TEST BANK PHYSIOLOGY

Done by abdallah alanzy

Feedback

اللهم علّمنا ما ينفعنا وانفعنا بما علّمتنا

A 65-year-old patient suffers a sudden cardiac event diagnosed as ventricular fibrillation (VF). Which structural component, essential for the heart to contract as a single functional unit, is responsible for the rapid, coordinated spread of depolarization necessary to prevent VF?

- A. Sarcoplasmic Reticulum (SR)
- B. T-Tubules at the A-I junction
- C. Desmosomes
- D. Gap junctions within the intercalated discs
- E. Titin filaments

D

When strong vagal stimulation temporarily stops the SA and AV nodes, the subsequent ventricular escape rhythm often takes 15-30 seconds to appear. This delay is largely explained by the phenomenon of overdrive suppression, which requires time to resolve because:

A. The ventricles must passively fill with blood.

B. The Purkinje fibers need to synthesize new gap junction proteins.

C. The enhanced $\mathrm{Na}^{+}/\mathrm{K}^{+}$ ATPase activity generated during overdrive must subside.

D. The AV node must repolarize from $-40\ \mathrm{mV}$ to $-90\ \mathrm{mV}$.

E. Ca^{2+} ions must be pumped out of the sarcoplasmic reticulum.

The repolarization of the slow-response action potential in the SA node is primarily driven by:

- A. The continued inward flux of Ca^{2+} through L-type channels.
- B. Increased permeability to Na^{+} ions.
- C. Increased permeability and efflux of K^{+} ions.
- D. Rapid closure of K^{+} channels.
- E. Active transport of Na^{+} out of the cell via the Na^{+}/K^{+} pump.

ربِّ زدني علمًا

The Sarcoplasmic/Endoplasmic Reticulum Calcium ATPase (SERCA pump) plays a crucial role in cardiac relaxation (diastole) by performing which function?

A. Extruding Ca^{2+} to the extracellular fluid.

B. Returning Ca^{2+} to the Sarcoplasmic Reticulum using ATP.

C. Maintaining the Na^{+} gradient across the cell membrane.

D. Activating the Ryanodine Receptors (RyR).

E. Triggering Ca^{2+} release from the SR during systole.

B

Compared to skeletal muscle, cardiac muscle cells are uniquely characterized by:

- A. A highly developed sarcoplasmic reticulum (SR) serving as the main source of Ca^{2+}
- B. Hyperplasia as the primary mechanism for increasing muscle mass.
- C. A functional syncytium created by low-resistance pathways allowing ion flux between cells.
- D. Voluntary control depending completely on neural input for contraction initiation.
- E. T-tubules located at the A-I junction of the sarcomere.

The embryonic heart typically begins to beat at approximately what stage of gestation, reflecting the vital need for immediate circulatory support?

- A. Second week of gestation
- B. Fourth week of gestation
- C. Eighth week of gestation
- D. Twelfth week of gestation
- E. Birth (post-partum)

حسبي الله لا إله إلا هو عليه توكلت

The parasympathetic nervous system decreases conduction velocity, primarily at the AV node (negative dromotropic effect). This mechanism relies on decreasing the permeability to:

A. K^+ and Cl^-

B. Na^+ and K^+

C. Ca^{2+} and K^+

D. Na^+ and Ca^{2+}

E. Cl^- only

Which component of the conduction system is characterized by the fastest conduction velocity, enabling near-simultaneous depolarization of the ventricular myocardium?

- A. Atrioventricular (AV) node
- B. Right and left bundle branches
- C. Sinoatrial (SA) node
- D. Internodal pathways
- E. Purkinje fibers

E

Under normal, resting, and aerobic physiological conditions, what is the primary energy substrate (fuel source) utilized by the adult myocardium for continuous ATP production?

- A. Glucose (via glycolysis).
- B. Lactate.
- C. Amino acids.
- D. Ketone bodies.
- E. Fatty acids

E

The pulmonary artery is classified as an artery because it:

- A. Carries blood rich in oxygen from the lungs.
- B. Contains muscular walls to withstand high pressure.
- C. Delivers deoxygenated blood to the lungs.
- D. Transports blood away from the heart (right ventricle).
- E. Returns blood from the periphery to the right atrium.

اللهم لا سهل إلا ما جعلته سهلًا

A researcher is comparing the ultrastructure of ventricular cardiomyocytes and thigh muscle fibers. Which key difference in the T-tubule system of the cardiac cell necessitates reliance on extracellular Ca^{2+} for contraction?

- A. Cardiac T-tubules are narrower and longer, impeding fluid exchange.
- B. Cardiac T-tubules are positioned at the A-I junction, creating two per sarcomere.
- C. The cardiac T-tubule system is entirely absent, forcing reliance on surface membrane channels.
- D. The sarcoplasmic reticulum (SR) in cardiac muscle is poorly developed, and cardiac T-tubules are short and wide, facilitating greater ECF Ca^{2+} exchange.
- E. Cardiac T-tubules contain dihydropyridine receptors that directly block ryanodine receptors (RyR).

The rapid and synchronized contraction of the ventricles is critical for efficient blood ejection. The primary histological feature that enables the Purkinje fibers to achieve extremely fast conduction velocity is:

- A. Reliance on fast {Na}^+ channels for Phase 0 depolarization.
- B. Their small cell diameter and high density of contractile filaments.
- C. Numerous gap junctions located at the intercalated disks.
- D. Exclusive innervation by the vagus nerve.
- E. Their location subendocardially along the interventricular septum.

اللهم افتح لي أبواب رحمتك

The valve located between the left atrium and the left ventricle is known by two names. Which of the following is one of those names, and how many cusps does it typically possess?

- A. Tricuspid Valve, 3 cusps
- B. Pulmonary Valve, 3 cusps
- C. Mitral Valve, 2 cusps
- D. Aortic Valve, 3 cusps
- E. Tricuspid Valve, 2 cusps

A Ventricular Septal Defect (VSD) primarily results in a shunt in which direction, and why?

- A. Right-to-Left, due to higher resistance in the pulmonary circuit.
- B. Right-to-Left, due to lower oxygen concentration in the right ventricle.
- C. Left-to-Right, due to the higher systemic pressure exerted by the left ventricle.
- D. Left-to-Right, due to the larger size of the right ventricle.
- E. Bypassing the heart chambers entirely.

A young male trauma victim presents with symptoms consistent with cardiac tamponade. The immediate physiologic cause of reduced cardiac output in this condition is primarily related to which feature of the pericardium?

- A. The visceral pericardium secreting excessive vasoconstrictive endothelin.
- B. Atrophy of the myocardium due to severed sympathetic nerve supply.
- C. The inability of the pericardial sac to rapidly stretch, leading to mechanical restriction of diastolic filling.
- D. The rapid depletion of ATP stores due to high mitochondrial activity.
- E. Chaotic electrical signaling originating in the atrial syncytium.

The two main coronary arteries originate directly from the:

- A. Pulmonary Trunk.
- B. Brachiocephalic Trunk.
- C. Arch of the Aorta.
- D. Ascending Aorta.
- E. Inferior Vena Cava

During Phase 0 of the ventricular action potential, the membrane potential rapidly rises toward which ion's equilibrium potential?

- A. (Potassium)
- B. (Chloride)
- C. (Calcium)
- D. (Sodium)
- E. (Magnesium)

D

What is the fundamental ionic mechanism responsible for establishing the sustained depolarization observed during Phase 2 of the cardiac action potential?

A. Rapid K^+ efflux through transient outward channels.

B. Opening of voltage-gated fast Na^+ channels.

C. Influx of Ca^{2+} through L-type slow channels balanced against reduced K^+ efflux.

D. Active transport of Na^+ out of the cell via the $\mathrm{Na}^+/\mathrm{K}^+$-ATPase pump.

E. A sudden increase in Cl^- influx through open chloride channels.

Which physiological state describes the condition of Angina Pectoris?

- A. Total cessation of blood flow leading to irreversible damage.
- B. Reversible ischemia caused by a blood flow decrease of >70%.
- C. Irreversible tissue necrosis due to prolonged lack of perfusion.
- D. The complete inability of the heart to pump blood forward.
- E. Fluid accumulation in the pericardial sac.

Compared to the SA node, the action potential in the AV node is characterized by which difference in its electrophysiological properties?

- A. The AV node begins from a less negative potential.
- B. The AV node has a steeper slope of Phase 4 depolarization.
- C. The AV node relies solely on fast Na^+ channels for Phase 0.
- D. The AV node takes longer to reach the threshold potential.
- E. The AV node possesses a prominent Phase 2 plateau.

The opening and closing mechanism of all four cardiac valves is primarily determined by which physiological factor?

- A. Active contraction of the papillary muscles.
- B. The tension exerted by the chordae tendineae.
- C. Electrical impulses generated by the SA node.
- D. The pressure gradient across the valve.
- E. The elasticity of the fibrous skeleton.

What is the essential mechanical function of the Papillary Muscles and Chordae Tendineae during ventricular contraction?

- A. Initiating the opening of the tricuspid and mitral valves.
- B. Preventing the semilunar valves from prolapsing into the ventricles.
- C. Actively closing the AV valves during ventricular relaxation.
- D. Preventing the AV valve leaflets from prolapsing backward into the atria.
- E. Generating the force required for blood ejection into the great arteries.

﴿ وَمَا تَوْفِيقِي إِلَّا بِاللَّهِ ﴾

Based on the patient's symptoms and LVEF of less than 30%, the most likely clinical diagnosis is:

- A. Stable Angina Pectoris
- B. Myocardial Infarction with ST Elevation
- C. Heart Failure with Reduced Ejection Fraction (HFrEF)
- D. Acute Pericarditis
- E. Severe Aortic Stenosis

An Ejection Fraction (EF) of 30% signifies that the patient's heart is primarily suffering from:

- A. Diastolic dysfunction (impaired filling).
- B. Hypertrophic Cardiomyopathy (excessive muscle thickness).
- C. Primary electrical conduction defect.
- D. Systolic dysfunction (impaired contractility and ejection).
- E. Valvular stenosis (narrowed outflow tracts).

A key distinction between the sarcolemmal NCX and the SERCA pump is their kinetic properties related to calcium handling. The sarcolemmal NCX is characterized by:

A. High affinity (K_m) and low capacity ($V_{\max}$).

B. Low affinity (K_m) and high capacity ($V_{\max}$).

C. Electroneutral exchange stoichiometry.

D. Dependence on Ca^{2+} channel blockers for activation.

E. High affinity and low capacity, similar to the sarcolemmal Ca^{2+} pump.

B

The unique absence of sustained maximal contraction (tetany) in cardiac muscle, compared to skeletal muscle, is primarily attributed to which electrophysiological property?

- A. The heart's reliance on fatty acids as the main energy source.
- B. TheNa+/K+ ATPase pump activity being suppressed by the SA node.
- C. The long refractory period caused by the sustained plateau phase (Phase 2) of the action potential.
- D. The Purkinje fibers having the fastest conduction velocity.
- E. The low percentage (less than 1%) of autorhythmic cells in the myocardium.

c

During myocardial ischemia, excess cytosolic Ca2+ enters the mitochondria. To prevent mitochondrial overload, the mitochondrial Na+/Ca2+ exchanger is activated. Which statement correctly describes this pathological exchanger?

A. It is electrogenic, exchanging $3\mathrm{Na}^{+}$ in for $1\mathrm{Ca}^{2+}$ out.

B. It is electroneutral, exchanging $2\mathrm{Na}^{+}$ in for $1\mathrm{Ca}^{2+}$ out.

C. It relies on ATP hydrolysis as its primary energy source.

D. It is constitutively active and provides 90% of diastolic calcium clearance.

E. It directly regulates the Phase 2 plateau duration.

B

A patient is diagnosed with Aortic Valve Regurgitation. When does the resulting heart murmur typically occur, and why?

- A. Systole, due to flow through a narrowed valve (stenosis).
- B. Systole, due to backward flow into the Left Atrium.
- C. Diastole, due to backward flow from the Aorta into the Left Ventricle.
- D. Diastole, due to backward flow from the Right Ventricle.
- E. Holosystole, covering the entire period of contraction.

سبحان الله وبحمده

The essential physiological phenomenon known as "potassium rectification" during Phases 0, 1, and 2 is necessary to:

A. Speed up the conduction velocity through the AV node.

B. Ensure that the Na^{+} channels fully inactivate quickly.

C. Maintain the long plateau phase by preventing K^{+} efflux from overpowering the Ca^{2+} influx.

D. Achieve the rapid upstroke (Phase 0).

E. Cause a brief, initial hyperpolarization (Phase 1).

C

What is the role of the Ca^{2+} that enters the cardiac cell via L-type channels during Phase 2?

- A. To immediately cause muscle relaxation (lusitropy).
- B. To directly block Na^{+} channels, preventing Phase 0 recurrence.
- C. To act as a ligand, binding to the ryanodine receptor (RyR) and initiating Calcium-Induced Calcium Release (CICR).
- D. To provide 90% of the total cytosolic Ca^{2+} required for contraction.
- E. To maintain the Na^{+} concentration gradient.

C

In the normal cardiac cycle, the depolarization of the atria is followed by mechanical atrial contraction (systole). The primary purpose of ensuring this contraction is completed before ventricular systole is to:

- A. Maximize K^+ efflux from the ventricular muscle.
- B. Ensure the ventricles are fully emptied of residual blood.
- C. Allow the ventricles to complete relaxation (diastole).
- D. Maximize ventricular filling, utilizing the atrial kick for stroke volume.
- E. Minimize the absolute refractory period in the ventricular muscle.

During the rapid ejection phase of ventricular systole, which pressure relationship holds true, causing blood to flow out of the ventricles?

- A. Atrial pressure > Ventricular pressure
- B. Arterial pressure > Ventricular pressure
- C. Ventricular pressure > Arterial pressure
- D. Right Ventricular pressure > Left Ventricular pressure
- E. Atrial pressure is zero

When Left Ventricular pressure is higher than Left Atrial pressure, the Mitral Valve closes. This closure is initiated by:

- A. The active pull of the chordae tendineae.
- B. The rapid inward movement of the valve leaflets due to the pressure difference.
- C. The tension exerted by the papillary muscles.
- D. The onset of atrial contraction.
- E. The high oxygen tension in the left ventricle.

In the sequence of events leading to contraction, the binding of Ca2+ to Troponin C is immediately preceded by:

A. The closure of L-type Ca^{2+} channels.

B. The pumping of Ca^{2+} out of the cell via NCX.

C. The rapid, massive release of Ca^{2+} from the Sarcoplasmic Reticulum (SR).

D. Final repolarization (Phase 3).

E. Increased K^{+} conductance.

استغفر الله العظيم

Given the equilibrium potential for Ca2+ is approximately +120~mVand the resting membrane potential is -90mV ,which statement accurately describes the forces governing Ca2+ movement during the action potential?

A. There is a strong electrochemical gradient favoring Ca^{2+} efflux out of the cell.

B. The electrical gradient for Ca^{2+} is negligible, but the chemical gradient favors influx.

C. The membrane potential must reach $+120\mathrm{mV}$ for Ca^{2+} entry to cease.

D. There is a massive electrochemical gradient favoring Ca^{2+} influx into the cell.

E. The Nernst equation cannot be used to calculate E_{Ca} because calcium is divalent ($z = 2$).

An LVEF of 30% strongly places the patient in the high-risk category for sudden cardiac death, necessitating consideration for which advanced intervention?

- A. Lifestyle changes only.
- B. Routine aspirin therapy.
- C. Evaluation for an Implantable Cardioverter-Defibrillator (ICD).
- D. Immediate coronary artery bypass graft (CABG).
- E. Strict fluid restriction only.

An experimental drug shortens the Phase 2 plateau of the ventricular myocyte. If this drug were administered, which immediate mechanical outcome would be most concerning?

- A. Decreased heart rate (negative chronotropy).
- B. Failure of the Na+K+ATPase pump.
- C. Susceptibility to wave summation and cardiac tetanus.
- D. Increased dependence on intrinsic pacemaker activity.
- E. Accelerated repolarization due to reduced K+ efflux.

Upon binding Ca2+, the Troponin-Tropomyosin complex undergoes a conformational change that permits contraction by:

A. Directly hydrolyzing ATP to power the cross-bridge cycle.

B. Exposing the Ca^{2+} binding sites on the myosin filament.

C. Activating the SERCA pump to increase Ca^{2+} uptake.

D. Shifting Tropomyosin off the Actin binding sites, allowing myosin attachment.

E. Inhibiting the $\mathrm{Na}^{+}/\mathrm{K}^{+}$-ATPase pump.

D

If auscultation of this patient's heart revealed a loud, harsh, holosystolic murmur best heard at the apex and radiating to the axilla, this would suggest failure of which valve/structure, which is a common consequence of HFrEF?

- A. Aortic Stenosis
- B. Mitral Regurgitation
- C. Tricuspid Stenosis
- D. Pulmonary Regurgitation
- E. Aortic Regurgitation

Sympathetic stimulation exerts a powerful influence on the heart. Which of the following is an effect unique to the sympathetic nervous system compared to the parasympathetic nervous system?

- A. Increased heart rate (positive chronotropic effect).
- B. Decreased conduction velocity (negative dromotropic effect).
- C. Increased force of contraction in the ventricles (positive inotropic effect).
- D. Hyperpolarization of the SA node.
- E. Use of Acetylcholine as a neurotransmitter.

Understanding the cardiovascular and respiratory functions is the foundation of which life-saving procedure that supports both the heart and lungs when they stop functioning?

- A. Angiography
- B. Echocardiography
- C. Cardiopulmonary Resuscitation (CPR)
- D. Hemodialysis
- E. Artificial Respiration (only)

الحمد لله دائمًا وأبدًا

When examining the sarcomere, the T-tubule in cardiac muscle is located at which structure?

- A. The H zone.
- B. The M line.
- C. The A-I junction.
- D. The Z line.
- E. The I band center.

The electrical excitation of the cardiac muscle must precede mechanical contraction. If the autonomic inputs to the heart are severed (e.g., during a heart transplant), the heart continues to beat spontaneously. This observation primarily supports the conclusion that:

- A. Extracellular Ca^{2+} is the sole factor initiating contraction.
- B. Autonomic nerves initiate the heartbeat rhythm.
- C. Cardiac muscle is controlled by somatic (voluntary) nerves.
- D. The cardiac conduction system provides an intrinsic rhythm.
- E. The Purkinje fibers act as the primary pacemaker under all conditions.

Which component of the conduction system is primarily responsible for distributing the electrical impulse rapidly and almost simultaneously throughout the entire ventricular walls?

- A. Atrioventricular (AV) node
- B. Right and left bundle branches
- C. Sinoatrial (SA) node
- D. Internodal pathways
- E. Purkinje fibers

E

In which structure does the most significant electrical delay occur, ensuring that atrial contraction is completed before ventricular contraction begins?

- A. Sinoatrial (SA) node
- B. Internodal pathways
- C. Atrioventricular (AV) node
- D. Atrioventricular (AV) bundle
- E. Right and Left Bundle Branches

اللهم صلّ وسلم على نبينا محمد

If the atria and ventricles were to contract simultaneously, the physiological outcome would most likely be:

- A. Increased cardiac output due to synchronized chamber emptying.
- B. Decreased efficiency of pumping and impaired cardiac function.
- C. A prolonged phase 2 in ventricular contractile cells.
- D. A necessary requirement for ventricular fibrillation.
- E. Hyperpolarization of the SA nodal cells.

Which phases typically present in a fast-response action potential are notably absent or reduced in the SA/AV nodal slow response?

- A. Phase 0 and Phase 3
- B. Phase 1 and Phase 2
- C. Phase 4 and Phase 3
- D. Phase 0 only
- E. Phase 4 only

B

A critical physiological characteristic of autonomic regulation is that the shape of the action potential peak in the SA node:

- A. Is significantly altered by both sympathetic and parasympathetic stimulation.
- B. Is prolonged by sympathetic stimulation and shortened by parasympathetic stimulation.
- C. Remains relatively unchanged by autonomic influences.
- D. Is driven by K^+ efflux during Phase 0.

The unstable Phase 4, or pacemaker potential, in SA nodal cells is the result of gradual depolarization toward the threshold. This spontaneous inward current is primarily driven by:

- **A. Rapid influx of** Na^+ **through voltage-gated channels.**
- **B. Efflux of** K^+ **ions causing hyperpolarization.**
- **C. Slow influx of** Na^+ **through (funny) channels.**
- **D. Inward current of** Ca^{+2} **through L-type channels.**
- **E. Rapid efflux of** Cl^- **ions.**

The rapid upstroke (Phase 0) of the SA nodal action potential, which occurs when the membrane potential reaches approximately -40 mV, is caused by the activation of which ion channel type?

- A. Fast voltage-gated Na+ channels
- B. Voltage-gated K+ channels
- C. K+leak channels
- D. Slow voltage-gated Ca2+ channels (L-type)

ربِّ اشرح لي صدري ويسّر لي أمري

If a researcher isolates a patch of SA nodal cells and chemically blocks the funny Na+ channels , what is the expected result on the spontaneous action potential cycle?

- A. Phase 0 depolarization would become faster.
- B. Repolarization (Phase 3) would be prolonged.
- C. The slope of Phase 4 depolarization would decrease.
- D. The membrane would hyperpolarize to \bm{-90 \text{ mV}}.
- E. The peak amplitude of the action potential would increase.

In a typical fast-response action potential of a ventricular contractile cell, the plateau phase is prolonged. This phase is characterized by the balance between:

A. Inward Na^{+} current and outward K^{+} current.

B. Inward Ca^{2+} current and outward K^{+} current.

C. Outward K^{+} current and outward Cl^{-} current.

D. Inward I_f current and outward K^{+} current.

E. Inward Na^{+} current and inward Ca^{2+} current.

B

The Purkinje system exhibits the fastest speed of electrical conduction among all cardiac tissues. What is the fundamental physiological purpose served by this rapid conduction velocity?

- A. To introduce a coordinated delay between atrial and ventricular contraction.
- B. To ensure instantaneous, synchronous contraction across both ventricles.
- C. To prevent the occurrence of ventricular escape.
- D. To compensate for the slow conduction speed of the SA node.
- E. To drive the intrinsic heart rate to 70-80 beats per minute.

Which statement best describes the primary function of the fibrous skeleton that separates the atria and ventricles?

- A. Provides a scaffolding for valve attachment.
- B. Anchors the Purkinje fibers within the myocardium.
- C. Ensures one-way conduction by actively propagating the signal from atria to ventricles.
- D. Acts as an electrical insulator, preventing direct transmission of impulses between the chambers.
- E. Contains the specialized autorhythmic cells necessary for initiating the heartbeat.

اللهم ارزقني فهم النبيين وحفظ المرسلين

A patient with refractory heart failure and concurrent atrial fibrillation (AF) is started on Digoxin. Digoxin is beneficial in this dual pathology because it provides:

A. Negative inotropy and positive chronotropy.

B. Positive inotropy (via Ca^{2+} retention) and negative dromotropy (via vagal effect).

C. Increased K^{+} efflux and accelerated AV conduction.

D. Direct antagonism of L-type Ca^{2+} channels.

E. Vasodilation and decreased systemic vascular resistance via direct smooth muscle effects.

B

A patient experiences a prolonged period of strong vagal stimulation. The heart rate decreases dramatically, and the SA node potential hyperpolarizes from -60 mV to approximately -70mV. This hyperpolarization makes the Phase 4 slope shallower by:

- **A. Increasing the Na^+ leak rate.**
- **B. Increasing the threshold potential.**
- **C. Increasing the time required to reach the fixed threshold potential.**
- **D. Activating L-type Ca^{2+}channels earlier.**
- **E. Inhibiting the K^+ efflux pathway.**

C

Chronic accumulation of residual blood in the ventricle due to the volume of blood entering exceeding the volume ejected (Stroke Volume) is the defining physiological characteristic of:

- A. Ventricular Fibrillation
- B. Normal Cardiac Output
- C. Heart Failure
- D. Sinus Tachycardia
- E. Overdrive Suppression

If a patient experiences severe aortic stenosis, leading to a chronically high systemic pressure against which the left ventricle must pump (increased Afterload), how is the Frank-Starling curve expected to shift?

- A. Upward and to the left (increased contractility).
- B. Downward and to the right (decreased stroke volume at a given preload).
- C. Only the preload (x-axis) will be affected.
- D. The curve remains constant as Afterload only affects heart rate.
- E. The plateau duration (Phase 2) shortens significantly.

اللهم اجعل هذا العمل خالصًا لوجهك

B