular level of K+ is increased (hyperkalemia), the resting potential moves closer to the threshold for eliciting an action potential, thus the neuron becomes more excitable. This

may inactivate Na+ channels, which increases the refractory period and may lead to cardiac arrhythmias.

D. False
When the action potential reaches +30mv, Na+ channels close and Voltage-gated K+ channels open up. K+ efflux occurs. Positive ion leaving the inside causes more negativity inside the membrane. Repolarisation occurs.

E. False
Once threshold intensity is reached, a full-fledged action potential is produced. Further increases in the intensity of a stimulus produce no increment or other change in the action potential as long as the other experimental conditions remain constant.

Question 08

A. True
The acetylcholine diffuses to nicotinic cholinergic receptors that are concentrated at the tops of the junctional folds of the membrane of the motor end plate.

B. True
Acetylcholine is then removed from the synaptic cleft by acetylcholinesterase, which is present in high concentration at the neuromuscular junction.

C. True
The binding of acetylcholine to receptors increases the Na + and K + conductance, and the resultant influx of Na+ produces a depolarizing potential, the end plate potential.

D. True
The impulse arriving at the end of the motor neuron opens voltage-gated Ca channels. Ca+2 enters and triggers a marked increase in exocytosis of the acetylcholine-containing synaptic vesicles.

E. True

REFERENCE –
Lecture note - Neurotransmitters and neuromuscular junction
Ganong's physiology- synaptic and junctional transmission – Neuromuscular transmission.

Question 09

A. True
Myasthenia Gravis is caused by the formation of circulating antibodies to the muscle type of nicotinic cholinergic receptors. These antibodies destroy some of the receptors and bind others to neighbouring receptors, triggering their removal by endocytosis.

B. True
There is a characteristic pattern of progressively reduced muscle strength with repeated use of the muscle and recovery of muscle strength following a period of rest. Also present with ptosis, fatiguability, speech difficulty, and respiratory difficulty.

C. False
Muscle weakness due to myasthenia gravis improves after a period of rest or after administration of an acetylcholinesterase inhibitor such as neostigmine or pyridostigmine. Cholinesterase inhibitors prevent the metabolism of acetylcholine and can thus compensate for the normal decline in released neurotransmitters during repeated stimulation.

D. True
Immunosuppressive drugs (prednisone, azathioprine, or cyclosporine) can suppress antibody production and have been shown to improve muscle strength in some patients with myasthenia gravis. Thymectomy is indicated especially if a thymoma is suspected in the development of myasthenia gravis.

E. True
Patients with myasthenia gravis have a greater than normal tendency to have rheumatoid arthritis, systemic lupus erythematosus, and polymyositis.

REFERENCES
Lecture note- Nerve conduction Neurotransmitters and neuromuscular junction Ganong's Physiology -synaptic and junctional transmission - neuromuscular transmission – clinical box 6.2

Question 10

A. True
The muscle fibers are responsible for the characteristic cross-striations seen in skeletal muscle when viewed under the microscope. The parts of the cross-striations are frequently identified by letters. The light I band which contains actin filaments is divided by the dark Z line, and the dark A band which contains both actin and myosin filaments, has the lighter H band in its center. The transverse M line is seen in the middle of the H band which contains myosin filaments. The area between two adjacent Z lines is called a sarcomere.

B. False
A band - both actin and myosin filaments.
I band - actin filaments
H band - myosin filaments.

C. True
If a transverse section through the A band is examined under the electron microscope, each thick filament (Myosin) is seen to be surrounded by six thin filaments (Actin) in a regular hexagonal pattern.

D. True

E. True
The muscle fibrils are surrounded by structures made up of membranes. These structures form the sarcotubular system, which is made up of a T system and a sarcoplasmic reticulum. The T system of transverse tubules, which is continuous with the sarcolemma of the muscle fiber,

forms a grid perforated by the individual muscle fibrils. The sarcoplasmic reticulum, which forms an irregular curtain around each of the fibrils, has enlarged terminal cisterns in close contact with the T system at the junctions between the A and I bands. The T system provides a path for the rapid transmission of the action potential from the cell membrane to all the fibrils in the muscle.

REFERENCES

Lecture note - muscle physiology.

Ganong's physiology – Excitable tissue- Muscle

Question 11

A. True
At rest, the myosin head contains tightly bound ADP (cocked position). Following an action potential, cytosolic Ca 2+ is increased and free Ca 2+ binds to troponin C. This binding results in a weakening of the troponin I interaction with actin and exposes the actin-binding site for myosin to allow for the formation of myosin/actin cross-bridges. Then ADP is released from the myosin head causing a conformational change in the myosin head that moves the thin filament relative to the thick filament comprising the cross-bridge "power stroke." ATP quickly binds to the free site on the myosin, which leads to a detachment of the myosin head from the thin filament. ATP is hydrolyzed and inorganic phosphate is released, causing a "re-cocking" of the myosin head and completing the cycle. As long as Ca 2+ remains elevated and sufficient ATP is available, this cycle repeats.

B. True

C. False
When action potential is transmitted to all the fibrils in the fiber via the T system. It triggers the release of Ca 2+ from the terminal cisterns of the sarcoplasmic reticulum next to the T system. Ca+2 binds to troponin C and initiates contraction.

D. True
Nerve Impulse comes through the motor neuron and release of neurotransmitter, acetylcholine, and binds to receptors in the postsynaptic membrane. The action potential is generated in the Muscle fiber due to the influx of (Na+).

E. True

Question 12

A. True
Ca 2+ plays a prominent role in the initiation of contraction of smooth muscle. Ca 2+ increase can be due to influx through voltage- or ligand-gated plasma membrane channels. Myosin in smooth muscle must be phosphorylated for activation of the myosin ATPase. In smooth muscle, Ca 2+

Binds to calmodulin, and the resulting complex activates calmodulin-dependent myosin light chain kinase. This enzyme catalyzes the phosphorylation of the myosin light chain on serine at position 19, increasing its ATPase activity.

B. True
Actin and myosin-II are not arranged in regular arrays, as in skeletal and cardiac muscle, and so the striations are absent. Instead of Z lines, there are dense bodies in the cytoplasm and attached to the cell membrane, and these are bound by α-actinin to actin filaments.

C. False
Smooth muscle is distinguished anatomically from skeletal and cardiac muscle because it lacks visible cross-striations. Actin and myosin-II are present, and they slide on each other to produce contraction. However, they are not arranged in regular arrays.

D. True
Relaxation of smooth muscle is by dephosphorylation of myosin light chain by myosin light chain phosphatase. Dissociation of Ca±2- calmodulin complex leads to muscle relaxation. In blood vessels, NO produced in endothelial cells is free to diffuse into the smooth muscle for its effects. Once in muscle, NO directly activates a soluble guanylate cyclase to produce another second messenger molecule, cyclic guanosine monophosphate (cGMP). cGMP stimulates protein kinases which stimulate Myosin light chain phosphatases leading to muscle relaxation.

E. True
Unitary smooth muscle occurs in large sheets, has many low-resistance gap junctional connections between individual muscle cells, and functions in a syncytial fashion. Unitary smooth muscle is found primarily in the walls of hollow viscera. The musculature of the intestine, the uterus, and the ureters are examples.

REFERENCES
Lecture note - muscle physiology.
Ganong's physiology – Excitable tissue- Muscle- smooth muscle morphology.

Question 13

A. True
In general, smooth muscle can be divided into unitary (or visceral) smooth muscle and multiunit smooth muscle. Multiunit smooth muscle is made up of individual units with few (or no) gap junctional bridges. Each fiber has its own nerve supply.

B. True
Multi-unit smooth muscle is found in structures such as the iris of the eye, in which fine, graded contractions occur. It is not under voluntary control.

C. False
Unitary smooth muscle occurs in large sheets, has many low-resistance gap junctional connections between individual muscle cells, and functions in a syncytial fashion.

D. True
E. False

Question 14

A. True
The kidneys are the major site of regulated excretion of water.

B. True

Urea is the major nitrogenous waste product, making up some 80% of it. Urea is formed in the liver and is excreted by the kidneys in the urine along with the other types of protein waste products.

C. True
Metabolic alkalosis is defined as an elevation of the body's pH above 7.45. Metabolic alkalosis involves a primary increase in serum bicarbonate (HCO3-) concentration, due to a loss of H+ from the body or a gain in HCO3-. The most common causes of metabolic alkalosis are the use of diuretics and the external loss of gastric secretions.

D. True

E. True
In chronic kidney disease, the pH of body fluids decreases due to the inability to excrete metabolic acids due to renal impairment causing metabolic acidosis.

Question 15

A. True
High PaCO2 indicates respiratory acidosis caused by impaired gas exchange (obstructed bronchioles, reduced surface area for gas exchange)
Eg: COPD, Severe ARDS
Impaired ventilatory mechanics
Eg: damage to the respiratory center in the medulla and respiratory muscle paralysis.

B. False
Plasma bicarbonate concentration is reduced in metabolic acidosis.

C. True
Diabetic ketoacidosis (DKA) is an acute, major, life-threatening complication of diabetes characterized by hyperglycemia, ketoacidosis, and ketonuria. It occurs when absolute or relative insulin deficiency inhibits the ability of glucose to enter cells for utilization, the result being that the liver rapidly breaks down fat into ketones to employ as energy. The overproduction of ketones accumulates in the blood and urine and turns the blood acidic.
Biochemically, DKA is defined as an increase in the serum concentration of ketones greater than 5 mEq/L, a blood sugar level greater than 250 mg/dL, and blood (usually arterial) pH less than 7.3.

D. True
Metabolic alkalosis is caused by hyperaldosteronism due to increased H+ resorption.

E. True
Metabolic compensation occurs by kidney excreting HCO3- in respiratory alkalosis.

REFERENCES
Lecture note - Hydrogen ion haemostasis.

Question 16

A. True
The nervous system can be divided into the central nervous system and the peripheral system. The central nervous system consists of the brain and spinal cord. The peripheral nervous system consists of the autonomic and somatic nervous system. The autonomic nervous system consists of the sympathetic and parasympathetic nervous system.

B. True
The sympathetic nervous system is also called the thoracolumbar system. All preganglionic sympathetic fibers arise from the lateral horn of the spinal cord and leave the spinal cord with the ventral roots of the spinal nerve.
Cell body located in grey matter from T1-L2. Post-ganglionic fibers pass to the effector organ.

C. True
The autonomic nervous system consists of a chain of two motor neurons; preganglionic neuron and postganglionic neuron. The impulse conduction is slower due to thin or un-myelinated axons and not under voluntary control.

D. True
Nerve supply to colon, bladder, and reproductive organs.

E. False
In the parasympathetic nervous system, preganglionic fibers are long and post-ganglionic fibers are short.

REFERENCES
Lecture note-Autonomic nervous system.

Question 17

A. True
Acetylcholine is a neurotransmitter for all preganglionic sympathetic fibers and parasympathetic fibers.

B. True
Parasympathetic effects are normally not activated as a whole; stimulation of separate parasympathetic nerves. Relaxing effects such as decreased heart rate, dilated visceral blood

vessels, increased digestive activity, bronchoconstriction, GI motility increases, relaxation of sphincters and etc.

C. True
The parasympathetic nervous system is sometimes called the craniosacral division of the ANS because of the location of its preganglionic neurons; preganglionic neurons are located in several cranial nerve nuclei (III-oculomotor, VII-facial, IX-glossopharyngeal, and X- vagus). The cell bodies in the Edinger-Westphal nucleus of the oculomotor nerve project to the ciliary ganglia to innervate the sphincter (constrictor) muscle of the iris and the ciliary muscle. Neurons in the superior salivatory nucleus of the facial nerve project to the sphenopalatine ganglia to innervate the lacrimal glands and nasal and palatine mucous membranes and to the submandibular ganglia to innervate the submandibular and submaxillary glands. The cell bodies in the inferior salivatory nucleus of the glossopharyngeal nerve project to the otic ganglion to innervate the parotid salivary gland. Vagal preganglionic fibers synapse on ganglia cells clustered within the walls of visceral organs.

D. False
E. True

REFERENCES

Lecture note-Autonomic nervous system

Ganong's physiology – chapter 13 – ANS

Question 18

A. True
The red blood cells (erythrocytes) carry hemoglobin in the circulation. They are biconcave disks (Figure 31–4) that are manufactured in the bone marrow. In mammals, they lose their nuclei before entering the circulation. In humans, they survive in the circulation for an average of 120 days. The average normal red blood cell count is 5.4 million/μL in men and 4.8 million/ μL in women. The number of red cells is also conveniently expressed as the hematocrit, or the percentage of the blood, by volume, that is occupied by erythrocytes. Each human red blood cell is about 7.5 μm in diameter and 2 μm thick, and each contains approximately 29 pg of hemoglobin.

B. True
The membranes of human red cells contain a variety of blood group antigens, which are also called agglutinogens. The most important and well-known are the A and B Antigens.

C. True
D. True
E. False

The blood of the human normally contains fetal hemoglobin (Hemoglobin F). Its structure is similar to that of hemoglobin A except that the β chains are replaced by γ chains; that is, hemoglobin F is α 2 α γ.

Question 19

A. True
In platelet deficiency, there is a defect in the formation of platelet plug. Therefore bleeding time is increased.

B. False
They are un-nucleated small cell particles.

C. False
Life span is 7-10 days.

D. True
The spleen and the liver are the organs where aged platelets are destroyed if they have not been used for hemostasis after 10 days of life.

E. True
Platelets secrete chemicals such as ADP and thromboxane A2 to stimulate platelet aggregation.

Question 20

A. True
In vessel injury, bleeding is prevented by vascular contraction and obliteration of the injured vessel.

B. False
Factor Xa activates prothrombin.

C. True
Extrinsic pathway is triggered by tissue trauma and release of tissue thromboplastin resulting in activation of factor VII.

D. True

E. True
Fibrinogen is converted to fibrin monomers by thrombin. Fibrin monomers are stabilized into fibrin fibers by factor XIIIa and Ca+2.

REFERENCES – Lecture note – clotting mechanisms.

Question 21

A. True

B. True
Thrombin is a serine protease that is formed from its circulating precursor, prothrombin (factor II) by the action of activated factor X.

C. True

D. True
Laboratory studies for factor II deficiency include coagulation studies and clotting factor assays. In coagulation studies, prothrombin time (PT) and activated partial thromboplastin time is prolonged.

E. True
Hypoprothrombinaemia (hemorrhagic tendency in liver disease) is caused by decreased hepatic synthesis, usually secondary to vitamin K deficiency.

Question 22

A. True

B. False
Activated protein C (APC), along with its cofactor protein S, inactivates factors V and VIII and inactivates an inhibitor of tissue plasminogen activator, increasing the formation of plasmin.

C. False
Activated protein C inactivates activated clotting factors VIII and V.

D. True
Plasmin is formed from its inactive precursor, plasminogen, by the action of thrombin and tissue-type plasminogen activator (tPA).

E. True
Human tissue plasminogen activator is also produced by recombinant DNA techniques. It is clinically used to lyse clots in coronary arteries in acute myocardial infarction.

Question 23

A. True
RBC production is increased in hemolytic anemia resulting in increasing reticulocyte count in circulation.

B. True
Invading malignant cells in bone marrow damages the stem cells and reduces the production of RBC, WBC, and platelets.

C. False
MCV is reduced in iron deficiency anemia. MCV is elevated folate deficiency and vitamin B12 deficiency.

D. True
Iron is absorbed in the duodenum and proximal jejunum and its absorption is enhanced by gastric acid secretion. Duodenal bypass contributes to iron deficiency in patients with gastrectomy.

E. True

REFERENCES
Lecture note - Hemoglobinopathies, anemia, and polycythemia.

Question24

A. True
Hemolysis is the premature destruction of erythrocytes. Hemolysis can be due to hereditary and acquired disorders. The etiology of premature erythrocyte destruction is diverse and can be due to conditions such as intrinsic membrane defects, abnormal hemoglobins, erythrocyte enzymatic defects, immune destruction of erythrocytes, mechanical injury, and hypersplenism. Hemolysis can occur intravascularly or extravascularly. Autoimmune hemolytic anemia and hereditary spherocytosis thalassemia and sickle cell disease are examples of extravascular hemolysis because the red blood cells are destroyed in the spleen and other reticuloendothelial tissues. Intravascular hemolysis involves cell destruction within blood vessels. Examples are,

- Prosthetic cardiac valves
- Glucose-6-phosphate dehydrogenase (G6PD) deficiency
- Thrombotic thrombocytopenic purpura
- Disseminated intravascular coagulation
- Transfusion of ABO-incompatible blood
- Paroxysmal nocturnal hemoglobinuria (PNH)
- COVID-19 [4, 5]
- Pyruvate kinase deficiency

B. False
C. True
D. True
E. False

Question 25

A. True
The A and B antigens are inherited as Mendelian dominants, and individuals are divided into four major blood types on this basis. Type A individuals have the A antigen, type B has the B, type AB has both, and type O has neither. Therefore type A individuals develop anti-B antibodies, type B individuals develop anti-A antibodies, type O individuals develop both, and type AB individuals develop neither.

B. False
Rh positive means that the individual has agglutinogen D and no anti-D antibodies in serum. Unlike the antibodies of the ABO system, anti-D antibodies do not develop without exposure of a D-negative individual to D-positive red cells by Transfusion.

C. True
B-positive red blood cells can be given to both B-positive and AB-positive patients. B-positive patients can receive blood from B-positive, B-negative, O-positive, and O-negative donors.

D. False
E. True

Question 26

A. False
Rh system is composed primarily of the C, D, and E antigens, although it actually contains many more. Unlike the ABO antigens, the system has not been detected in tissues other than red cells. D is by far the most antigenic component, and the term Rh-positive as it is generally used means that the individual has agglutinogen D. The D protein is not glycosylated.

B. True
C. True
D. True

E. True
Rh incompatibility arises when a Rh-negative mother carries an Rh-positive fetus. Small amounts of fetal blood leak into the maternal circulation at the time of delivery, and some mothers develop significant titers of anti-Rh agglutinins during the postpartum period. During the next pregnancy, the mother's agglutinins cross the placenta to the fetus. In addition, there are some cases of fetal-maternal hemorrhage during pregnancy, and sensitization can occur during pregnancy. In any case, when anti-Rh agglutinins cross the placenta to an Rh-positive fetus, they can cause hemolysis and various forms of hemolytic disease of the newborn (erythroblastosis fetalis). If hemolysis in the fetus is severe, the infant may die in utero or may develop anemia, severe jaundice, and edema (hydrops fetalis). Kernicterus, a neurologic syndrome in which unconjugated bilirubin is deposited in the basal ganglia, may also develop, especially if birth is complicated by a period of hypoxia.

Because sensitization of Rh-negative mothers by carrying an Rh-positive fetus generally occurs at birth, the first child is usually normal. However, hemolytic disease occurs in about 17% of the Rh-positive fetuses born to Rh-negative mothers who have previously been pregnant one or more times with Rh-positive fetuses. Fortunately, it is usually possible to prevent sensitization from occurring the first time by administering a single dose of anti-Rh antibodies in the form of Rh immune globulin during the postpartum period. Such passive immunization does not harm the mother and has been demonstrated to prevent active antibody formation by the mother.

Question 27

The innate immune system is triggered by receptors that bind sequences of sugars, lipids, amino acids, or nucleic acids that are common in bacteria and other microorganisms

Pathogen-associated molecular patterns – recognized by Pattern recognition receptors in neutrophils, macrophages, NK cells – Toll-like receptors

• These receptors, in turn, activate various defense mechanisms. The receptors are coded in the germ line, and their fundamental structure is not modified by exposure to antigens.

• Activated defenses include release of interferons, phagocytosis, production of antibacterial peptides, activation of the complement system

• innate immunity provides the first line of defense against infections, but it also triggers the slower but more specific acquired immune response

Components of innate immunity

- Cells
- Phagocytes – PMN, Monocytes, macrophages
- NK cells – cytotoxic lymphocytes (Non T,B)
- Mast cells and Basophils
- Eosinophils
- Molecules
- Complement system
- Cytokines

A. False
B. True
C. True
D. True
E. True

Question 28

A. False
Innate immunity is the basic resistance to a disease that an individual is born with. It provides a first-line defense against invading pathogens.
Less specific and no immunologic memory.

B. True

C. True
It kills cells that are infected with viruses and tumor cells through the release of granules and activates macrophages.

D. False
E. True

REFERENCES – Lecture note WBC and Immunity

Question 29

A. True
The complement system consists of a series of plasma proteins constituting an amplification enzyme system that is capable of lysis of bacteria or can opsonize (coat) bacteria or cells so that they are phagocytosed.
When the complement sequence goes to completion (C9) there is generation of an active phospholipase that punches holes in the cell membrane causing direct lysis of bacteria.

B. True
It may trigger anaphylaxis by the release of mediators from tissue mast cells and basophils which causes vasodilatation and increased permeability.

C. True
D. False

E. True
Complement prevents immune complex precipitation and solubilizes complexes that have already been precipitated. Complexes coated in C3b bind to CR1 on red blood cells and then removed in the spleen.

Question 30

A. True
Cytokines are hormone-like molecules that act in a paracrine fashion to regulate immune responses. They are secreted by lymphocytes, macrophages, endothelial cells, neurons, and glial cells.

B. True
INF γ activates PMNs and macrophages for enhanced killing.

C. True
IL-1 activation of T cells and macrophages; promotion of inflammation.
IL – 6, 11 stimulation of the production of acute phase proteins.
TNF alpha- promotion of inflammation.

D. True
Activate NK cells to produce INF gamma.

E. True

Question 31

A. False
IgM cannot cross the placenta. IgG is the only antibody that crosses the placenta. IgM is predominant Ab produced by fetus, More efficient than IgG in complement activation. The First Ig of primary immune response is IgM.

B. True
IgA is predominant Ig in secretions (Milk, saliva, tears, mucus)
More important in mucosal immunity. Doesn't bind complement via classical pathway. Opsonize foreign particles

C. True
An immune response to parasites, specifically worms, triggers an IgE response. IgE elicits an immune response by binding to Fc receptors on mast cells, eosinophils, and basophils, causing degranulation and cytokine release.
Participate in immediate hypersensitivity reactions. Ex. Asthma, anaphylaxis, hives.

D. True
Expressed on B-cell Surface. Involved as an Ag receptor on B cell activation.

E. False
The most abundant immunoglobin is 80% of serum Ig. Major Ab in the secondary immune response. Monomer. IgG1, IgG3 and IgG4 cross placenta. IgG3 Most effective complement activator. IgG1 and IgG3 High affinity for FcR on phagocytic cells, good for opsonization.

Question 32

A. True
The heavy and light chains each have - highly variable regions (Fab fragments) which give the immunoglobulin specificity - antigen-binding sites.

B. True
Multiple genes are involved in antibody production.

C. True
constant regions (Fc fragment) in which the amino acid sequence is the same - is the effector portion, which mediates the reactions initiated by antibodies.

D. True
The hinge region is a stretch of heavy chains between the Fab and Fc portions. Its unique structure and position provide segmental flexibility, which is essential for the normal functioning of antibodies.

E. True
Immunoglobulins are made up of the same basic structure consisting of two heavy chains, (gamma (γ) in IgG, alpha (α) in IgA, mu (μ) in IgM, delta (δ) in IgD and epsilon (ε) in IgE) and two light chains, kappa (κ) or lambda (λ) light chain are common to all five immunoglobulins.

Question 33

A. True
The initiating component is the Antigen-Antibody complex (adaptive immune system) in the classical pathway. Involved antibodies are IgM or IgG.

B. True
The complement system is a collection of circulating and membrane-associated proteins that are important in defense against microbes. C3 is the most abundant and important factor.

C. True

D. True
C5b Attaches to the microbe and acts as an anchor to Factor C6 C7 C8 & C9. This factor cluster makes the Membrane attack Complex (MAC). MAC makes a hole-like channel in the microbial membrane which facilitates the fluid influx and destruction of the microbe.

E. True
Initiation components are bacterial cell wall components (endotoxin, Inulin, yeast cell wall, Cobra venom, etc.)

Question 34

- Phase 0 - Initial rapid depolarization and overshoot due to rapid opening of voltage-gated Na+ channels
- Phase 1 - Initial rapid repolarization due to closure of Na+ channels and opening of one type of K+ channels
- Phase 2 (Plateau phase) - due to slower but prolonged opening of voltage-gated Ca++ channels.
- Phase 3 (final repolarization) - due to the closure of Ca++ channels and efflux of K+ from the cell
- Phase 4 - Resting membrane potential

A. True
B. True
C. False
D. True
E. True

Question 35

A. True
In cardiac muscle action potential initial rapid depolarization and overshoot due to rapid opening of voltage-gated Na+ channels and Na+ influx.
In a pacemaker potential opening of transient Ca++ channels completes the prepotential and the opening of long-lasting Ca++ channels causes action potential.

B. True
Phase 2 (Plateau phase) - due to slower but prolonged opening of voltage-gated Ca++ channels in cardiac muscle action potential.
C. True
In a pacemaker potential opening of transient Ca++ channels completes the prepotential.

D. False
Repolarization is due to K+ efflux in both.

E. True
SA node, AV node has a property called automaticity (rhythmic activation even with no nerve supply. K+ efflux causes repolarization. Then a channel permeable to both Na+ and K+ is activated ('h' channel or 'f' channel).
Opening of Transient Ca++ channels completes the prepotential. Opening of long-lasting Ca++ channels causes action potential.

Question 36

A. True
action potentials in the SA and AV nodes are large, with no contribution by Na + influx.

B. True
At the peak of each impulse, K+ efflux brings about repolarization. Then a channel permeable to both Na + and K+ is activated. Because this channel is activated following hyperpolarization, it is referred to as an "h" channel; however, because of its unusual (funny) activation it has also been dubbed an "f" channel and the current produced as "funny current." As funny current increases, the membrane begins to depolarize, forming the first part of the prepotential.

C. True
There are two types of Ca channels in the heart. Transient channels and the Long-lasting channels. The calcium current due to the opening of T channels completes the prepotential and the opening of long-lasting calcium channels contributes to action potential.

D. True
The rate of discharge of the SA node and other nodal tissue is influenced by temperature and drugs. The discharge frequency is increased when the temperature rises, and this may contribute to the tachycardia associated with fever. Digitalis depresses nodal tissue and exerts an effect like that of vagal stimulation, particularly on the AV node. Digitalis has been used for the treatment of systolic heart failure. It augments contractility, thereby improving cardiac output, improving left ventricle emptying, and decreasing ventricular filling pressures. Digitalis has also been used to treat atrial fibrillation and atrial flutter. In this scenario, digitalis reduces the number of impulses transmitted through the AV node and thus, provides effective rate control.

E. True
When the cholinergic vagal fibers to nodal tissue are stimulated, the membrane becomes hyperpolarized and the slope of the prepotentials is decreased because the acetylcholine released at the nerve endings increases the K + conductance of nodal tissue.

Question 37

A. True
All valves are closed during both isovolumetric contraction and relaxation.

B. True
Ventricular pressure increases iso volumetrically while all four valves are closed.

C. True
Period of isovolumetric ventricular contraction lasts about 0.05 s until the pressures in the left and right ventricles exceed the pressures in the aorta (80 mm Hg; 10.6 kPa) and pulmonary artery (10 mm Hg) and the aortic and pulmonary valves open.

D. False
C wave of the JVP occurs due to high ventricular pressure in isovolumetric contraction. V wave of the JVP occurs at the end of atrial filling in isovolumetric ventricular relaxation.

E. True
Acute mitral regurgitation classically occurs with a spontaneous chordae tendineae or papillary muscle rupture secondary to myocardial infarction. Other causes include rupture of these structures due to mitral valve prolapse, endocarditis, and trauma.

Question 38

A. True
The duration of systole is 0.27 s at a heart rate of 65 and the duration of diastole is 0.62 s.

B. True

C. False
When the aortic and pulmonary valves open, the phase of ventricular ejection begins. Ejection is rapid at first, slowing down as systole progresses.

D. True
Blood flows into the heart throughout the diastole, filling the atria and ventricles. The rate of filling declines as the ventricles become distended, and, especially when the heart rate is low, the cusps of the AV valves drift toward the closed position. The pressure in the ventricles remains low. About 70% of the ventricular filling occurs passively during diastole.

E. True
Since pulmonary arterial pressure is lower than aortic pressure, right ventricular ejection begins before that of the left. During expiration, the pulmonary and aortic valves close at the same time; but during inspiration, the aortic valve closes slightly before the pulmonary. The slower closure of the pulmonary valve is due to the lower impedance of the pulmonary vascular tree. When measured over a period of minutes, the outputs of the two ventricles are, of course, equal, but transient differences in output during the respiratory cycle occur in normal individuals.

Question 39

A. True
The first is a low, slightly prolonged "lub" caused by vibrations set up by the sudden closure of the AV valves at the start of ventricular systole. The second is a shorter, high-pitched "dup" caused by vibrations associated with the closure of the aortic and pulmonary valves just after the end of ventricular systole.

B. False

C. True
A soft, low-pitched third sound is heard about one-third of the way through diastole in many normal young individuals. It coincides with the period of rapid ventricular filling and is probably due to vibrations set up by the inrush of blood.

D. True
A fourth sound can sometimes be heard immediately before the first sound when atrial pressure is high or the ventricle is stiff in conditions such as ventricular hypertrophy. It is due to ventricular filling and is rarely heard in normal adults.

E. True
Wide splitting of S2 is found in conditions that prolong the RV ejection time and shorten the left ventricular ejection. It is in conditions in which the amount of blood ejected by the Right ventricle is increased such as ASD.

Question 40

A. True
Crescendo-decrescendo murmur can be heard at the right upper sternal border which radiates to the carotid artery.

B. True
Can be heard at the apex and radiate to the axilla.

C. False
Early diastolic murmur.

D. True
Can be heard at the left sternal border.

E. True
Best heard in the posterior interscapular region.

PHYSIOLOGY ESSAY QUESTIONS & ANSWERS

pH and Hydrogen ion haemostasis

1. A newborn boy with pyloric stenosis presented with projectile vomiting following breastfeeding. His respiratory rate was 6 breaths/minute. Interpret the findings of his ABG.

pH – 7.48 (7.35 - 7.45)

PO2 – 90 mmHg (75 - 100 mmHg)

PCO2 – 50 mmHg (35 - 45 mmHg)

HCO3 - – 31 mEq/l (22 - 26 mEq/l)

Answer: Metabolic alkalosis with partial respiratory compensation

2. A 50-year-old man presents with fever and cough for 4 days with worsening shortness of breath since the morning. Interpret the findings of his ABG.

pH – 7.35 (7.35 - 7.45)

PO2 – 70 mmHg (75 - 100 mmHg)

PCO2 – 55 mmHg (35 - 45 mmHg)

HCO3 - – 30 mEq/l (22 - 26 mEq/l)

Answer: Respiratory acidosis with complete metabolic compensation

3. A 5-year-old child presented with a history of severe watery diarrhea. On examination, she was dehydrated and had a respiratory rate of 50 breaths per minute.

pH – 7.32 (7.35 - 7.45)

PO2 – 80 mmHg (75 - 100 mmHg)

PCO2 – 28 mmHg (35 - 45 mmHg)

HCO3 - – 12 mEq/l (22 - 26 mEq/l)

Answer: Metabolic acidosis with partial respiratory compensation

4. A 74-year-old man with chronic kidney disease presented with anuria for 1 da and shortness of breath of a few hours' duration due to acute pulmonary edema. Interpret the findings of his ABG.

pH – 7.21 (7.35 - 7.45)

PO2 – 75 mmHg (75 - 100 mmHg)

PCO2 – 60 mmHg (35 - 45 mmHg)

HCO3 - – 12 mEq/l (22 - 26 mEq/l)

BE – -10mEq/l (-2 – +2mEq/l)

AG – 20 mEq/l (8-16mEq/l)

Answer: Mixed metabolic and respiratory acidosis

5. A 64-year-old who gave a history of long-term use of antacids was admitted with shortness of breath due to a severe lower respiratory tract infection. Interpret the findings of his ABG.

pH – 7.38 (7.35 - 7.45)

PO2 – 82 mmHg (75 - 100 mmHg)

PCO2 – 60 mmHg (35 - 45 mmHg)

HCO3 - – 40 mEq/l (22 - 26 mEq/l)

Answer: Mixed respiratory acidosis and metabolic alkalosis

Autonomic Nervous System

1. A 67-year-old man presents to his physician following a right-sided carotid endarterectomy. He reports mild pain at the surgical site but currently does not have any concerns. On physical exam, there is anisocoria with the right eye being miotic. There is also mild ptosis in the right eye as well.

1.1. What could be the pathophysiology behind his symptoms?

2. Two middle-aged patients presented to the emergency unit with acute gastrointestinal symptoms including epigastric pain, vomiting, and diarrhea, followed by miosis, palpitations, and diaphoresis. The patient volunteered a history of taking two tablespoons of cooked wild mushrooms collected in a country park. Mildly elevated liver transaminase was noted in one female patient. Mushroom specimens were sent to a mycologist for identification using morphological analysis.

2.1. What could be the reason for the collection of symptoms?

2.2. Name the receptor that the above acts on.

2.3. List out the effects of the above on the human body.

Answers

1.1.

- The autonomic nervous system controls myosis and mydriasis (myosis – constriction, mydriasis – dilation) of the pupils.
- The autonomic nervous system is composed of sympathetic and parasympathetic nervous systems
- The sympathetic nervous system evokes a flight or fight response eg: increased heart rate, increased blood pressure
- It causes pupils to dilate
- The neurotransmitter released by the sympathetic post-ganglionic axon is norepinephrine
- The parasympathetic nervous system causes a relaxing effect, eg: decreased heart rate, dilated blood vessels
- It causes pupils to constrict
- The neurotransmitter released by the parasympathetic post-ganglionic axon is acetylcholine
- The symptoms described—right-sided miosis (constricted pupil) and mild ptosis (drooping eyelid)—are indicative of Horner's syndrome
- The pathophysiology behind Horner's syndrome involves disruption of the sympathetic nerve pathway that supplies the eye and surrounding structures
- carotid endarterectomy is a surgical procedure performed to remove atherosclerotic plaque from the carotid artery to prevent stroke
- sympathetic nerve fibers can be damaged during this procedure
- Miosis can occur due to unopposed parasympathetic activity as the sympathetic innervation to the dilator pupillae muscle is impaired
- Ptosis can occur due to denervation of the superior tarsal muscle (Mueller's muscle), which is responsible for a portion of eyelid elevation

2.1

- Miosis (pupillary constriction) and bradycardia are responses of the parasympathetic nervous system
- The parasympathetic nervous system is one component of the autonomic nervous system in the body
- The sympathetic nervous system mediates sweating.
- The parasympathetic nervous system releases acetylcholine from pre-ganglionic and post-ganglionic axons
- Acetylcholine activates two types of receptors, Muscarinic and Nicotinic
- Muscarinic receptors are found in all effector cells that are stimulated by post-ganglionic cholinergic neurons
- Muscarinic receptors are found in the heart, eye, and gastrointestinal tract, causing parasympathetic effects.

- They are also found in sweat glands which are mediated by the sympathetic nervous system.
- In this clinical scenario, muscarinic receptors are stimulated due to some effect caused by mushrooms, causing miosis, bradycardia, and diaphoresis.

2.2

- muscarinic receptors

2.3

- Increase gastric acid secretion
- Reduce the force of contraction of the heart
- Reduce the heart rate
- Contraction of smooth muscles in the gut, bladder, trachea, iris circular muscle
- Increased salivation
- Increased secretion from sweat, lacrimal glands

Neuromuscular Junction

Clinical Scenario 1 (30 minutes)

A 45-year-old farmer is brought to the emergency department after accidentally spraying pesticides without adequate protective gear. On arrival, he is diaphoretic, tremulous, and complaining of excessive salivation and blurry vision. His vital signs show bradycardia and hypotension.

Upon further examination, he develops muscle fasciculations and weakness, progressing to respiratory distress.

Prompt intervention is necessary to manage his condition and prevent further deterioration.

Questions:

1. Explain the mechanisms underlying the above clinical features A, B, and C observed in this scenario using your physiology knowledge.

2. Discuss the physiological basis behind the pharmacological treatment options for reversing neuromuscular blockade caused by organophosphate poisoning.

Answer

In this scenario, the farmer's symptoms are consistent with organophosphate poisoning, which commonly occurs due to exposure to pesticides. Organophosphates inhibit acetylcholinesterase (AChE), the enzyme responsible for breaking down acetylcholine (ACh) at cholinergic synapses. This results in the accumulation of ACh at cholinergic receptor sites, leading to overstimulation of the parasympathetic nervous system and neuromuscular junctions. Let's address each clinical feature:

1. Bradycardia :

Organophosphate poisoning can cause bradycardia due to excessive stimulation of muscarinic receptors in the heart. Acetylcholine acts on muscarinic receptors in the sinoatrial node, leading to increased vagal tone and subsequent bradycardia. Additionally, there may be decreased sympathetic activity due to the overall cholinergic excess.

2. Hypotension (B):

Organophosphate poisoning can lead to hypotension through various mechanisms. Excessive activation of muscarinic receptors can cause vasodilation, resulting in decreased peripheral vascular resistance and hypotension. Additionally, the poisoning can impair sympathetic nervous system function, further contributing to hypotension.

3. Muscle fasciculations, weakness, and respiratory distress :

These symptoms result from the overstimulation of nicotinic receptors at the neuromuscular junctions. Initially, muscle fasciculations occur due to the sustained depolarization of muscle fibers. Subsequently, muscle weakness develops as neuromuscular transmission becomes impaired. Severe poisoning can lead to respiratory muscle paralysis, resulting in respiratory distress and potentially respiratory failure.

The mainstay of treatment involves the administration of antidotes that counteract the effects of organophosphates by either reactivating AChE or providing competitive inhibition at cholinergic receptor sites:

1. Atropine:

Atropine is a competitive antagonist of muscarinic receptors and is used to counteract the excessive cholinergic stimulation in organophosphate poisoning. By blocking muscarinic receptors, atropine can reverse bradycardia, reduce excessive salivation, and alleviate bronchoconstriction.

2. Pralidoxime (2-PAM):

Pralidoxime is an acetylcholinesterase reactivator that can restore the activity of inhibited AChE. It works by binding to the phosphorylated AChE enzyme and removing the phosphate group, thereby restoring AChE activity. This helps to reverse the neuromuscular blockade and improve muscle strength and respiratory function.

3. Benzodiazepines:

Benzodiazepines such as diazepam or midazolam may be used to control seizures, which can occur as a result of severe organophosphate poisoning.

These pharmacological interventions aim to stabilize the patient's condition, reverse the toxic effects of organophosphates, and prevent further deterioration. Early recognition and prompt treatment are crucial in improving patient outcomes in cases of organophosphate poisoning.

Clinical Scenario 2 (30 minutes)

A 35-year-old woman presents to a dermatologist's office seeking treatment for facial wrinkles. She expresses dissatisfaction with the appearance of fine lines around her eyes and forehead. After discussing various treatment options, including topical creams and laser therapy, the patient opts for botulinum toxin injections (Botox) to address her cosmetic concerns. The dermatologist administers the injections, targeting specific facial muscles to reduce the appearance of wrinkles.

Questions:

Explain the mechanism of action of botulinum toxin at the neuromuscular junction and its therapeutic implications.

How does botulinum toxin selectively block the release of acetylcholine from presynaptic nerve terminals, leading to localized muscle paralysis?

Discuss how this mechanism underlies the use of botulinum toxin in cosmetic procedures and the treatment of various medical conditions such as spasticity in stroke.

Assess the potential adverse effects and complications associated with botulinum toxin injections at the neuromuscular junction.

Answer

1. Mechanism of action of botulinum toxin at the neuromuscular junction and its therapeutic implications:

Botulinum toxin works by inhibiting the release of acetylcholine (ACh) from presynaptic nerve terminals at the neuromuscular junction. It achieves this by cleaving specific proteins involved in the fusion of synaptic vesicles containing ACh with the presynaptic membrane. By preventing the release of ACh, botulinum toxin blocks the signal transmission from motor neurons to muscle fibers, resulting in localized muscle paralysis. Therapeutically, this property is exploited to treat various conditions characterized by excessive muscle activity, such as dystonia, spasticity, and muscle spasms.

2. Selective blockade of acetylcholine release:

Botulinum toxin selectively targets and cleaves proteins involved in the release of ACh at the neuromuscular junction. Specifically, it cleaves SNARE (soluble N-ethylmaleimide-sensitive factor attachment protein receptor) proteins, which are essential for the fusion of synaptic vesicles with the presynaptic membrane. This prevents the release of ACh specifically at the injected site, leading to localized muscle paralysis without affecting other neuronal functions.

3. Use of botulinum toxin in cosmetic procedures and medical conditions:

In cosmetic procedures, botulinum toxin is injected into specific facial muscles to reduce the appearance of wrinkles by inducing localized muscle paralysis. By selectively targeting muscles responsible for facial expression, such as the muscles around the eyes (orbicularis oculi) and forehead (frontalis), botulinum toxin temporarily reduces muscle activity, thereby smoothing out wrinkles and fine lines.

In medical conditions such as spasticity following stroke or cerebral palsy, botulinum toxin injections can help relax overactive muscles, alleviate muscle stiffness and pain, and improve

functional outcomes. By blocking the release of ACh at the neuromuscular junction, botulinum toxin reduces muscle spasticity and allows for better muscle control and range of motion.

4. Potential adverse effects and complications:

While botulinum toxin injections are generally considered safe when administered by qualified healthcare professionals, there are potential adverse effects and complications to be aware of. These may include temporary muscle weakness or paralysis at the injection site, bruising, swelling, or redness. Rarely, systemic effects such as flu-like symptoms, headache, or difficulty swallowing may occur. Additionally, improper injection technique or dosage can lead to unintended muscle weakness or asymmetry of facial features. It's important for patients to discuss the risks and benefits of botulinum toxin treatment with their healthcare provider and ensure proper administration for optimal outcomes.

Anaemia

A 17-year-old boy was brought by his mother with a history of progressive shortness of breath on exertion, feeling of physical and mental lethargy, and mild headache for 2 months duration. examination revealed moderate pallor, mild icterus, and mild splenomegaly. The rest of the clinical examination was unremarkable.

Following blood investigations were performed.

- Hemoglobin 6.7 g/dL (12-14 g/dL)
- MCV-105fl (76-96)
- MCH -35pg (27-33)
- Platelets 343000 /L (150-450)
- WBC 5.8 (4-11)
- Reticulocytes count 4% (<2%)
- LDH -2345 U/L (140-280)
- Total bilirubin – 2mg/dL (0.3-1.0)
- Direct bilirubin 0.2 mg/dL (0-0.3)
- Indirect bilirubin 1.8mg/d/L (0,2-0.8)
- ESR 74mm
- Serum haptoglobin 25 mg/dL9 41-165)
- Direct antiglobulin test (DAT)-positive
- Blood picture-
  - RBC- hypochromic macrocytic red cell. polychromasia, reticulocyte count is increased. high rouleaux formation
  - WBC- normal in number and morphology
  - Platelets normal in number

1. What is the type of anemia observed in this patient?
   - Hemolytic anemia

2. Name two physical signs and two hematological findings for your answer.

   Physical sings

   - Pallor(anemic), icterus (Jaundice)

   Hematological findings

   - Elevated reticulocytes number (4%)
   - Morphological features of RBC in the blood picture





3. Explain the physiological basis for the symptoms of this patient.
   - Due to anemia hemoglobin concentration in the RBCs will be reduced
   - This leads to reduced oxygen-carrying capacity
   - It causes decreased oxygen level (Hypoxia) and hypoxia induces effects on organ function
   - This causes symptoms of anemia.

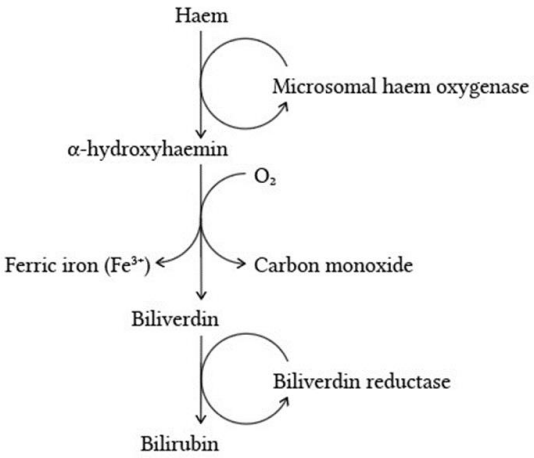
4. List 3 biochemical abnormalities you observed and explain the physiological basis for the abnormalities.

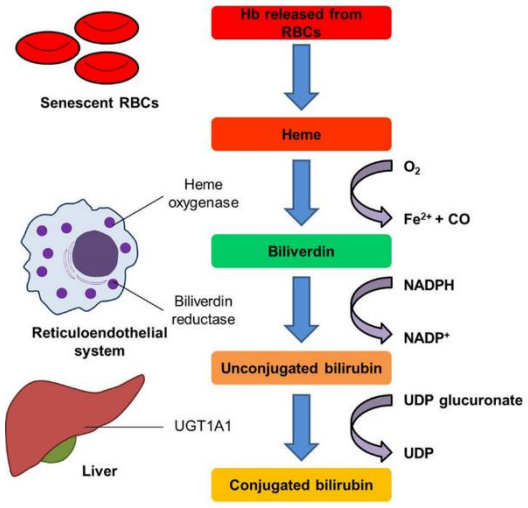
- Increased total and indirect bilirubin level
- Increased LDH level
- Reduced serum haptoglobin level
- Increased total and indirect bilirubin

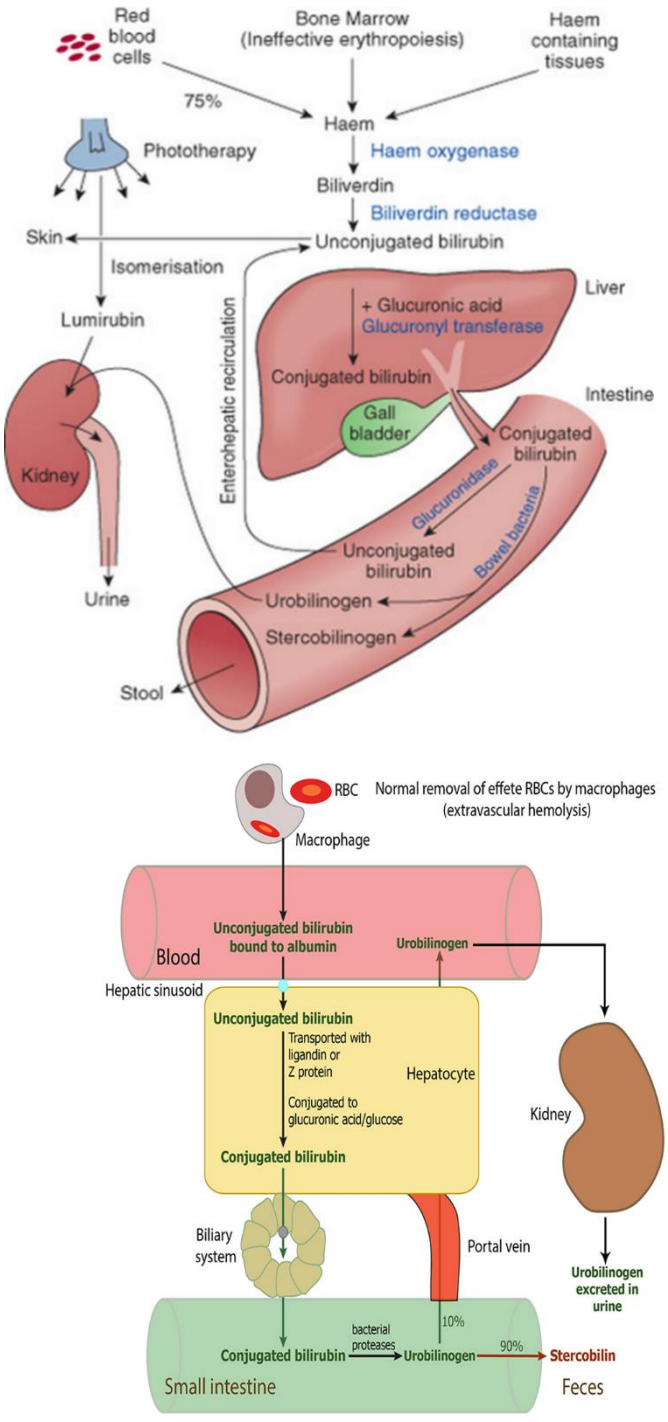
Increased bilirubin production and consequential unconjugated hyperbilirubinemia can result from increased catabolic degradation of hemoglobin and other heme proteins, typically due to accelerated hemolysis,

LDH is present in red cells and hemolysis causes release into the plasma.

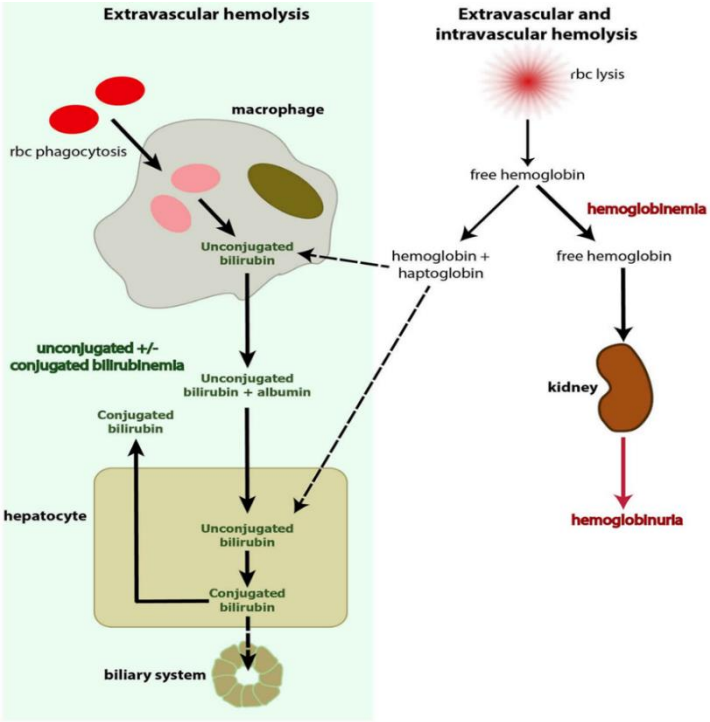
Heme metabolism

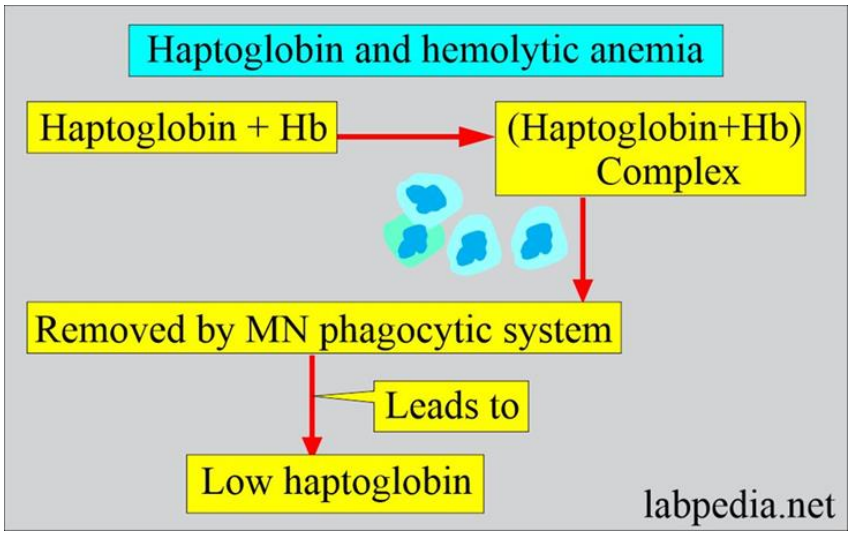


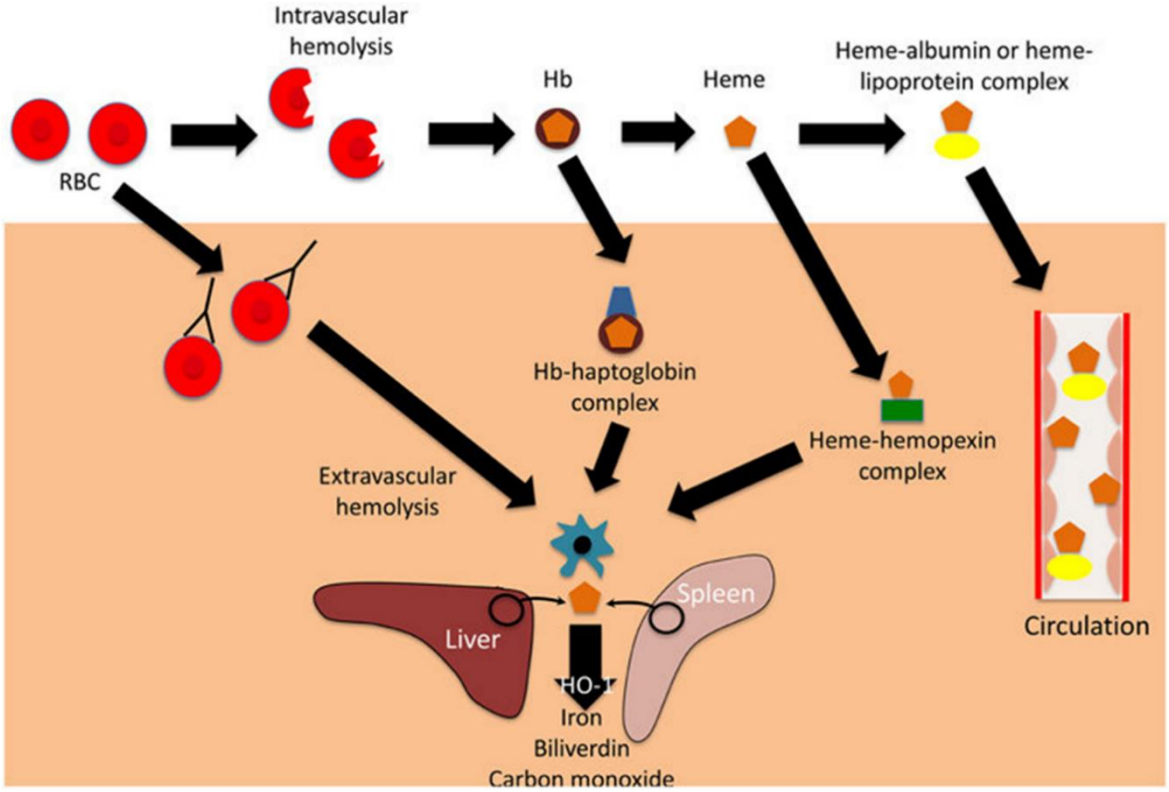




- Haptoglobin is primarily produced in the liver and is functionally important for binding free hemoglobin from lysed red cells in vivo, preventing its toxic effects.
- Because haptoglobin levels become depleted in the presence of large amounts of free hemoglobin, decreased haptoglobin is a marker of hemolysis.


Extravascular hemolysis
macrophage
rbc phagocytosis
Unconjugated bilirubin
unconjugated +/- conjugated bilirubinemia
Unconjugated bilirubin + albumin
Conjugated bilirubin
hepatocyte
Unconjugated bilirubin
Conjugated bilirubin
biliary system
Extravascular and intravascular hemolysis
rbc lysis
free hemoglobin
hemoglobinemia
hemoglobin + haptoglobin
free hemoglobin
kidney
hemoglobinuria


Haptoglobin and hemolytic anemia
Haptoglobin + Hb
(Haptoglobin+Hb) Complex
Removed by MN phagocytic system
Leads to
Low haptoglobin
labpedia.net

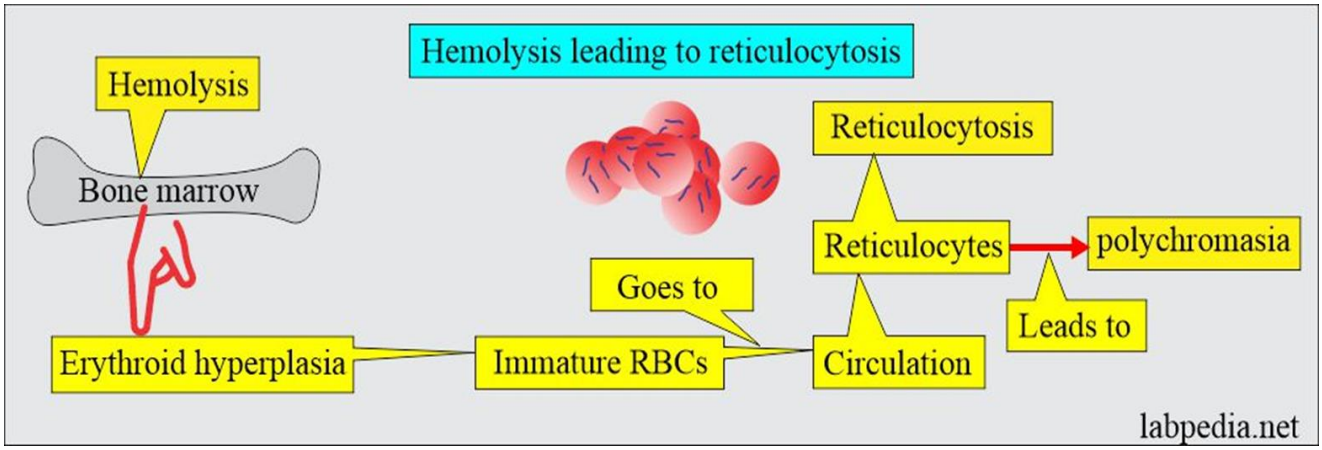


5. What would be the reason for splenomegaly?

- Splenomegaly is defined as the enlargement of the spleen measured by size or weight.
- The spleen is frequently found to play a significant role in the destruction of red cells in hemolytic diseases.
- During hemolysis, the spleen becomes overactive hence its size and weight are increased.

6. Give the reason/s for having high MCV and retic count.

- As a compensatory mechanism for the hemolysis. the erythropoiesis will be increased.
- Hence immature forms of RBC including reticulocytes are released into the circulation.
- Increased reticulocyte count directly increases the MCV.



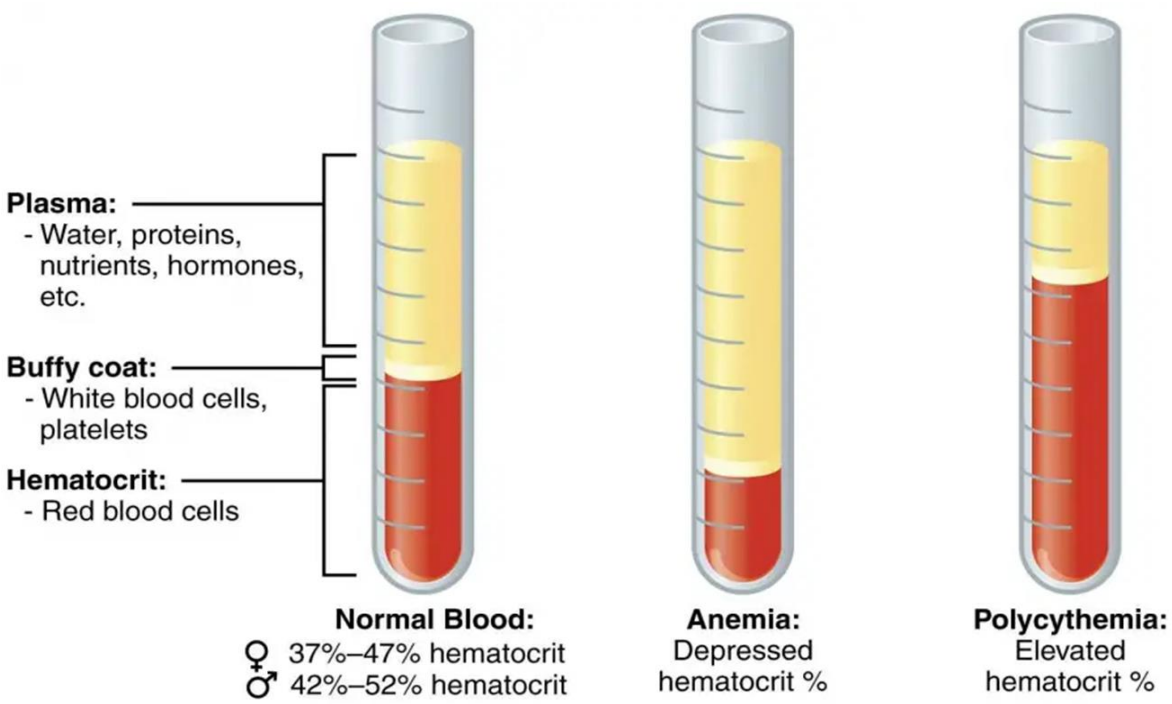
7. Explain the reason for this patient's high ESR.

- Anemia and macrocytosis increase the ESR.
- In anemia, with the hematocrit reduced, the velocity of the upward flow of plasma is altered so that red blood cell aggregates fall faster.
- Macrocytic red cells with a smaller surface-to-volume ratio also settle more rapidly.

Factors That May Influence ESR[14]

Factors that increase ESR	*Factors that decrease ESR*	*Factors with no clinically significant effect or questionable effect*
Old age	Extreme leukocytosis	Obesity
Female	Polycythemia	Body temperature
Pregnancy	Red blood cell abnormalities	Recent meal
Anemia	Spherocytosis	Aspirin
Red blood cell abnormalities	Acanthocytosis	NSAIDs
Macrycytosis	Microcytosis	
Technical factors	Technical factors	
Dilution problem	Dilution problem	
Increased temperature of specimen	Inadequate mixing	
Tilted ESR tube	Clotting of blood sample	
Elevated fibrinogen level	Short ESR tube	
Infection	Vibration during testing	
Inflammation	Protein abnormalities	
Malignancy	Hypofibrinogenemia	
	Hypogammaglobulinemia	
	Dysproteinemia with hyperviscosity state	

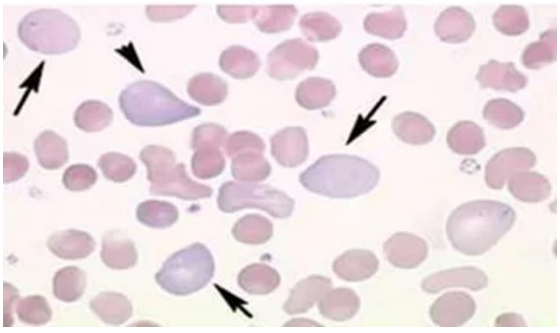
NSAIDs = nonsteroidal anti-inflammatory drugs; ESR = erythrocyte sedimentation rate.

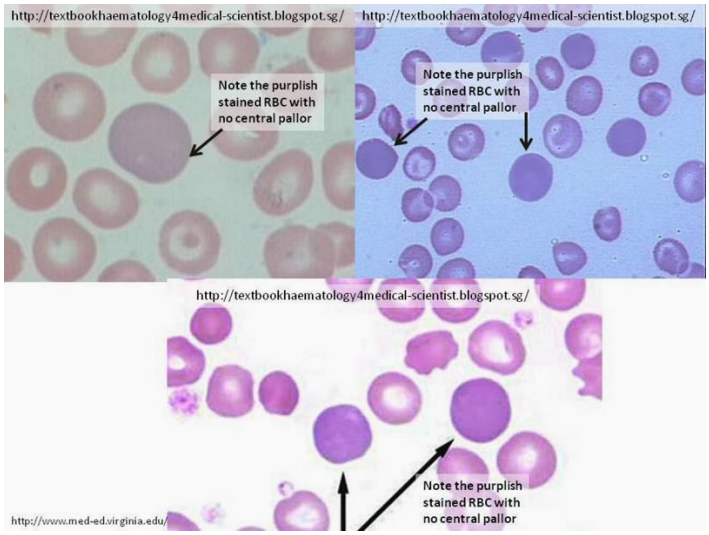


8. Explain the physiological basis for red cell abnormalities observed in the blood picture.

- RBC- hypochromic macrocytic red cell. polychromasia, reticulocyte count is increased. high rouleaux formation
- WBC- normal in number and morphology
- Platelets normal in number
- In hemolytic anemia, only the red cell line is affected. so platelets and white cells are normal in number and morphology
- Increased erythropoiesis results in high reticulocyte numbers hence polychromasia.
- As reticulocytes are large cells macrocytosis occurs.
- Due to low hemoglobin concentration red cells become hypochromic.

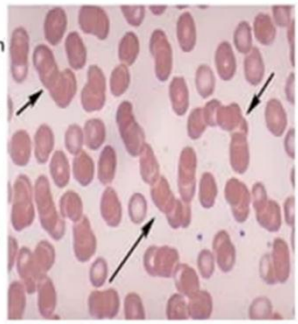
Polychromasia





Rouleaux formation

- **Rouleaux formation:** describes an aggregation of erythrocytes that are aligned one upon the other, resembling stacks of coins
- High level of circulating acute-phase proteins.
- with High ESR rate.
- autoimmune conditions
- myeloma



Rouleaux vs Agglutination



Rouleaux: Cells are arranged 'like stacks of coins'

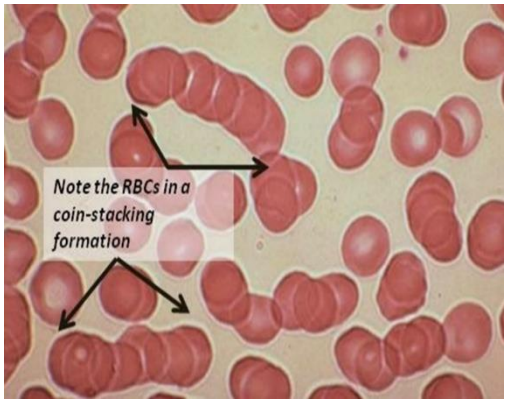
Agglutination: Cells are randomly clumped together

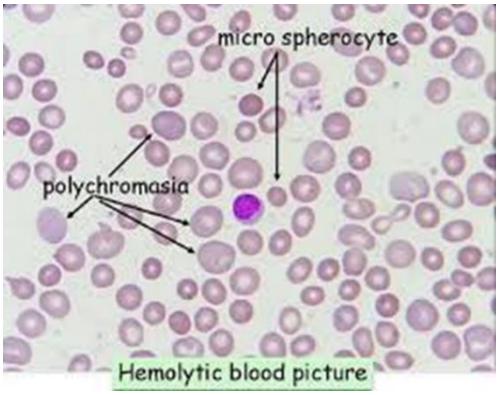
- Question 16: **ROULEAUX**

Rouleaux formation is a common artifact in the thick area of any blood film.
True Rouleaux is seen in the ***thin*** part of the blood smear.
There are four or more red cells organized in a linear arrangement like a stack of coins.
True rouleaux formation is due to increased amounts of plasma proteins primarily fibrinogen and globulins.

Rouleaux are commonly seen in:

- Infections
- Inflammation
- Monoclonal gammopathies
- Neoplastic diseases
- AIHA warm antibody disease



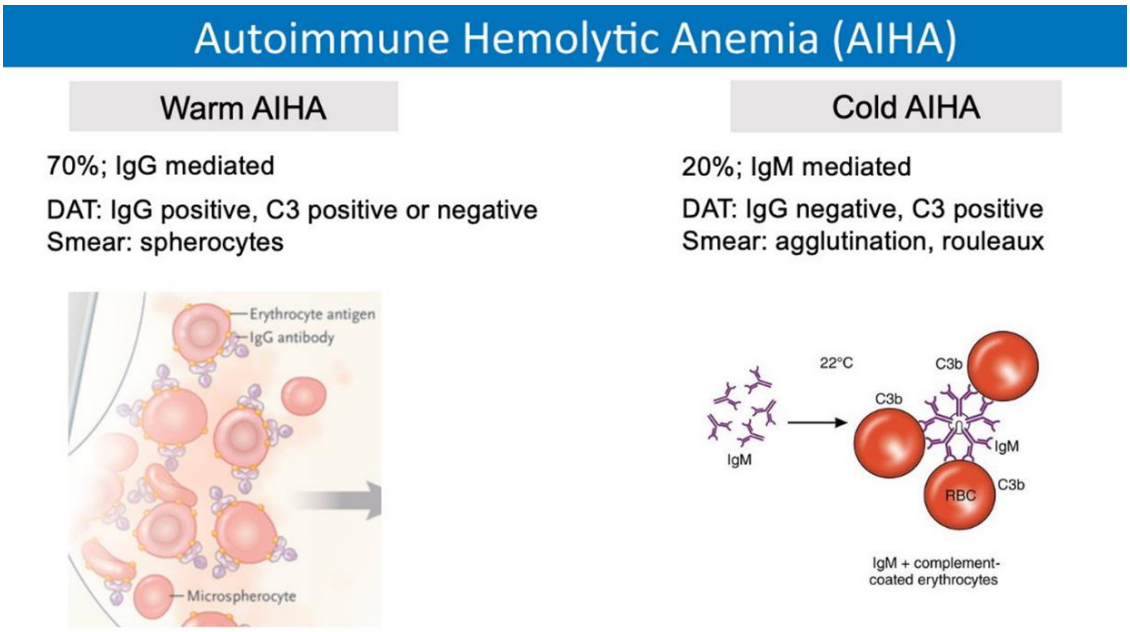


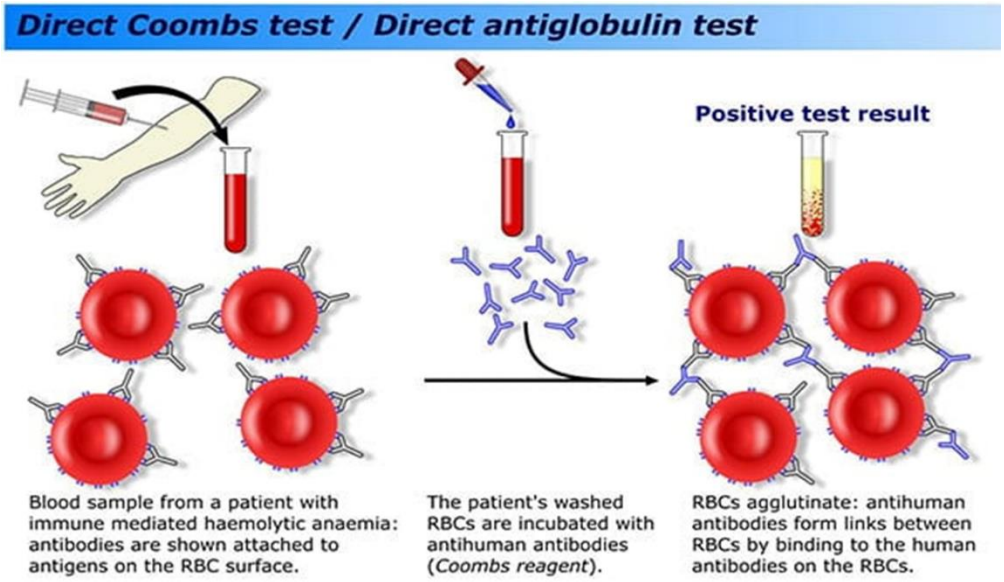
9. What is the significance of the positivity of DAT in this patient for the diagnosis?

- It indicates Auto Immune Hemolytic Anemia (AIHA)

10. What drug group would be beneficial in managing this patient?

- Corticosteroids





Disorders of Hemostasis

1. A nine-month-old baby boy presents to the pediatric clinic with a history of recurrent bruising. Apart from bruising the physical examination did not reveal any abnormality. His investigation results are as follows.

Hemoglobin concentration -11.2 g/dl (11.3-14.1)

Platelet count- 188,000/mm3 (150,000- 450,000)

Bleeding time - 5min (1-9 mins)

Prothrombin time- 12s (12-15s)

Whole blood clotting time -22min (8-15 mins)

Activated partial thromboplastin time-prolonged

1.1. List two diseases that give rise to the above findings.

1.2. Explain the physiological basis for bruising in this child.

Answer

1.1 Haemophilia A

1.2

- Bruise appears as a result of blood getting trapped below the skin surface, due to injury to blood vessels or capillaries. The investigations show prolonged APTT and WBCT.
- When there is an injury to blood vessels, blood loss is prevented by following mechanisms.

1. Vascular spasm
   By local myogenic contraction of vessels and release of serotonin and vasoconstrictor substances by platelets, traumatized tissues lead to vascular contraction and obliteration of injured tissue.

2. Formation of platelet plug
   Platelets adhere to exposed endothelial connective tissue and secrete chemicals such as ADP thromboxane A2 resulting in platelet aggregation.

3. Clot formation
   In the clotting mechanism, there are 3 pathways, intrinsic, extrinsic, and common pathway.

- As APTT is prolonged this child has a disorder in the intrinsic pathway.
- When there is injury to capillaries they become ruptured due to excess pressure on that area and bleeding occurs due to impaired Clot formation. Blood accumulates under the skin which shows as bruising in this child. This child can have hemophilia A or B with a deficiency in factor VIII or IX.

2. A 40-year-old woman presented with deep vein thrombosis (DVT). Thrombosis was treated with intravenous heparin and monitored with APTT.

2.1. Explain the physiological basis of treating with heparin and monitoring with APTT.

Answers

- What is deep vein thrombosis – thrombus formation in a deep vein
- Use of heparin in DVT – prevent extension of thrombus, reduce the incidence of pulmonary embolism
- Heparin acts on intrinsic and common pathway
- Explain the coagulation pathway
- Heparin is an anticoagulant.
- APTT is a method of measuring bleeding or coagulatory tendency. It tests the integrity of the common and intrinsic pathway of clotting.
- If the APTT is increased it means that there is an increased risk of bleeding and if APTT is decreased means there is risk decreased risk of bleeding and an increased risk of clot formation. So APTT is decreased the goal of heparin therapy is not met.
- The goal of heparin therapy is to prevent the coagulate cascade (intrinsic pathway and common pathway) from progressing into blood clot formation.
- If the APTT is increased it means there is over infusion of heparin and the heparin levels should bough down.
- APTT is used for monitoring heparin therapy levels.
- The coagulatory cascade of the hemostatic mechanisms has two main pathways, Intrinsic and Extrinsic, and both lead to a common pathway.
- In the common pathway, the activation of factor X into factor Xa stimulates prothrombin conversion into thrombin. Platelet phospholipids, calcium, and factor Va aid this activation of thrombin by factor Xa.
- Thrombin is a proteolytic enzyme that degrades plasma-dissolved fibrinogen into water-insoluble fibrin monomers. Fibrin monomers are polymerized into the fibrin polymer and the definitive reticulum of the blood clot is formed.
- This polymerization is further stimulated by activated factor XIII (XIIIa) which was activated by thrombin.
- The intrinsic pathway starts from the activation of factor XIII into XIIa which is stimulated by high molecular weight kalikkerins and killinogens.
- Then factor XIIa activates factor XI into XIa.
- Factor XIa activates factor IX into IXa which activates factor X.
- This activates a common pathway of clotting.
- Heparin binds to antithrombin III in serum and forms the heparin antithrombin complex. This complex binds to thrombin and inhibits the action of thrombin; the conversion of fibrinogen to fibrin.
- Also inhibits the activated forms of clotting factors II, IX, X, XI, XII.
- Since heparin mainly inhibits the intrinsic pathway and is part of the common pathway; APTT is the most suitable monitoring method.

Electrical activity of the heart

1. Briefly describe the ventricular myocardial action potential and the electrical basis of each phase.
2. Briefly describe the physiological basis use of atropine in bradycardia.

Answers

- Cardiac action potential lasts for 300ms and consists of five phases. Phase 0, 1, 2, 3, 4
- The resting membrane optional is -90mV.
- Phase 0 is the upstroke of action potential. Depolarization occurs rapidly and overshoot is present. This phase is due to the opening of voltage-gated Na channels and Na+ intake takes place.
- Phase 1 is the rapidly repolarizing phase. Closure of voltage-gated Na channels and reduction of Na+ influx.
- Phase 2 plateau phase. The prolonged opening of Ca channels results in influx of Ca.
- Phase 3 is the final repolarization to resting membrane potential caused by the closure of Ca channels and K efflux through various K channels.
- Phase 4 is the resting membrane potential. resting membrane potential is determined by external K concentration.
- The absolute refectory period is phase 0, 1, 2, and half of 3. So during this period, another stimulus cannot evoke an action potential in cardiac muscle.
- So cardiac muscles do not undergo tetanization. The relative refectory period is the remaining part of Phase 3 and Phase 4.

2.

- Pacemaker cells discharge rhythmically and spontaneously.
- After each impulse, membrane potential declines to a firing level. This fires another action potential. This declining potential is known as prepotential or pacemaker potential.
- Repolarization results due to the efflux of K.
- K+ efflux then declines and a channel permeable to both Na+ and K± is activated. (‘h’ channel or ‘f’ channel.) the current is produced as a funny current and it increases and the membrane begins to depolarize, forming the first part of the pre-potential.
- Opening of transient Ca+2 channels complete prepotential.
- Opening of long-lasting Ca+2 channels causes action potential.
- When the cholinergic vagal fibers to nodal tissue are stimulated, the membrane becomes hyperpolarized and the slope of the prepotentials is decreased because the acetylcholine released at the nerve endings increases the K +conductance of nodal tissue. This action is mediated by muscarinic receptors.
- This slows the opening of Ca 2+ channels and the result is a decrease in firing rate. Reduce heart rate.

- Stimulation of the sympathetic cardiac nerves speeds the depolarizing effect of funny current and the rate of spontaneous discharge increases and reaches the Firing level quicker causing an increased heart rate.
- Atropine is a muscarinic receptor blocker that blocks the action of acetylcholine.
- It causes inhibition of parasympathetic stimulation and allows to stimulate of sympathetic innervation of the heart.
- It results in a fall of membrane potential more rapidly and an increased slope of prepotential. It leads to an increased frequency of action potential.
- Results increase in heart rate.

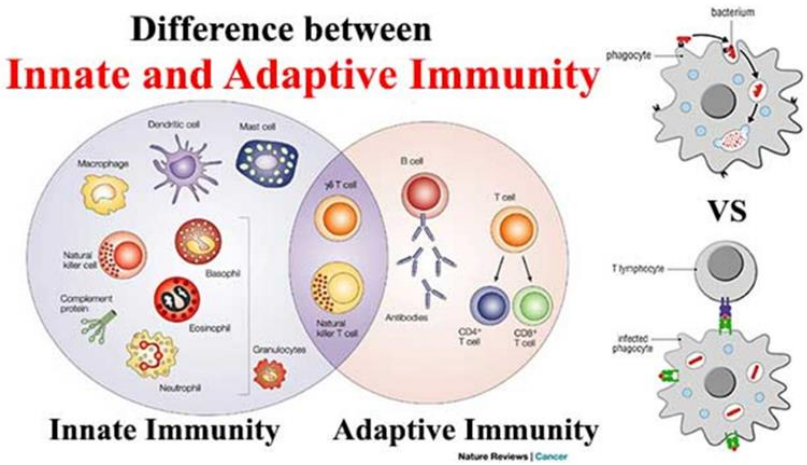
WBC and Immunity

1. A 32-year-old female presents to the emergency department with a high fever, severe sore throat, swollen lymph nodes, and a rash on her torso and extremities. She reports that the symptoms began suddenly two days ago. The patient has no significant past medical history and has not traveled recently. On examination, her vital signs are as follows: temperature 39.5°C, heart rate 110 bpm, blood pressure 120/80 mmHg, respiratory rate 18 breaths per minute, and oxygen saturation 98% on room air. The physical examination reveals an erythematous pharynx with exudates, tender cervical lymphadenopathy, and a diffuse maculopapular rash. Laboratory tests show elevated white blood cell count with a predominance of neutrophils. A rapid strep test is negative, and a throat culture is pending.

1. Explain the role of the innate immune system in the initial response to the patient's symptoms. Include the mechanisms by which the innate immune system recognizes and responds to pathogens.
2. Discuss the specific components of the innate immune response that would be involved in this clinical scenario and how they contribute to the symptoms observed
3. Describe the process by which the acquired immune system becomes activated following the initial innate immune response in this patient.
4. Discuss the potential long-term outcomes of the acquired immune response, including the development of immunological memory. How would this affect the patient if she encounters the same pathogen in the future?

Answers

1.



Innate immunity

- First-line defense.
- Immediate response.
- Non-specific immune response.

- recognizes pathogens through pattern recognition receptors (PRRs) such as toll-like receptors (TLRs) on the surface of immune cells – neutrophils, macrophages, and NK cells.
- Activates defense mechanisms.

Components of the innate immune system

- Phagocytic Cells: Neutrophils and macrophages are key phagocytic cells that engulf and destroy pathogens. The elevated white blood cell count with a predominance of neutrophils in this patient indicates an active neutrophil response to infection.
- Cytokines and Chemokines: Cytokines such as interleukin-1 (IL-1), tumor necrosis factor-alpha (TNF-α), and interleukin-6 (IL-6) are released by activated macrophages and other cells. These cytokines induce fever, promote inflammation, and recruit other immune cells to the site of infection. Chemokines direct the migration of immune cells to the infected tissues.
- Natural Killer (NK) Cells: NK cells recognize and kill infected cells by releasing cytotoxic granules.
- Complement System: The complement system consists of plasma proteins that enhance phagocytosis by opsonization, lyse pathogens, and promote inflammation. Activation of the complement system contributes to the recruitment of immune cells and the clearance of pathogens.

Symptoms and innate immune response

- Fever: Mediated by cytokines such as IL-1, IL-6, and TNF-α, which act on the hypothalamus to raise body temperature, enhancing immune function and inhibiting pathogen replication.
- Sore Throat: Caused by inflammation of the pharyngeal tissues due to cytokine release and immune cell infiltration.
- Swollen Lymph Nodes: Indicative of lymphocyte proliferation and immune activation within lymphoid tissues.
- Rash: Likely resulting from immune-mediated inflammation of the skin, possibly involving mast cells and the release of histamine and other inflammatory mediators.

Acquired Immunity

- Provide a specific response
- Activated by specific antigens
- Involves B and T lymphocytes
- components: humoral, cellular
- Humoral immunity – mediated by circulating immunoglobulin antibodies secreted by plasma cells (differentiated B cells), activates the complement system
- Cellular immunity – mediated by T lymphocytes: cytotoxic, helper.

Activation of acquired immunity

- Antigen Presentation: Dendritic cells and macrophages, after ingesting pathogens, process, and present antigens on their surface using major histocompatibility complex (MHC) molecules.
- Produce HLA (Human leukocyte Antigens) These antigen-presenting cells (APCs) migrate to lymph nodes where they interact with T lymphocytes.
- T Lymphocyte Activation:
- Helper T Cells (CD4+): Recognize antigens presented by MHC class II molecules on APCs. Upon activation, helper T cells secrete cytokines that promote the activation and proliferation of other immune cells, including B cells and cytotoxic T cells.
- Cytotoxic T Cells (CD8+): Recognize antigens presented by MHC class I molecules and kill infected cells directly.
- B Lymphocyte Activation:
- B cells recognize specific antigens via their B cell receptors (BCRs). Upon activation, and with the help of helper T cells, B cells differentiate into plasma cells that produce antibodies specific to the pathogen.
- Antibodies neutralize pathogens, facilitate opsonization (marking for phagocytosis), and activate the complement system.
- Helper T Cells: Secrete cytokines that enhance the activity of B cells, cytotoxic T cells, and macrophages.
- Cytotoxic T Cells: Destroy infected cells by inducing apoptosis.
- B Cells and Antibodies: Produce antigen-specific antibodies that neutralize pathogens and facilitate their removal.
- Memory T and B Cells: After the resolution of the infection, memory cells persist in the body, providing a rapid and robust response if the same pathogen is encountered again. This immunological memory is the basis for long-term immunity

Heart sounds and Murmurs

1. A 60-year-old male presents with exertional dyspnea and angina-like chest pain. Also, he complains of syncopal events while working in the garden. On auscultation, a harsh, murmur is best heard at the second right intercostal space that radiates to the carotid arteries. There is also a sustained, palpable thrill over the carotid arteries.

1.1 What is the murmur expect to hear?

1.2 What is the physiological basis of the murmur that is heard on auscultation?

1.3 Briefly explain the basis of his clinical symptoms.

- Exertional dyspnea
- Chest pain
- Syncope

Answers

1.1 Aortic stenosis

1.2

- The harsh, crescendo-decrescendo systolic murmur best heard at the second right intercostal space that radiates to the carotid arteries is characteristic of aortic stenosis.
- This murmur results from turbulent blood flow across the narrowed aortic valve during systole.
- The aortic valve consists of three cusps (tricuspid valve) that normally open during systole to allow blood to flow from the left ventricle into the aorta.
- In AS, there is narrowing or stiffening of the valve cusps, leading to reduced opening during systole.
- This narrowing obstructs the flow of blood creates a turbulent flow aortic valve and generates the murmur.
- Turbulent blood flow through the stenotic (narrowed) aortic valve creates vibrations that radiate along the blood vessels, particularly toward the aorta. This radiation is due to the transmission of sound waves through the blood column.

1.3

Exertional Dyspnea

- During exertion, the body requires increased oxygen delivery to the muscles and organs.
- In AS, this increased demand is compromised due to reduced stroke volume and cardiac output.
- This mismatch between oxygen demand and supply can lead to exertional dyspnea.

- The narrowing of the aortic valve obstructs the flow of blood from the left ventricle into the aorta. This obstruction increases the pressure within the left ventricle during systole making it harder for the heart to eject blood into the systemic circulation.
- In AS, due to increased pressure and stiffed left ventricle which has reduced compliance, it impairs its ability to relax and fill properly during diastole. This leads to reduced stroke volume and hence reduced cardiac output.

Chest pain

- Increased pressure within the left ventricle in AS and reduced coronary artery perfusion can cause myocardial ischemia, which manifests as chest pain or angina.
- Also, the heart compensates for the reduced cardiac output in AS by increasing heart rate and myocardial contractility leading to increased myocardial oxygen demand
- During exertion or stress, when the heart rate and contractility increase further, the oxygen demand exceeds the supply, leading to chest pain due to limited blood flow through the stenotic valve.

Syncope

- syncope in aortic stenosis typically occurs due to reduced cardiac output and cerebral perfusion caused by the obstruction of blood flow through the narrowed aortic valve.
- In severe AS, the narrowed aortic valve obstructs blood flow from the left ventricle to the aorta. This obstruction reduces the amount of blood that can be ejected into the systemic circulation.
- The reduced cardiac output compromises the delivery of oxygen-rich blood to the brain and other vital organs.
- During exertion or other activities that increase oxygen demand, the heart may not be able to compensate adequately for the narrowed valve. This can lead to a decrease in cerebral perfusion, causing dizziness or syncope.

Physiology of Shock

1. A 30-year-old female patient is brought to the emergency department after a motor vehicle accident. On arrival, she is hypotensive with a blood pressure of 90/60 mmHg, heart rate of 140 beats per minute, and oxygen saturation of 88% on room air. Physical examination reveals a rapid pulse and no signs of external bleeding. Also, rapid abnormal breathing was noted in the patient. Abdominal examination is notable for tenderness in the left upper quadrant. Focused assessment with sonography for trauma (FAST) reveals fluid in the abdomen consistent with hemoperitoneum.

1.1 What is the type of shock this patient suffered from after the accident?

1.2 What is the reason that leads to the above type of shock in this patient?

1.3 What are the clinical features that the patient has to prove your answer?

1.4 Discuss the compensatory reactions activated in this patient's body.

1.5 List 3 complications that may develop in this patient if she is not treated properly.

Answers

1.1. Hypovolemic shock

1.2

- As there are no signs of external bleeding, hypovolemic shock in this patient is due to acute major circulating blood loss secondary to trauma.
- Specifically hemoperitoneum due to internal bleeding from a suspected splenic injury.

1.3

- Low blood pressure- 90/60
- Pulse rate- 140bpm
- Rapid pulse
- Rapid abnormal breathing

1.4

- Initially, the decrease in circulating blood volume leads to decreased central venous pressure and subsequently preload.
- This results in decreased stroke volume and output leading to reduced arterial pressure.
- Then baroreceptors in the carotid sinus and aortic arch detect the decrease in blood pressure and activate the sympathetic nervous system.
- This results in the release of Catecholamines such as Epinephrine, and NE and also renal angiotensin system is activated. [Renin is secreted by the kidney]
- The release of catecholamines, particularly epinephrine, further enhances vasoconstriction and increases heart rate to maintain cardiac output.
- Renin convert Angiotensinogen in to Angiotensin 1.

- Angiotensin 1 converted into Angiotensin 2 by Angiotensin-converting enzyme [secreted by kidney]
- Angiotensin 2 stimulates the secretion of aldosterone by the adrenal cortex and stimulates the secretion of Vasopressin by the pituitary gland.
- Aldosterone increases water and sodium retention which leads to increased blood volume and cardiac output.
- Vasopressin act on systemic vessels and increase systemic vascular resistance increase after load resulting in increased cardiac output.
- This activation causes redistribution blood to vital organs like the heart, brain, and kidneys.
- Hypoxemia and metabolic acidosis may develop due to inadequate tissue perfusion, causing respiratory compensation (tachypnea).

1.4

- Acute renal failure.
- Myocardial infarction.
- Disseminated intravascular coagulation,
- Multi-organ failure, Death

Blood pressure and Hypertension

1. **The arterial blood pressure of a man was 120/90 mm Hg. Calculate the following in this man. (10 marks)**

a. Pulse pressure

• Pulse Pressure = Systolic Blood Pressure – Diastolic Blood Pressure

120 mm Hg – 90 mm Hg = 30 mm Hg

b. Mean arterial pressure

• Mean Arterial Pressure = Diastolic Blood Pressure + 1/3 (Systolic Blood Pressure – Diastolic Blood Pressure)

90 m Hg + 1/3 (120 – 90) mm Hg = 100 mm Hg.

2. **Explain the physiological basis of the measurement of systolic blood pressure by auscultatory method. (40 marks)**
    - In auscultatory method, which is a non-invasive method, blood pressure is measured by using a sphygmomanometer by detecting the changes of blood flow through the artery with changes in the pressure applied to it.
    - In here, the sounds generated due to the turbulent flow are detected using a stethoscope.
    - The hand, heart and the sphygmomanometer all should be placed at a same horizontal level.
    - Hand should be supinated with the arm relaxed, and the forearm preferably kept on a horizontal surface.
    - An inflatable pressure cuff is placed over the upper arm, (2-3 cm) above the cubital fossa and a stethoscope is placed over the brachial artery at the elbow, in the cubital fossa.
    - Radial pulse is also palpated.
    - The cuff is rapidly inflated about 30 mmHg above the expected systolic pressure in the brachial artery.
    - The point at which the pulse is no longer felt is the estimated systolic blood pressure.
    - The artery is occluded by the cuff and no sound is heard with the stethoscope.
    - When the external pressure exceeds the systolic blood pressure, which is the lateral distending pressure of the brachial artery, the artery becomes occluded which prevents blood flow downstream.
    - The pressure in the cuff is then lowered slowly.
    - Then the occlusion reduces and then the systolic pressure just exceeds the cuff pressure, blood slowly starts to flow through the artery.
    - As the velocity of the blood through that part is increased, it exceeds the critical velocity of the flow and becomes turbulent.
    - Turbulent blood flow creates a noise, a tapping sound is heard below the cuff over the stethoscope, synchronizing with each heartbeat.
    - A sound can be heard because blood flows through a narrowed brachial artery which causes the velocity of flow to be increased through the constriction according to

Bernoulli's Principle. (since total energy has to be conserved before, within and after the constriction)

- This causes the Reynold's number to be increased, higher than the critical point, which makes turbulence of blood flow more likely, which causes the described sound.

$$Re = VDp/n$$

- The Reynold's number is increased when velocity of flow is increased, despite the reduction in diameter at the constriction, because velocity has a greater effect on the Reynold's number than diameter.

$$V \propto 1/D2$$

- The pressure at which the sounds are first heard is the systolic pressure. • When the cuff pressure is lowered further, the sounds become louder, as more blood flows through the artery, then dull and muffled.
- When the cuff pressure is close to the diastolic blood pressure, the vessel is still constricted, but the turbulent flow is continuous, giving rise to the muffling sound.
- Finally, the sounds disappear, • The diastolic blood pressure (in resting adults) correlates with the pressure at which the sounds disappear. • It is due to that the artery is no longer constricted and therefore, blood returns to laminar flow, from turbulent flow, and laminar flow doesn't create a noise.
- These sounds are named the sounds of Kortokoff. • Systolic pressure estimation tends to be higher than that, made by the palpatory method, since palpation may fail to detect the fast tiny pulse.

3. Discuss how changes in vessel wall structure contribute to age related changes in blood pressure.

- Blood pressure is usually expressed in terms of the systolic pressure over diastolic pressure.
- Systolic pressure is the maximum pressure during one heartbeat, and diastolic pressure is the minimum.
- Blood pressure is normally depicted as 120/70 mmHg.
- With age some changes occur in blood pressure.
- The systolic pressure normally rises with age.
- In men it is increased in a linear manner, but in women there is a ride in systolic blood pressure after the menopause.
- Because usually, female sex hormones act as a protective mechanism against increased BP.
- Therefore, men are more prone to such conditions than women of similar age.
- But with menopause, there is an overshoot in systolic pressure in women, passing the SBP level of men in similar age, due to the reduced blood concentrations of sex hormones.
- Diastolic pressure rises initially and then falls, due to the decreased recoiling of blood vessels, as their compliance is decreased.
- One of the factors affecting the blood pressure change with age, is Arteriosclerosis.
- It is the degeneration and stiffening of tunica media of vessels due to loss of elastin.

- It increases with age.
- The elastic function of vessels has a large contribution in maintaining the blood pressure level
- In systole, arteries stretch and decrease the systolic pressure acting as a pressure reservoir
- In diastole the stored pressure is released by recoiling. increasing the diastolic pressure.
- This is called the “Windkessel’ effect”.
- With age, when elastin is reduced, the systolic pressure in increased and the diastolic pressure is decreased.
- Therefore, the pulse pressure (SBP - DBP) is increased.
- Arterial wall waves reflect at sites of discontinuity, such as origin branching sites etc. and add on to the subsequent wave.
- Elastic arteries have slow reflections; therefore, the reflected wave is added to the late diastole.
- In stiff arteries, a rapid reflation happens, and the wave is added to the systolic peak, increasing the systolic pressure even further.
- Therefore, children have a higher diastolic and a lower systolic pressure due to higher amount of elastin in arteries.
- With age elastin reduces, and the reflection is added to the systolic peak.
- Another condition that comes with age is atherosclerosis.
- It refers to the intraluminal atheroma formation.
- Then the vessel caliber of the vessels is decreased, increasing the peripheral resistance and thus increasing the SBP and DBP.
- Also due to the endothelial dysfunction, decreased production of NO, which is the main vasodilator, impairs the vasodilation, increasing SBP and DBP in a similar pathway.
- Both Arteriosclerosis and atherosclerosis increase with age and can calcify causing further stiffening of the blood vessels.

Dehydration

A 50-year-old male is admitted to the ward with 3-day history of fever, vomiting, and diarrhea. He complains of body weakness. On examination, he is lethargic with dry mucus membranes, capillary refill time 4 seconds, heat rate 100(increased) Blood pressure normal. Body weight 46 kg. His body weight was 50kg 3 days back. Investigations

Na 138 (135 - 140)

K 3.5 (3.5 - 5.0)

1. How would you classify his dehydration (severity and type)?

2. What are the fluids that you may use to treat his dehydration?

3. Explain how 1 pint of normal saline administered intravenously would change the extracellular compartment and intercellular compartment.

4. What are the other measures you would take in the management of this patient?

Answers

1. Moderate, isotonic (isonatremic)
2. Normal saline, Hartman, can give ORS once vomiting is settled
3.
   - Normal saline, also known as 0.9% sodium chloride solution, is a common intravenous fluid used in medical settings to replenish fluids and electrolytes in the body.
   - it is isotonic
   - When 1 pint (which is approximately 473 milliliters) of normal saline is administered intravenously, it affects the extracellular and intracellular compartments differently due to osmotic forces.
   - The extracellular compartment includes all the body fluids outside the cells, such as blood plasma and interstitial fluid.
   - When normal saline is administered intravenously, it increases the volume of extracellular fluid due to the addition of water and sodium chloride. –
   - The osmolarity (concentration of solutes) of normal saline is similar to that of extracellular fluid, so it doesn't cause a significant shift of water between compartments. Therefore, the change in osmolarity in the extracellular compartment is minimal.
   - However, the increase in extracellular fluid volume can lead to improved hydration, increased blood pressure (temporarily), and enhanced perfusion of tissues.
   - The intracellular compartment refers to the fluid contained within the body's cells.
   - When normal saline is administered intravenously, it does not directly affect the intracellular compartment because it does not freely cross cell membranes.
4. Treat vomiting
   Find a cause for the fever, vomiting, and diarrhea

Cardiac Cycle and Cardiac Output

1) What is the importance of having an isovolumetric contraction and relaxation in the cardiac cycle?
2) The length of the diastole is higher than the systole. What is the benefit?
3) what is ejection fraction? what is the importance of clinical practice?
4) Explain the reason for the paradoxical splitting of the second heart sound that occurs in the Right Bundle Branch Block.

Answers

1)

- The reason for isovolumetric contraction and relaxation is to make the necessary pressure changes that are necessary to allow blood to flow into or flow out of the ventricles.
- The pressure in the aorta is about 80 mmHg. For blood to flow from the left ventricle should exceed the pressure in the aorta.
- When the Left Ventricle starts contracting the pressure in the LV rapidly overcomes the pressure in the left atrium leading to the closure of the mitral valve. At the same time the pressure in the LV is not sufficient to overcome the pressure in the aorta. So the semilunar valve remains closed.
- The ventricle continues contracting causing a time period in which there is an increase in pressure without volume change as both inlet and outlet are closed. This period is called the period of isovolumetric contraction.
- The isovolumetric contraction ends when the pressure in the left ventricle becomes higher than the pressure in the aorta, which will cause the semilunar valves to open and blood to flow from the left ventricle to the aorta to the arterial system all over the body.
- The reverse happens in isovolumetric relaxation. As the blood volume in the ventricle decreases and the left ventricle starts relaxing the pressure in the left ventricle falls.
- When the pressure gets below that of the aorta, the semilunar valve closes. However, the pressure in the ventricle is still higher than the pressure in the left atrium. So the mitral valve remains closed.
- So here too both the inlet and outlet are closed but as the ventricle is relaxing the pressure keeps falling. So till the pressure in the left ventricle falls below that of the left atrium, there is a time period when volume is constant and the pressure keeps falling.
- The falling pressure makes the pressure gradient open mitral valve. (as the pressure in the LV falls below that of the LA) and blood flows into the ventricle.

2)

- Cardiac muscle has the unique property of contracting and repolarizing faster when the heart rate is high.
- The duration of systole decreases from 0.27 s at a heart rate of 65 to 0.16 s at a rate of 200 beats/min. The reduced time interval is mainly due to a decrease in the duration of systolic ejection.
- However, the duration of systole is much more fixed than that of diastole, and when the heart rate is increased, diastole is shortened to a much greater degree. For example, at a heart rate of 65, the duration of diastole is 0.62 s, whereas at a heart rate of 200, it is only 0.14 s.
- This fact has important physiologic and clinical implications. It is during diastole that the heart muscle rests, and coronary blood flow to the subendocardial portions of the left ventricle occurs only during diastole. Furthermore, most of the ventricular filling occurs in diastole.

3)

- The amount of blood ejected by each ventricle per stroke at rest is 70–90 mL. The end-diastolic ventricular volume is about 130 mL. Thus, about 50 mL of blood remains in each ventricle at the end of systole (end-systolic ventricular volume).
- The ejection fraction, the percentage of the end-diastolic ventricular volume that is ejected with each stroke, is about 65%.
- The ejection fraction is a valuable index of ventricular function. In heart failure, the ejection fraction of the heart is reduced due to impaired contractility in systole or reduced filling during diastole; this results in inadequate blood supplies to meet the body's needs.
- Heart failure occurs when the heart is unable to put out an amount of blood that is adequate for the needs of the tissues. It can be acute and associated with sudden death, or chronic.
- Heart failure may also be systolic or diastolic. In systolic failure, stroke volume is reduced because ventricular contraction is weak. This causes an increase in the end-systolic ventricular volume, so that the ejection fraction falls from 65% to as low as 20%.
- In diastolic failure, the ejection fraction is initially maintained, but the elasticity of the myocardium is reduced so filling during diastole is reduced. This leads to inadequate stroke volume.

4) Two sounds are normally heard through a stethoscope during each cardiac cycle. The first is a low, slightly prolonged "lub" caused by vibrations set up by the sudden closure of the AV valves at the start of ventricular systole. The second is a shorter, high-pitched "dup" caused by vibrations associated with closure of the aortic and pulmonary valves just after the end of ventricular systole.

PHYSIOLOGY MOCK PAPERS & ANSWERS

MOCK MCQ

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 is/are true regarding both facilitated diffusion and active transport?

A. Are energy dependent
B. Require carrier proteins
C. Move solute from low to high concentration
D. Inhibited by competitive molecules
E. Participate in the transport of Na+ from intracellular to extracellular environment

2. Which of the following conditions does colloid osmotic pressure act as the main pathophysiological mechanism which causes oedema?

A. Cirrhosis liver
B. Nephrotic syndrome
C. Filariasis
D. Right heart failure
E. Protein malnutrition

3. Which of the following is/are true regarding formation of interstitial fluid in muscle capillary in health?

A. Protein content in interstitial fluid is negligible
B. Sodium ion is the principal determinant of colloid osmotic pressure
C. Osmosis occurs from capillaries to interstitial fluid compartment
D. The pressure at the arterial end is higher than that at the venous end
E. The filtration is due to the pressure difference between arterial and venous end

4. Which of the following is/are true regarding the generation of action potential of a sensory neuron?

A. At the 1st node of Ranvier
B. Following a sub-threshold stimulus
C. By the summation of graded potentials
D. Due to the opening up of voltage-gated Na+ channels
E. Due to efflux of K+ ions through voltage-gated K+ channels.

5. Which of the following is /are true regarding the action potentials of myocytes?

A. Action potential of the smooth myocytes spread through T tubules.
B. Cardiac muscle pacemaker cells have a plateau phase.
C. Gap junctions help in the transmission of action potential in cardiac muscles.
D. Repolarization of skeletal muscle is due to K+ efflux.
E. Initial depolarization of cardiac muscle is due to the opening of voltage-gated Na+ channels.

6. Which of the following is /are true regarding primary platelet plug formation in blood clotting?

A. Platelet to platelet cohesion.
B. Release of serotonin
C. ADP-dependent platelet aggregation.
D. VWF-dependent platelet adhesion.
E. Inhibited by secretion of prostaglandin.

7. Which of the following is/are true regarding the conducting tissue of the heart?

A. Internodal pathways are present in both atria
B. Fibrous layer in atrioventricular septum is electro-conductive.
C. Conduction velocity in the AV node is very low.
D. interventricular septum depolarizes from left to right
E. Depolarization of the myocardium extends from epicardial to endocardial direction.

8. Which of the following is/are true statements regarding cardiovascular physiology?

A. Preload of the heart increases when changing to supine from an upright position.
B. End diastolic Volume is increased in inspiration.
C. Aortic stenosis results in increased Afterload.
D. Afterload is decreased with reduced peripheral resistance.
E. Oxygen consumption of the heart increases to a greater extent in aortic stenosis than in aortic regurgitation.

9. Which of the following is /are true regarding the dynamics of blood flow?

A. 50% of total blood volume is in capillaries.
B. The greatest resistance to the blood flow is in capillaries.
C. Arteriolar distension leads to contraction of the smooth muscle.
D. In anemia, the decrease in O2 carrying capacity is partially compensated by improved flow of blood.
E. Blood flow tends to become turbulent with increasing velocity.

10. Which of the following statements is/are true regarding ECG

A. QRS complex follows the onset of ventricular contraction.
B. The PR interval in ECG is measured from the beginning of the P wave to the beginning of the QRS complex.
C. The V6 lead is usually placed in the midaxillary line at the same level as V4 & V5.
D. Action potential is spread from left to right in the interventricular septum
E. Recording from lead 'aVR' shows predominantly a positive deflexion

Single Best Answer Questions

1. A young boy who has met with an accident and had blood loss was admitted and given an infusion of 500ml intravenously. Following infusion plasma 125ml increased. What is the intravenous fluid?

A. 0.9% saline
B. 0.45% saline
C. 5% dextrose
D. 10% dextrose
E. Dextran

2. What is the function of tropomyosin in voluntary muscle contraction?

A. Bind to Ca2+ and initiate muscle contraction
B. Bind to myosin during muscle contraction.
C. Covering the myosin binding site in actin on rest
D. Releasing Ca2+ after propagation of action potential
E. Sliding on actin to produce shortening

3. A patient presents to your office complaining of extreme fatigue and shortness of breath on exertion that has gradually worsened over the past 2 weeks. On physical examination, you observe a well-nourished woman who appears comfortable but somewhat short of breath. Her vital signs include a pulse of 120, respiratory rate of 20 and blood pressure of 120/70. When she stands up her pulse increases to 150 and her blood pressure falls to 80/50. Her hematologic values are Hgb 7 g/dL, Hct 20%, RBC count 2 × 106/μl, and platelet count of 400,000/μl. On a peripheral smear, her RBCs are microcytic and hypochromic. What would be your diagnosis of this patient?

A. Aplastic anemia
B. Renal failure
C. Iron deficiency anemia
D. Sickle cell anemia
E. Megaloblastic anemia

4. A teenage boy with numerous nosebleeds was referred to a physician for evaluation prior to a minor surgery. His prothrombin time (PT) was 11 sec (11–15 sec normal), partial thromboplastin time (PTT) was 58 sec (25–40 sec normal), and bleeding time was 6.5 min (2–7 min normal). Which of the following is most likely abnormal in this young man?

A. Decreased platelet number
B. Defective platelets
C. Intrinsic pathway
D. Extrinsic pathway
E. Production of clotting factors by the liver

5. CD4 is a marker of

A. B cells
B. Helper T cells
C. Cytotoxic T cells
D. An activated macrophage
E. A neutrophil precursor

6. A 45-year-old man presents to the emergency room with a 2-week history of diarrhea that has gotten progressively worse over the last several days. He has minimal urine output and is admitted to the hospital for dehydration. His stool specimen is positive for parasitic eggs. Which type of WBCs would have an elevated number?

A. Eosinophils
B. Neutrophils
C. T lymphocytes
D. B lymphocytes
E. Monocytes

7. Which of the following is normally associated with an increased cardiac output?

A. Increased venous compliance
B. Cardiac tamponade
C. Surgically opening the chest
D. Moderate anemia
E. Severe aortic stenosis

8. A 50-year-old female patient at UMC has been diagnosed with a heart murmur. A murmur of relatively low pitch is heard maximally over the second intercostal space to the right of the sternum. The chest x-ray shows an enlarged heart. The mean QRS axis of the ECG is −45°. The diagnosis is

A. Mitral valve stenosis
B. Aortic valve stenosis
C. Pulmonary valve stenosis

D. Tricuspid valve stenosis
E. Tricuspid valve regurgitation

9. Which of the following is the most frequent cause of decreased coronary blood flow in patients with ischemic heart disease?

A. Increased adenosine release
B. Atherosclerosis
C. Coronary artery spasm
D. Increased sympathetic tone of the coronary arteries
E. Occlusion of the coronary sinus

10. Which of the following conditions often occurs in progressive hemorrhagic shock?

A. Increased capillary permeability
B. Stress relaxation of veins
C. Tissue alkalosis
D. Increased urine output
E. Increased mean systemic filling pressure

MOCK MCQ ANSWERS

1.

A. F-only active transport
B. T
C. F-active transport happens vice versa
D. T
E. F-only active transport

2.

A. T-as plasma proteins are produced in the liver any liver disease causes edema
B. T- glomerular filtering of proteins
C. F-lymphatic edema
D. F-elevated venous hydrolytic pressure
E. T

3.

A. T
B. F-plasma proteins
C. F-it is only a filtration, osmosis is driven into capillaries
D. T-close to heart
E. F-difference between starling forces.

4.

A. T
B. F
C. T -summation can happen after ARP
D. T
E. F

5.

A. F-no T system in smooth muscles, spread by varicosities
B. F -myocytes only
C. T
D. T
E. T

6.

A. T – facilitated by Thromboxane A 2
B. T – Release by platelets
C. T
D. T
E. T

7.

A. T
B. F- AV bundle is the only way of electrical conduction between the atria and ventricles.
C. T- lowest I SA and AV nodes fastest in purkinjie fibers.
D. T- causes the Q wave in ECG
E. T- endocardial to epicardial direction.

8.

A. T – increase venous return
B. T - \increase venous return
C. T – Increase resistance due to narrowed orifice
D. T
E. T - Pressure work requires more O2 consumption than volume work

9.

A. T - About 50% of total blood volume is in veins.
B. F - The greatest resistance is at arterioles.
C. T - Intrinsic contractility of smooth muscle in response to stretch.
D. T - Reduced resistance to blood flow due to reduced viscosity.
E. T - Re = VDρ/η (Reynolds Number equation].

10.

A. T
B. T
C. T - At midaxillary line in same horizontal plane as V4 and V5
D. T
E. Depolarization spreads away from the aVR lead.

Single Best Answer Questions

1. Answer A

2. Answer C

3. Answer C

The blood count values show that the patient is anemic. Her bone marrow is functioning and she has a normal platelet count but is generating a decreased number of abnormal RBCs. The microcytic (small), hypochromic (decreased intracellular hemoglobin) is a classic description of iron deficiency anemia. With renal failure, the patient would be anemic with normal RBCs. Sickle cell anemia has misshapen RBCs. Megaloblastic anemia is characterized by macrocytic (large) RBCs.

4. Answer C

The prothrombin time, a test of extrinsic pathway, is the time required for clot formation following the addition of tissue thromboplastin. This is normal so no problem with extrinsic. Partial thromboplastin time is a test of the intrinsic pathway. This is longer than normal so there

is a problem with the intrinsic pathway. Bleeding time tests platelets, and since this is normal there is no problem with the platelets.

5. Answer B

CD4 helper T cells recognize the MHC class II + peptide on the presenting cell. CD8 T cells recognize the MHC class I + peptide on the infected cell.

6. Answer A

Eosinophils constitute about 2% of the total WBC count but are produced in large numbers in people with parasitic infections.

7. Answer D

Decreased cardiac output can result from a weakened heart or from a decrease in venous return. Increased venous compliance decreases the venous return of blood to the heart. Cardiac tamponade, surgically opening the chest, and severe aortic stenosis will effectively weaken the heart and thus decrease cardiac output. Moderate anemia will cause an arteriolar vasodilation, which increases the venous return of blood back to the heart thus increasing cardiac output.

8. Answer B

This patient has a QRS axis of −45°, indicating a leftward axis shift. In other words, the left side of the heart is enlarged. In aortic valve stenosis, the left side of the heart is enlarged because of the extra tension the left ventricular walls must exert to expel blood out the aorta. Therefore, these symptoms fit with a patient with aortic stenosis. In pulmonary valve stenosis, the right side of the heart hypertrophies, and in mitral valve stenosis there is no left ventricular hypertrophy. In tricuspid valve regurgitation, the right side of the heart enlarges, and in tricuspid valve stenosis, no ventricular hypertrophy occurs.

9. Answer B

Several factors contribute to decreased coronary flow in patients with ischemic heart disease. Some patients will have spasms of the coronary arteries which acutely decreases coronary flow. However, the major cause of decreased coronary flow is an atherosclerotic narrowing of the lumen of the coronary arteries.

10. Answer A

A number of things occur in progressive shock, including increased capillary permeability, which allows fluid to leak out of the vasculature thus decreasing the blood volume. Other deteriorating factors include vasomotor center failure, peripheral circulatory failure, decreased cellular mitochondrial activity, and acidosis throughout the body. Usually, urine output strikingly decreases; therefore, the increased urinary output answer is incorrect. Tissue pH decreases and reverse stress relaxation of the veins occurs.

MOCK ESSAY PAPER

1. A. Compare and contrast the ionic basis of the pacemaker potential and the cardiac muscle action potential. (40)
   B. A healthy young man's blood pressure changes from 120/70mmHg to 110/76mmHg when standing from the supine position. Describe the changes in the following parameters (60)

   i) systolic blood pressure
   ii) diastolic blood pressure

2. A. Briefly explain the prolonged prothrombin time seen in severe liver disease (60)
   B. Explain the physiological basis for intravenous streptokinase injection in the treatment of myocardial infarction (40)

MOCK ESSAY PAPER ANSWERS

1.

A

Pacemaker cell action potential	Cardiac myocyte action potential
Initiation of the action potential is by the influx of funny sodium current	Initiated by the influx of ions that take place through the gap junction in an intercalated disk
Rapid depolarization due to rapid calcium influx	Rapid depolarization due to rapid sodium influx
Rapid repolarization due to potassium ion efflux, no initial and rapid repolarization phase	Initial rapid repolarization due to potassium ion efflux
No plateau phase	Plateau phase due to the opening of calcium channels causing calcium ion influx
No true resting membrane potential, around -60mV	Resting membrane potential is around -90mv
The threshold potential is -40mV	The threshold potential is about -60mV

B

i)

Systolic blood pressure is the blood pressure in the arteries during systolic ejection of the ventricular blood of the heart to the large vessels

Depends mainly on the stroke volume and peripheral resistance

Stroke volume is the amount of blood pumped by the heart in a single heartbeat, roughly 55-70ml

It is directly proportionate to venous return and cardiac contractility

And inversely proportionate to cardiac afterload (resistance to pump blood)

When standing up from a supine position venous return decreases

Cardiac preload is decreased, stroke volume decreased, therefore SBP decreased

This is minimized by the baroreceptor reflex

Which detects low blood pressure increases the peripheral vascular tone and increases cardiac contractility

If the decrease in blood pressure upon standing from the supine position is too great in magnitude it is known as orthostatic hypotension

ii)

Diastolic blood pressure in the blood pressure in the vessels during the diastolic phase of the cardiac cycle

Blood pressure is directly proportionate to stroke volume and peripheral vascular resistance

The major determinant is peripheral vascular resistance

When standing from the supine position, peripheral vascular resistance increases due to the baroreceptor reflex, causing the increased sympathetic tone

A drop in systolic blood pressure is sensed by the carotid sinus and baroreceptors, causing sympathetic outflow

2.

A

PT is the time taken to form a clot via extrinsic and common pathways

prolonged PT indicates that extrinsic or common pathways or both are impaired

In chronic liver disease liver functions are impaired

liver produces most of the clotting factors

Fibrinogen, factors II VII IX X are produced in the liver

Bile salts are produced in the liver and secreted via bile to GIT

which are important in fat digestion and absorption

Fat-soluble vitamins are absorbed with digested fat

So in liver disease absorption of vitamins A, D, E, and K is impaired

Vitamin K is important in gamma-carboxylation of

factors II VII IX X

liver is responsible for the clearance of tissue plasminogen activator

in liver disease due to

less production of clotting factors

lack of gamma-carboxylation of factors II VII IX X

decreased clearance of TPA

PT is prolonged

B

MI is the death of myocardium

due to inadequate blood supply to the heart muscle to satisfy its oxygen

requirement

Inadequate blood supply to the heart muscle is probably due to clotting of blood inside blood vessels (thrombus formation)

Streptokinase is a fibrinolytic bacterial enzyme which converts Plasminogen to plasmin (activates plasminogen)

plasmin lyses fibrin

produces fibrin degradation products which inhibits thrombin

therefore, streptokinase can be used to break blood clots which are formed within blood vessels

since FDP inhibits thrombin it prevents new clot formation inside blood vessels

MOCK OSPE QUESTIONS

1.

a) Identify the item

b) What is it used for?

c) Name two other items required for the process in.



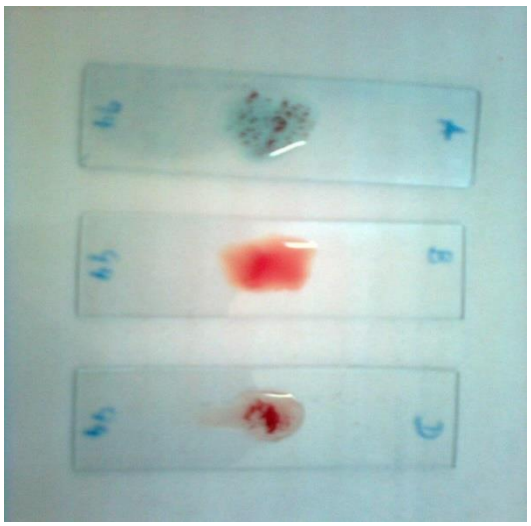
2.

This is regarding a test performed to detect the blood group of two individuals who got married recently

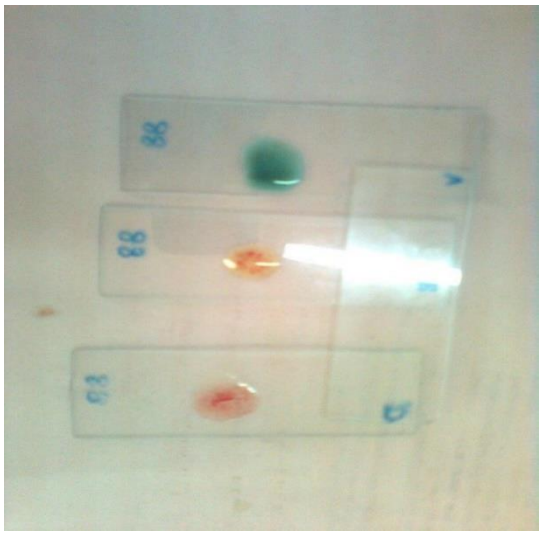
a. identify the blood group of the male and female

b. Write the genotype/s of the male and female

Male



Female

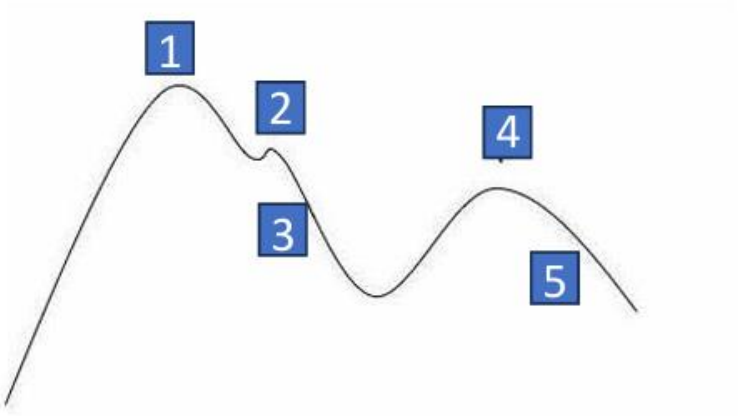


3.

Please examine the radial pulse of this patient (live station)

4.

Given below is the JVP waveform



a. Name 1,2,3,4,5
b. Mention two conditions
c. where you get abnormalities in 1

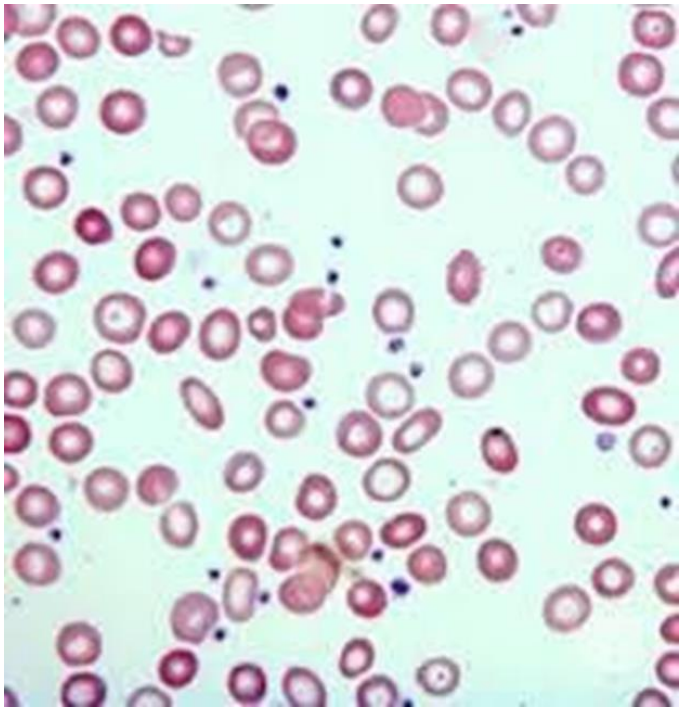
5.

An instrument used to measure the PCV of an individual is shown below



a. What is the name of the instrument
b. What is the name of the method that is used to measure the hematocrit using this instrument
c. Name two other important instruments needed to measure the PCV by this method

6.



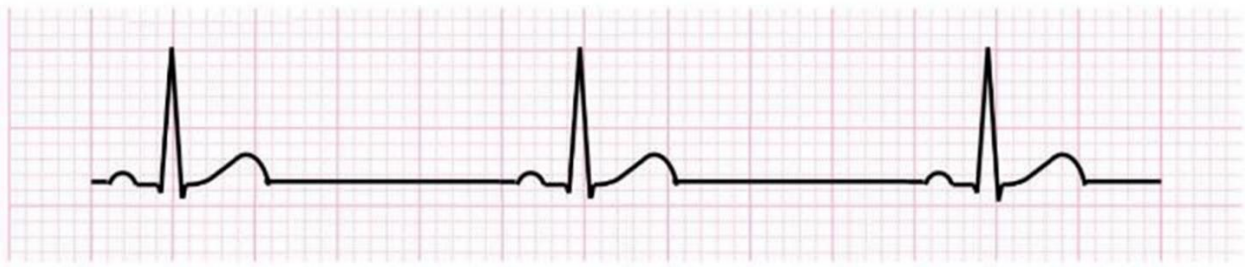
a. Name 3 abnormal cells seen in this blood picture
b. What is the hematological diagnosis?

7.



a. Identify the physical sign
b. Name 3 clinical conditions where you can observe this physical sign

8.



a. Calculate the heart rate in this ECG strip
b. What is the ECG diagnosis
c. Name one clinical condition where you can see this ECG pattern

9.

This instrument was used to examine a patient



a. Name the instrument
b. What is the parameter measured by this instrument

10.

Demonstrate how do you perform chest compressions in basic/advance life support (Live station)

MOCK OSPE ANSWERS

1. a. Number counting chamber
   b. To get red blood cell count/ white cell count
   c. Microscope, red cell/white cell pipette

2. a. Male A positive
   b. Female B positive
   Male AO or AA
   Female BO or BB

3. Marks will be given to, introducing yourself and taking consent, correct technique, correct pulse rate, and thanking the patient

4. a. i a wave
   ii c wave
   iii x
   iv v wave
   v y
   b. tricuspid stenosis
   c. pulmonary hypertension

5. a. centrifuge machine
   b. microhematocrit method
   c. capillary tube
   hematocrit meter

6. a. target cells, microcytosis
   b. iron deficiency anemia

7. a. pitting oedema
   b. heart failure, nephrotic syndrome

8. a. 60bpm
   b. sinus bradycardia
   c. hypothyroidism

9. a. mercury sphygmomanometer
   b. blood pressure

PHYSIOLOGY CONTINUOUS ASSESSMENT - 01

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 of following is/are, True/False regarding cellular receptors7
   A. G proteins are interfered by Cholera toxins.
   B. Receptor downregulation is facilitated by Lysosomes.
   C. Receptor upregulation is the reason for nitrate intolerance during GTN (Glyceryl Tri Nitrate) infusion.
   D. Second messengers are intracellular chemicals.
   E. Cell membrane receptors bind to steroid hormones.

2. Which of following is/are, True/False regarding membrane potential of a nerve or a muscle?
   A. All-or-none law is related to the opening of voltage gated potassium channel,
   B. Depolarization occurs at the nodes of Ranvier in myelinated nerve fibers.
   C. During relative refractory period, nerve can be excited with a stronger stimulus.
   D. membrane hyperpolarization is caused by decreasing extracellular potassium concentration.
   E. Plateau phase is related to the entry of calcium ions into the cell.

3. Which of following is/are, True/False regarding neurotransmitters,
   A. Acetylcholine is the most abundant excitatory neurotransmitter in the brain.
   B. GABA is the most abundant inhibitory neurotransmitter in the brain.
   C. Glutamate is important in memory functions.
   D. Increased dopamine levels cause sedative effect.
   E. Norepinephrine is important in stress reaction.

4. Which one of following are correctly linked with functions of adrenoceptors?

	Function	**Receptor**
A.	Bronchodilatation	beta 1.
B.	Increased myocardial contractility	beta l.
C.	Mydriasis	alpha 2.
D.	Tachycardia	beta 2.
E.	Vasoconstriction	alpha 1.

5. Which of the following mechanisms is/are primarily involved in the thermoregulation via skin?
   A. Increased production of melanin.
   B. Production of keratin by keratinocytes.
   C. Secretion of sebum by sebaceous glands.
   D. Synthesis of vitamin D.
   E. Vasodilation and vasoconstriction of dermal blood vessels.

6. Which of following is/are, True/False regarding haemoglobinopathies?
   A. Beta-Thalassemia is characterized by hypochromic microcytic anemia.
   B. Hemoglobin C disease is an autosomal recessive disorder.
   C. Hemoglobin S has higher affinity than hemoglobin F for oxygen.
   D. Hydrops fetalis is caused by absence of alpha globin chain.
   E. In alpha thalassemia, hemoglobin contains only alpha globin chain.

7. Which of following is/are, True/False regarding breakdown of RBC?
   A. Bilirubin diglucuronide formation occurs within the vessels.
   B. Bilirubin is converted to urobilinogen in the liver.
   C. Globin chain of the hemoglobin is converted to porphyrin.
   D. Heam part of the hemoglobin is reused after hemolysis.
   E. Urobilin is excreted in the urine.

8. Which of the following are correctly linked with the function of white blood cells
   A. Basophils - release of histamine.
   B. Cytotoxic T cells - organ transplant rejection.
   C. Eosinophils - acts against parasites.
   D. Monocytes - phagocytosis.
   E. Neutrophils - conversion to tissue macrophages.

9. Which of following is/are, True/False regarding acquired immunity
   A. Antigen presenting cells activate T lymphocytes.
   B. Complement is activated by antigen antibody complexes.
   C. Elevated IgG levels indicate a recent infection.
   D. Helper T cells secrete cytokines to activate B lymphocytes.
   E. Plasma cells are part of cell mediated immunity.

10. Which one of following is/are, Ture/False regarding cardiac murrnurs7
   A. Diastolic murmurs are usually pathologic.
   B. Mitral regurgitation causes mid diastolic murmur.
   C. Innocent murmurs are common in adults.
   D. Physiological murmurs are common during pregnancy.
   E. Regurgitant murmurs are due to incomplete closure of valves

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

11. A 60-year-old woman presented to her physician with swelling in both legs that had been gradually worsening over the past several weeks. On examination, pitting edema was noted up to the knees bilaterally. Laboratory tests revealed hypoalbuminemia.

Which of the following mechanisms is the most likely cause of her generalized oedema?

   A. Decreased plasma oncotic pressure.

B. Increased capillary hydrostatic pressure.
C. Increased capillary permeability.
D. Obstruction of lymphatic.
E. Retention of sodium.

12. A 25-year-old male presented to the emergency department with a history of persistent vomiting for the past three days. His laboratory results revealed the following:
    - Serum pH: 7.55
    - Serum bicarbonate (HCO3-): 36 mEq/L
    - Serum potassium (K+): 3.0 mEq/L
    - Arterial blood gas (ABG): pCO2 48 mmHg

What is the most likely acid-base disturbance in this patient†

A. Metabolic acidosis with respiratory compensation
B. Metabolic alkalosis with respiratory compensation
C. Mixed metabolic acidosis and respiratory alkalosis
D. Respiratory acidosis with renal compensation
E. Respiratory alkalosis with renal compensation

13. A 25 year-old athlete had undergone a Earning session to improve strength and endurance. During exercise, he experienced frequent muscle cramps.

Which of the following is the most likely explanation for the pathophysiology of his muscle cramps

A. Dehydration.
B. Electrolyte imbalance (e.g., hypokalemia, hyponatremia).
C. Lactic acidosis.
D. Fatigue due to muscle overuse.
E. Poor warm-up before exercise

14. A 4 year old girl was brought to the clinic with a complaint of fatigue. She had recently been treated for an infection. Blood investigations revealed the following.

RBC – 1.8 x 106 /ul

Reticulocytes count 10%

Hb – 7.2g/dL

PCV – 25%

MCV – 92 fL

WBC – 7.6 x 103/ml

Platelet count – 320 000/uL

These findings are compatible with

A. Aplastic anemia
B. Hemolytic anemia
C. Hereditary spherocytosis
D. Iron deficiency
E. Vitamin B12 deficiency

15. A 62-year-old female came to rite hospital with o complaint of headache end vertigo. The blood report showed the following:

Hemoglobin 189/dl WBC- 21,000/p1

Platelets - 640,000/p1

Erythropoietin levels were lower than normal.

Which of the following is the most likely diagnosis7

A. Leukemia
B. Leukocytosis
C. Polycythemia vera
D. Secondary polycythemia
E. Thrombocytosis

16. A 40-yen-old man presented to the emergency department with excessive bleeding after a minor surgical procedure. Laboratory tests revealed prolonged Prothrombin Time (PT) and Partial Thromboplastin Time (PTT).

Which of the following deficiencies is most likely responsible for these findings?

A. Factor IX deficiency.
B. Factor VII deficiency.
C. factor VIII deficiency.
D. Factor X deficiency.
E. Von Willebrand factor deficiency.

17. A 28 year old pregnant woman, who is Rh- negative, is at risk of hemolytic disease of the fetus and newborn (HDFN)

Which of the following mechanism best explains the development of HDFN in this scenario

A. Formation of maternal antibodies against fetal ABO blood group antigens
B. Formation of maternal antibodies against fetal Rh antigens crossing the placenta
C. Fetal production of antibodies against maternal red blood cells
D. Increased fetal erythropoiesis due to maternal iron deficiency
E. Fetal hemoglobinopathy leading to increased red blood cell destruction

18. A 35 year old man was brought to the emergency department after a motorcycle accident. He was conscious but appeared pale and diaphoretic. His blood pressure was 90/60mmHg, heart rate was 120bpm and respiratory rate was 24 breaths per minute. Based on these findings, which of the following changes is most likely to be occurring in this patient?
    A. Decreased renin release
    B. Decreased systemic vascular resistance
    C. Increased capillary hydrostatic pressure
    D. Increased cardiac output
    E. Increased sympathetic nervous system activity

19. A 55 year old male smoker presented to the emergency department with chest pain radiating to his left arm and shortness of breath. An electrocardiogram (ECG) was performed.
Which of the following is the most likely expected ECG change in this clinical scenario?

    A. Absence of P waves
    B. Prolongation of PR interval
    C. Prolongation of QT interval
    D. ST segment elevation
    E. T wave inversion in chest leads

20. A 68 year old male with a history of hypertension and coronary artery disease presented with shortness of breath, edema and fatigue.
Which of the following best explains the primary pathophysiology mechanism underlying heart failure in this patient?

    A. Decreased myocardial oxygen demand
    B. Decreased systemic vascular resistance
    C. Enhanced ventricular relaxation
    D. Impaired myocardial contractility
    E. Increased heart rate

MCQ PAPER ANSWERS

1. TTFTF
2. FTTTT
3. FTTFT
4. FTFFT
5. FFFFT
6. TTFTF
7. FFFTT
8. TTTTF
9. TTFTF
10. TFFTT
11. A
12. B
13. B
14. B
15. C
16. D
17. B
18. E
19. D
20. D

STRUCTURED ESSAY PAPER

1. A 3-year-old baby was admitted to the Emergency Department with reduced level of consciousness. He had vomiting and diarrhea for past three days with poor oral intake. He was lethargic with sunken eyes, cool peripheries, and prolonged capillary refilling time (>4 seconds). He we tachycardic with low volume pulse and low blood pressure. Investigations showed Na+ 135 (135 -140) and K+ 3.4 (3.5 -5.5).

1.1 Write how you would categorize the severity of dehydration in this case. (10 marks)

1.2 List 2 intravenous fluids that can be used to resuscitate this patient. (10 marks)

1.3 List 2 physiological characteristics of each intravenous fluid. (20 marks)

1.4 Explain the physiological basis for having tachycardia and hypotension of this patient (50 marks)

1.5 List 2 life-threatening complications of dehydration which could arise in above patient if not adequately treated. (10 marks)

2. A 45 year old female presented to a neurology clinic with complaints of progressive muscle weakness over the past six months. She reported that her symptoms initially started with drooping of her eyelids and double vision, which worsened as the day progressed. She also mentioned difficulty in chewing and swallowing, especially during meals. She denied any significant muscle pain. She had no significant past medical history and was not on any medication.

On examination, you observed ptosis and diplopia. The patient appeared fatigued, and her muscle strength decreased with repeated testing of muscle power. These clinical features improved with rest. Anticholinesterases were useful in the management of this patient.

2.1 Write the most likely diagnosis?
2.2 Write the key clinical features support this diagnosis.
2.3 With the help of a labelled diagram explain the mechanism of transmission of a nerve impulse from a somatic nerve to the skeletal muscle membrane
2.4 Briefly explain the reason for the decrease in muscle strength with repeated testing of muscle power in this patient.

SEQ PAPER ANSWERS

Q1

1.1. Severe dehydration (10 marks)

1.2. a) 0.9% NaCl/Normal saline (5marks)

b) Ringer-Lactate/Hartmann's solution/sodium lactate solution (5 marks)

1.3 a) Normal saline-

1) Isotonicity (5 marks)

2) Composition (5 marks) Na 154meq/L, Cl- 154 meq/L osmolarity 308 mOsm/L, PH around 5.5-6.5. OR

3) Acid base balance- slightly acidic due to its PH but generally doesn't alter the acid base balance

b) Ringer-Lactate solution-

1) Isotonicity (5 marks)

2) Composition (5 marks) Na+130, K+ 4, Ca++ 2.7, Cl- 109, Lactate 28, Osmolarity 273mOsm/L pH 6.5 OR

3) Buffering capacity - The lactate in the solution act as a buffer. Which correct acidosis.

OR

4) Electrolyte balance - it provides a balanced solution that more closely resemble the electrolyte composition of plasma, making it useful for replacing fluid and electrolytes in condition such as burns, surgery and trauma.

1.4

A. Tachycardia:

a) Due to significant fluid loss this patient is in hypovolemic shock (4 marks)

b) When the body loses a significant amount of fluid, the volume of blood circulating in the vessels decreases(hypovolemia)

c)This leads to reduced venous return to the heart,

d) which in turn decreases stroke volume

e) To maintain adequate cardiac output the heart rate increases to compensate for the reduced stroke volume.

f) Cardiac output is a product of heart rate and stroke volume (CO = HR x SV),

g) So, by increasing the heart rate, the body attempts to sustain sufficient blood flow to vital organs.

h) sympathetic overactivity due to hypovolemia and hypotension also contribute for tachycardia.

(3 marks for each answer from b to h)

B - Hypotension

1. Fluid Loss and Hypovolemia:

- Primary Cause: Vomiting and diarrhea result in the loss of large amounts of water, sodium, potassium, and other electrolytes.

This fluid loss decreases the volume of blood in the circulatory system (intravascular volume) (4 marks)

- The reduced blood volume leads to hypovolemia. (2 marks)

which directly reduces the venous return. (2 marks)

As a result, the heart has less blood to pump, leading to a decrease in stroke volume. (2 marks)

2. Decreased Cardiac Output:

- Cardiac output (CO) is determined by stroke volume and heart rate

(CO = Stroke Volume x Heart Rate) (3 marks)

With hypovolemia, stroke volume drops due to decreased venous return.

Even if the heart rate increases as a compensatory mechanism, the overall cardiac output may still be insufficient to maintain normal blood pressure. (5 marks)

The drop in cardiac output leads to hypotension (2 marks)

3. Compensatory Mechanisms and Their Limits:

Although the body attempts to compensate through mechanisms like sympathetic nervous system activation, Renin-Angiotensin-Aldosterone System (RAAS), and ADH secretion, these compensatory responses may become overwhelmed if fluid loss is severe or prolonged, leading to persistent hypotension. (5 marks)

1.5

A. Acute kidney Injury

B. Hypovolemic shock

C. Coma and death

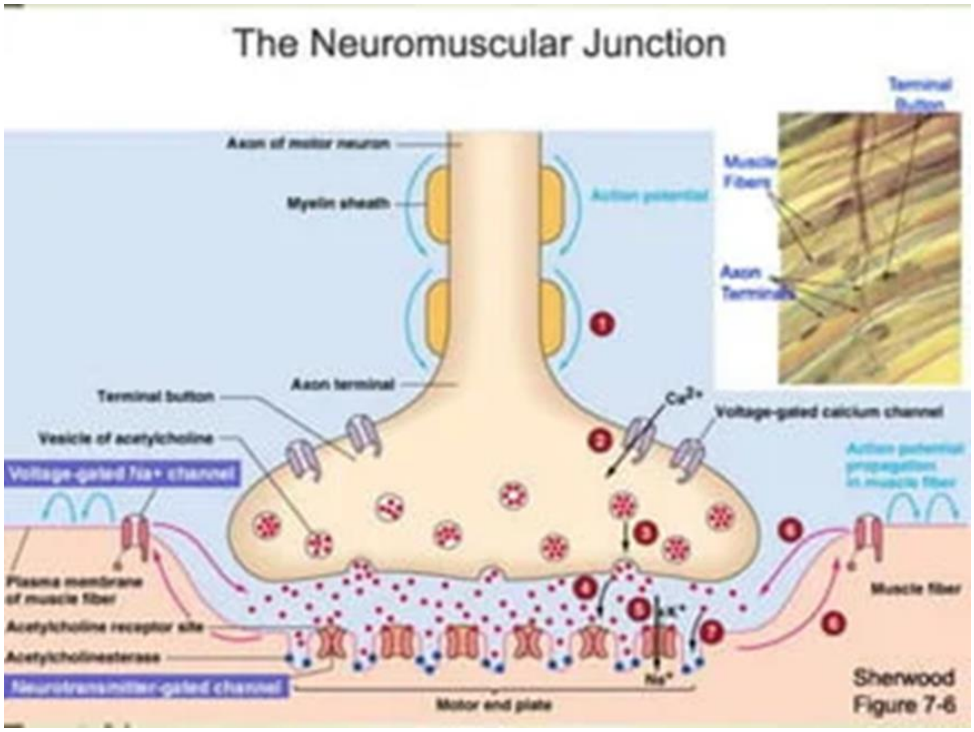
D. Cardiac arrythmias

E. Seizures

(Whichever 3 answers are accepted. Each one answer carries 5 marks)

2.1 Myasthenia gravis (10 marks)

2.2 Progressive muscle weakness that worsens with activity (5) and improves with rest (5), ocular symptoms (ptosis and diplopia) (5), bulbar symptoms (difficulty chewing and swallowing) (5) (total 20 marks)



1. An action potential (electrical signal) travels along the somatic motor neuron to the presynaptic terminal at the neuromuscular junction

2. The arrival of the action potential at the axon terminal causes voltage-gated calcium channels to open.

3. Calcium ions (Ca^{2+}) enter the terminal

4. Activate synaptic proteins (syntaxin, synaptobrevin, SNAP25)

5. Ach vesicles are docked to the inner surface of the presynaptic membrane

6. Exocytosis occurs

7. Leading to the release of the neurotransmitter acetylcholine (ACh) into the synaptic cleft

8. Ach binds to nicotinic Ach receptors on the muscle membrane

9. Ligand gated sodium channels on the muscle membrane opens

10. Na^+ influx occurs into the muscle

11. Resulting in depolarization of the muscle membrane

12. Initially causes end plate potential (EPP)

13. Once the membrane reaches the threshold level

14. Action potential is generated

15. Cholinesterase enzyme removes Ach

(2.5 marks each)

2.4 In myasthenia gravis antibodies are formed against Ach receptors. Many of the Ach receptors are inactivated. Availability of Ach receptors decrease with repeated stimulation. Therefore, muscle strength decreases with repeated stimulation. (20 marks)

OSPE QUESTIONS

Q1.

1.1 Identify following test tubes? (4 marks)



A



B



C



D

1.2 Mention one use for each tube? (6 marks)

Q2.



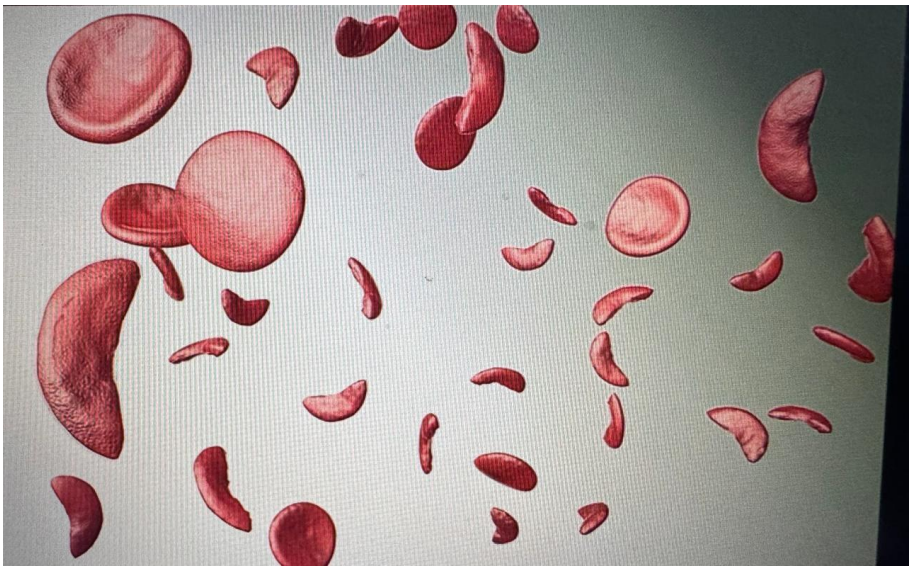
2.1 What is the ECG diagnosis? (4 Marks)

2.2 Mention a characteristic finding? (3 marks)

2.3 How this is differed from atrial fibrillation? (3 marks)

Q3.

A 12-year boy presents to the clinic with recurrent episodes of severe pain in his limbs and abdomen. A peripheral blood film is prepared to investigate the underlying condition.

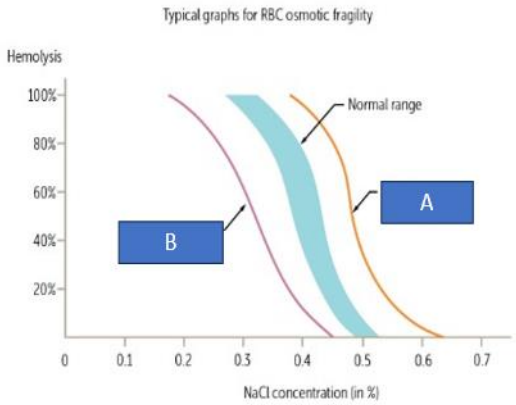


3.1 Identify the abnormal red blood cell shape you observed (4 marks)

3.2 What is the underlying genetic mutation that causes the RBC abnormality? (4 marks)

3.3 Name one other hematological test that can be used to confirm this disease? (2 marks)

Q4.

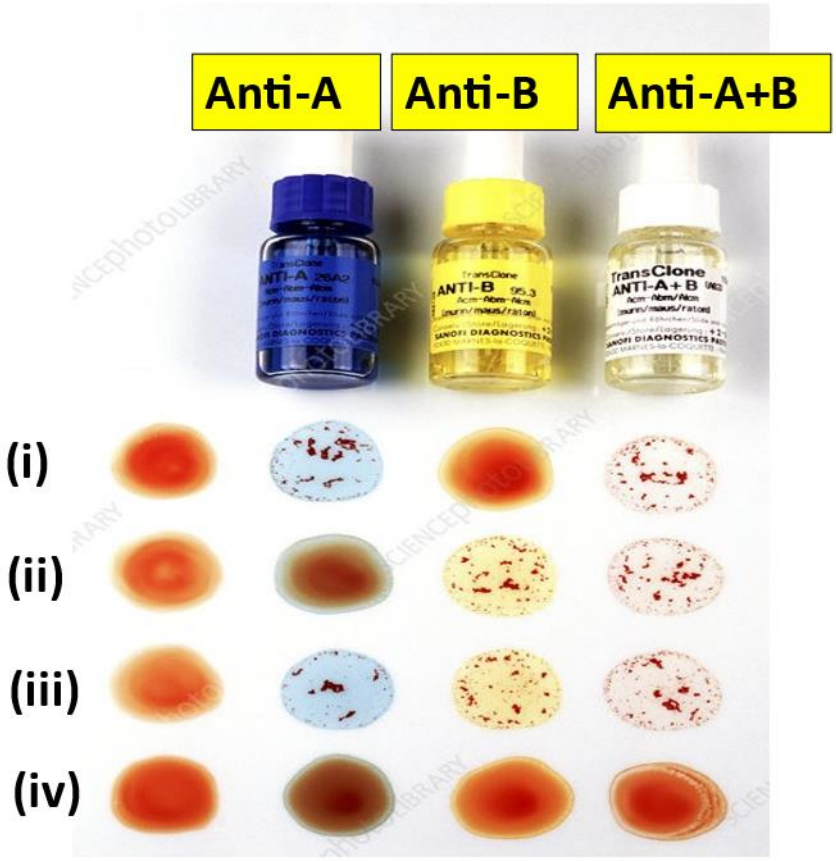


This is a graph of osmotic fragility test. Give a clinical condition that gives rise to

1. Curve A
2. Curve B

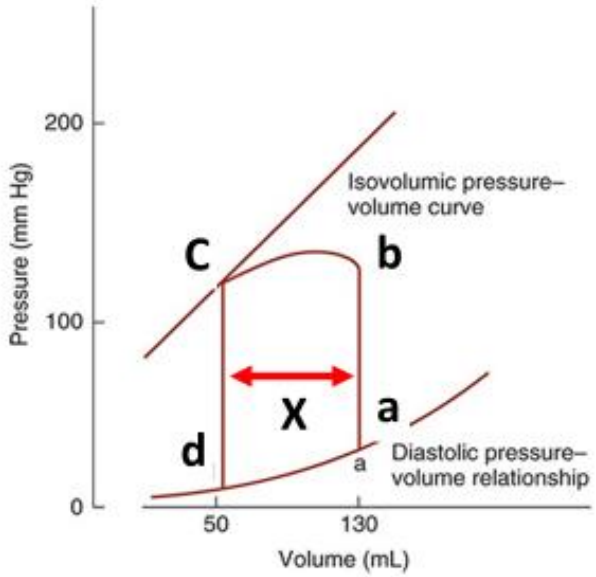
Q5.

Identify the blood groups.



Q6.

Below is the pressure volume loop of the left ventricle.



1. What are the cardiac events denoted by (8 marks)
   a. da
   b. ab
   c. bc
   d. cd
2. Write one condition where X is increased? (2 marks)

Q7.



7.1 Examine this photograph and identify the clinical sign present. (2 marks)

7.2 write two possible underlying causes of this condition, specifying whether they are pre-hepatic, hepatic, or post-hepatic (4 marks)

7.3. Name two relevant investigations that should be ordered to determine the cause of this condition (4 marks)

Q8.

(A Westergren tube is given)

8.1 Identify the equipment displayed (4 marks)

8.2 Name the test it is used for (2 marks)

8.3. Mention two clinical conditions that may cause an elevated test result (4 marks)

Q9.

Select the most appropriate solution for rehydration in the following conditions. (10 marks)

A. 0.9% NaCl B. ORS C. Plasma D. Whole Blood









1. Severe fluid loss in a burn injury
2. Hemorrhagic shock
3. Severe dehydration with vomiting
4. Mild diarrhea

Q10.

(Live station to assess the clinical skill of measuring blood pressure).

Please measure the blood pressure of this patient.

OSPE ANSWERS

1.
A. grey top tube – alcohol – glucose, lactate, blood
B. purple top tube – EDTA – FBC, blood picture
C. light blue tube – sodium citrate - coagulation
D. Red top tube – chemistry/serology/immune

2.
2.1 atrial flutter (4 marks)
2.2 Sawtooth/ flutter wave appearance (3 marks)
2.3 unlike atrial fibrillation where the atrial activity is chaotic and uncoordinated, atrial flutter has a more organized regular rhythm (3 marks)

3.
3.1 correct identification of sickle/crescent shaped red blood cell (4 marks)
3.2 Mutation in the HBB gene leading to the production of hemoglobin S (HbS) instead of normal HbA. (4 marks)
3.3. Hemoglobin electrophoresis (2 marks)

4.
4.1 Hereditary spherocytosis
4.2 Thalassemia, Sickle cell anemia

5.
i) A
ii) B
iii) AB
iv) O

6.
6.1
a) da – ventricular filling
b) ab – isovolumetric contraction
c) bc – Ventricular systole / ejection
d) cd – isovolumetric relaxation (marks 2 x4)
6.2
Aortic regurgitation / increased contractility (sympathetic stimulation)

7.
7.1 Icterus/jaundice (2 marks)
7.2 pre-hepatic - hemolytic anemia (4 Marks)
Hepatic- viral hepatitis
Post hepatic -biliary obstruction

7.3 Serum Bilirubin with direct and indirect fraction/ AST/ALT/ALP/Gama GT/FBC/Retic count/ Urine bile/urinary urobilinogen/Serum Haptoglobin. (Which evet two test -Each carry 2 marks)

8.
8.1 Westergren tube (3 marks)
8.2 ESR (3 marks)
8.3 tuberculosis/multiple myeloma/malignancy/Rheumatoid arthritis (whichever 2 answers- each carry 2 marks)

9.
i) C – plasma
ii) D – whole blood
iii) A - 0.9% NaCl
iv) ORS

10. Marks given for
i) introducing yourself and taking consent
ii) correct positioning of the patient
iii) palpation method
iv) auscultation method
v) writing blood pressure
vi) thanking the patient