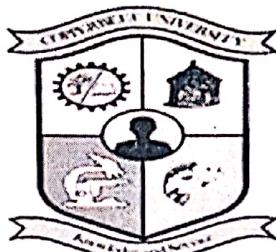


SEC A = 29.
SEC B =
SEC C = 26
~~255~~

210



THE COPPERBELT UNIVERSITY

MCS SCHOOL OF MEDICINE

END OF TERM ONE TEST – MARCH 2022

MBS 210 - PHYSIOLOGY

STUDENT NUMBER: PROGRAMME: MBChB

TIME ALLOWED: 3 hours

TOTAL MARK: 100 marks

INSTRUCTIONS:

1. Do not write your name, phone number or anything that discloses your identity on any other page apart from this page. Defaulters will have their evaluation nullified.
2. Write your computer number on every other page
3. Answer ALL questions in all **SECTIONS (A, B & C)**
4. Answer SECTION A in the grid sheet provided

SECTION A: CHOOSE THE SINGLE BEST OPTION [40 marks]
EACH QUESTION CARRIES 1 MARK

1. In which phase of the ventricular muscle action potential is potassium permeability the highest?
- A. 0
 - B. 1
 - C. 2
 - D. 3
 - E. 4
2. Which of the following best explains how sympathetic stimulation affects the heart?
- A. Permeability of the S-A node to sodium decreases
 - B. Permeability of the A-V node to sodium decreases
 - C. Permeability of the S-A node to potassium increases
 - D. There is an increased rate of upward drift of the resting membrane potential of the S-A node
 - E. Permeability of the cardiac muscle to calcium decreases
3. Myocardial contractility is best correlated with the intracellular concentration of
- A. Na^+
 - B. K^+
 - C. Ca^{2+}
 - D. Mg^{2+}
 - E. Fe^{2+}
4. During which phase of the ventricular action potential is the membrane potential closest to the K^+ equilibrium potential?
- A. Phase 0
 - B. Phase 1
 - C. Phase 2
 - D. Phase 3
 - E. Phase 4
5. During which phase of the ventricular action potential is the conductance to Ca^{2+} highest?
- A. Phase 0
 - B. Phase 1
 - C. Phase 2
 - D. Phase 3
 - E. Phase 4

6. Which of the following enzymes is responsible for phosphorylating myosin light chains to activate smooth muscle contraction?
- A. Calmodulin
 - B. Myosin light chain kinase
 - C. Myosin light chain phosphatase
 - D. Myosin ATPase
 - E. Actomyosin ATPase
7. Which characteristic or component is shared by skeletal muscle and smooth muscle?
- A. Thick and thin filaments arranged in sarcomeres
 - B. Troponin
 - C. Elevation of intracellular $[Ca^{2+}]$ for excitation-contraction coupling
 - D. Spontaneous depolarization of the membrane potential
 - E. High degree of electrical coupling between cells
8. A 56-year-old woman with severe muscle weakness is hospitalized. The only abnormality in her laboratory values is an elevated serum K^+ concentration. The elevated serum K^+ causes muscle weakness because
- A. the resting membrane potential is hyperpolarized
 - B. the K^+ equilibrium potential is hyperpolarized
 - C. K^+ channels are closed by depolarization
 - D. Na^+ channels are closed by depolarization
 - E. K^+ channels are opened by depolarization
9. How does the single-unit smooth muscle differ from multiunit smooth muscles?
- A. Single-unit muscle contraction speed is slow, while multiunit is fast
 - B. Single-unit muscle has T-tubules, while multiunit does not
 - C. Single-unit muscles are not innervated by autonomic nerves
 - D. Single-unit muscle produces action potentials spontaneously that spreads to neighbouring cells, while multiunit does not
 - E. They are all smooth muscles, they do not differ
10. In excitation-contraction of smooth muscle, calcium binds to which protein after influx into the cytoplasm?
- A. Calmodulin
 - B. Tropomyosin
 - C. Troponin C
 - D. Troponin I
 - E. Myosin
11. While attending an emergency care patient [soldier] who came from conflicted region of capital city KYIV at Ukrainian border with Russia, which of the following are isotonic fluids used for IV infusion?

- ✓ A. 1.9% NaCl
✓ B. 5% Dextrose
C. Fingers Lactate ~~S~~
D. 9% NaCl
E. 19% Dextrose solution
12. As a medical graduate, you got to infuse an IV solution at emergency department based on the particular patient's
✓ A. Serum electrolyte values
B. Liver-volume balance
C. Economic background
D. Attitude
E. NATO status
13. The function of gap junction or nexus that are present between two cells in any tissue is
✓ A. Transportation and communication between cells
B. Cl^- ions follows Na^+ ions
C. H_2O follows NaCl
D. Ca^{++} pumped out
E. 3 K^+ pumped out
14. Example for integral proteins of cell membrane: _____
A. Carriers
B. Channels
✓ C. Integral protein band 3
D. Antigen
E. Spectrin
15. Plasma membrane Action as semi permeable barrier aids to _____
✓ A. Maintains difference in composition of ICF & ECF & fluid in various organelles
B. Protects cell from toxic substances
C. Excretion of waste products
D. Transport of nutrients
E. Cell growth
16. Example for Passive transport mechanism across cell membrane _____
A. Voltage gated diffusion
✓ B. Facilitated diffusion
C. Exocytosis
D. Endocytosis
E. Sodium potassium pump
17. Example of an active transport mechanisms across cell membrane is _____
A. Cytolysis
B. Facilitated diffusion

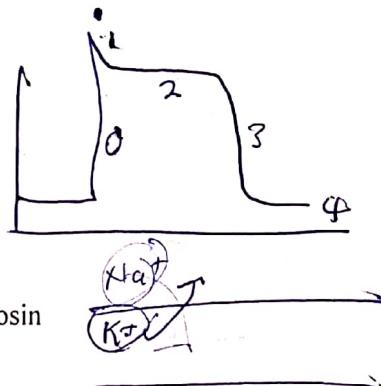
- C. Filtration
 - D. Secondary active transport
 - E. Osmosis
18. Skeletal muscle number is fixed at time of birth in humans. Which of the following hormones stimulate muscle hypertrophy?
- A. Estrógen
 - B. Growth hormone
 - C. Oestrone
 - D. Adrenaline
 - E. T4
19. Functional significance of sarcoplasmic reticulum in muscle cells is _____
- A. Membranous sacs which encircles each myofibril
 - B. Stores and release calcium ions (Ca^{++})
 - C. Release of Na^{+} triggers muscle contraction
 - D. Develops action potential
 - E. Releases sodium ions
20. Regarding contractile filaments in a skeletal muscle
- A. Function in the non contractile process
 - B. Three types of filaments (Thick, medium and Thin)
 - C. There are two thin filaments for every thick filament
 - D. Secrete Ca^{++}
 - E. Myosin are thin filaments
21. Regarding Sarcomeres
- A. Compartments of arranged fibres
 - B. Basic functional unit of a myofibril
 - C. Secrete Ca^{++}
 - D. Generate action potential
 - E. Has voltage
22. Regarding myosin filaments
- A. Thin filaments
 - B. Functions as a motor protein which cannot achieve motion
 - C. Convert ATP to glucose of motion
 - D. Projections of each myosin molecule protrude outward (myosin head)
 - E. Actin has cross bridges
23. Regarding Actin filaments in skeletal muscles
- A. Thick filaments
 - B. Actin molecules provide a site where a myosin head can attach
 - C. Tropomyosin and troponin are branched part of the thin filament
 - D. Doesnot contract
 - E. Has cross bridges

24. Physiotherapy is a branch of contemporary medicine that focuses on neuromuscular rehabilitation of patients. The total strength of a contraction in a muscle depends on the

- A. Motor neurons
- B. Less motor units
- C. Number of motor units that are activated
- D. Stimulus strength
- E. Energy drink

25. During Relaxation period of a simple muscle twitch:

- A. Na^+ is transported into the SR
- B. Myosin-binding sites are covered by tropomyosin
- C. Myosin heads attach from actin
- D. Power stroke of myosin occurs
- E. Binding sites are open always



26. Visualize an ACTION POTENTIAL curve, as it is. Regarding repolarization phase ;

- A. It is the decrease in cell electronegativity
- B. It is the increase in cell electropositivity outside
- C. It is the decrease in cell electropositivity inside of nerve membrane
- D. It is the decrease in cell electronegativity outside
- E. No voltage change

27. We are living in modern world of artificial intelligence. Still robots with AI brain, can never replace a human as best friend. An action potential in a nerve fibre

- A. Has amplitude which varies directly with the strength of the stimulus
- B. Induces graded electrical currents in adjacent segments of the fibre
- C. Is associated with a transient decrease in membrane permeability to potassium
- D. Is associated with a transient increase in membrane permeability to sodium
- E. Is associated with a transient increase in membrane permeability to Aluminium

28. Fast inhibitory postsynaptic potentials (IPSP);

- A. Are produced by the process of indirect inhibition
- B. Are a consequences of presynaptic facilitation
- C. Interact with other fast and slow potentials to move the membrane potential of the postsynaptic neuron toward or away from the firing level
- D. Are produced by a decrease in potassium permeability
- E. Donot exist

29. About synapses;

- A. Electrical synapses can be found between a neuron and a neuron
- B. Physical synapses can be found between a neuron and a muscle
- C. Chemical synapses cannot be found between a neuron and a neuron

- D. Chemical synapses can be found between a neuron and a bone
 - E. Exists inside bone
30. BMW group is at the forefront of global market in innovation of using AI sensors for automobiles. The following is related to nerve conduction senses in humans:
- A. Neurons not communicate with each other by synapses
 - B. A synapse is typically formed between an axon of a neuron and the dendrite of another neuron
 - C. Nerve impulses go from the axon to the nerve body and down the axon to the next synapse
 - D. The only form of transmission of an impulse from one neuron to another is direct electrical connection
 - E. Nerve impulse is a fiction
31. Regarding the sodium potassium pump;
- A. It transports sodium and potassium by breaking down ATP
 - B. Has no beta subunit with transportation occurring on the beta subunit
 - C. 3 sites inside the cell are for potassium and 2 sites on the extracellular allow sodium to bind
 - D. Pumps 2Na^+ outside to function
 - E. Pumps chloride ions
32. The following statement is true about electrical potentials of cells;
- A. Only plant cells have a resting membrane potential
 - B. Only excitable cells such as the muscle and neuronal cells have an action potential
 - ~~C.~~ Resting membrane potential is the transmembrane voltage that exists in a channel
 - D. Action potentials are fluctuating electrochemical changes across the mitochondria
 - E. Mitochondria generate action potentials
33. After understanding decades of neural research on living neurons, our scientists in modern world have developed neural schema in an AI robot. The following statement is true about electrical potentials of nerve cells;
- A. Action potentials are initiated by an appropriate stimuli and when not stimulated a cell membrane is at rest is called ALL or NONE law
 - B. Action potential are non-fluctuating but propagating membrane potential changes
 - C. Resting membrane potentials cannot be disturbed in cells
 - D. Local potentials can summate and propagate
 - E. Local potentials = Action potential
34. The following statement is true about RMP of cells;

- A. Action potential for muscle membrane at the NMJ is known as electro plate potentials
- B. Action potentials can summate to cause a larger impact
- C. All or none LAW implies that all action potentials are propagatable but none are summative
- D. The resting membrane potential can be hyperpolarizing
- E. RMP = Action potential

35. About the Na^+K^+ pump of cell membranes, the following hold true;

- A. All cells have the Na^+K^+ pump that pumps in Na^+ and takes out K^+ of the cell actively
- B. The Na^+K^+ pump breaks down ATP to ADP and a phosphate with the energy released being used to pump the ions
- C. The Na^+K^+ pump does not require it beta subunit to operate
- D. The Na^+K^+ pump is a synthetic pump
- E. A sympathetic pump

36. The property of muscle ability to contract forcefully when stimulated is _____

- A. Contractility
- B. Reproducibility
- C. Responsibility
- D. Excitability
- E. Elasticity

37. NATO soldiers are fighting along with Ukrainian forces, at Russia border. Ability of muscles to stretch without being damaged during a military action is _____

- A. Contractility
- B. Reproducibility
- C. Elasticity
- D. Excitability
- E. Extensibility

38. Neurons that stimulate skeletal muscle to contract are labelled as _____

- A. Visceral neurons
- B. Somatic motor neurons
- C. Basal ganglion
- D. Hypothalamus
- E. Sympathetic neurons

39. Humans have no capacity to regenerate skeletal muscles. But these cells retain the capacity to regenerate only the damaged muscle fibers

- A. Micro cells
- B. Vesicles
- C. Satellite cells
- D. Endothelial cells
- E. Basal laminar cells

40. Function of Contractile proteins inside myofibrils is _____

- A. Switch the contraction process prolonged
- B. Switch the contraction process off
- C. Generate force during contraction
- D. Align the thick and thin filaments properly
- E. Provide elasticity and extensibility

SECTION B: STRUCTURED AND SHORT ANSWER QUESTIONS [30 marks]
Answer all the questions in the provided spaces within the question paper

1. State two functional differences between plasma membrane calcium ATPase and sodium-calcium exchanger [2 marks]

~~- Calcium ATPase is a form of primary active transport mechanism while Sodium - calcium exchanger is a form of secondary active transport mechanism.~~

~~- Calcium ATPase is a form of a Uniport type of transport while Sodium - calcium exchanger is a type of Symport type of transport, also known as co-transporter.~~

2. What do you understand by the vagal escape phenomenon? [2 marks]

~~Vagal escape is the phenomenon where the cell membrane fails to maintain its permeability and the molecules escape spontaneously in and outside of the cell membrane.~~

~~X (60)~~

~~When there is excess~~

3. Explain the ionic basis for the absolute refractory period observed in the cardiac muscle [2 marks]

~~Absolute refractory period is a time when the membrane can not be stimulated by another action potential. This is due to the closure of the Sodium channels and the continuous efflux of potassium ions outside the cell.~~

4. What is the physiological significance of a long absolute refractory period in cardiac muscle tissue? [2 marks]

The significance of a long absolute refractory period is that:

- it allows all the ventricular muscle to contract so that blood is pushed out of the ventricles.
- helps in preventing short lived stimulation of cardiac muscle

(02)

5. With respect to the excitation-contraction coupling, give two differences between cardiac and smooth muscles [2 marks]

- Cardiac muscles' stimulus for contraction comes from the self activating or autorhythmic SA nodes while in smooth muscles stimulation comes from the nerves.
- In cardiac muscle during the influx of calcium into the cell, the released calcium binds to troponin C while in smooth muscles calcium binds to Calmodulin.

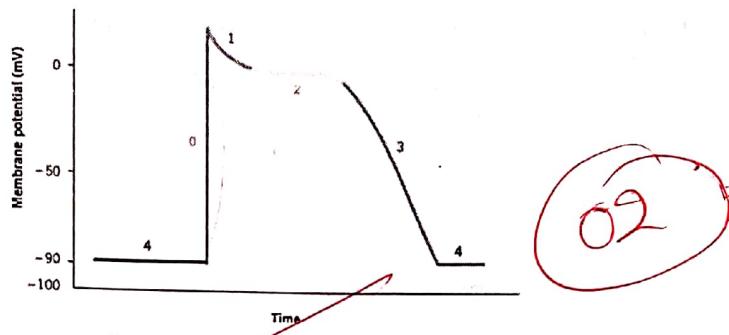
(02)

6. Explain briefly the mechanism underlying the therapeutic application of the Na^+/K^+ ATPase in the management of congestive heart failure [2 marks]

Congestive heart failure results in the failure of the heart to function properly due to either the increase or decrease of certain ions in the body. In the case of the Na^+/K^+ ATPase it helps maintain the electrical potential of sodium outside the cell and potassium inside the cell. The failure of the Na^+/K^+ ATPase can result in accumulation of either Na⁺ inside the cell and Potassium outside the cell resulting in congestive heart failure.

(00)

7. Label the parts 0 – 4 in the diagram and state the ionic basis for each [2 marks]



depolarization

0. ~~Upstroke~~ — rapid influx of sodium inside the cell due to the permeability of cell membrane to sodium
 1. ~~Partial Repolarization~~, this happens due to the closure of the sodium channels and efflux of potassium.
 2. ~~Plateau Phase~~, this is due to the opening of the long-term Ca²⁺ channels which causes influx of Ca²⁺ into the cell.
 3. ~~Rapid Repolarization or further Repolarization~~, this is due to the closure of the Ca²⁺ channels and further efflux K⁺.
 4. ~~Resting Phase~~, this is the coming back of the ions to how there were before stimulation.

8. Michael Jordan, LeBron James, Kareem Abdul-Jabbar are men who have changed the history of basketball. While the likes of Magic Johnson, Stephen Curry and Oscar Robertson are the best point guards, Kobe Bryant and Dwyane Wade and James Harden hold the world's greatest shooting guards.

- a. What would happen if one of these players had increased potassium in the ECF. Outline the physiology that would be disrupted at plasma membrane level of a nerve. [2 marks]

~~increased~~ Increased potassium levels in ECF would lead to the decrease in the functioning of the heart. This would lead to a condition known as Hyperkalemia which may lead to bradycardia.

- b. Body muscles assist in maintaining the appropriate TONE and posture. Outline the derangements that occur in myasthenia gravis in terms of NMJ in muscle physiology. [5 marks]

myasthenia gravis in terms of NMJ

We have the blockage of the receptors on the motor end plate such that there is no excitation of the muscle fibre. This happens because there is a problem with the

(2)

c. What would happen if one of these players had hypocalcemia? Outline the physiology of disruption at level of skeletal muscle membranes. [4 marks]

Hypocalcemia is due to low levels of potassium in the extracellular fluid, this would lead to increase in the function of the heart as a result leading to tachycardia.

1

9. Compare and contrast the APPLIED significance of osmolarity, osmolality and Tonicity. [5 marks]

Osmolarity is the amount of solute dissolved in a solvent per litre.

Osmolality is the amount of mols per kg measured in milli molar per kg mmol/kg.

Tonicity is the ability of the cell membrane to keep substance either inside or outside the cell. When the concentration of water molecules outside the cell is greater, the solution is said to be **hypotonic** to the cell and water will move from outside the cell to the inside. While a solution whose concentration is higher than that of the cell is said to be

hypertonic to the cell and water will move from the cell into the surroundings. A solution whose concentration is the same as that of the inside of the cell is said to be **isotonic**.

2

SECTION C: SCENARIO QUESTION

[30 marks]

Answer all the questions in the spaces provided within the question paper

1. An 8-year-old boy is brought to the emergency room after being stung by a bee. His mother noticed that he was playing in the backyard when he suffered the sting, and within minutes he began having trouble in breathing. She also noticed that he had a "hive" rash over most of his body, along with increased difficulty breathing. When the emergency medical service (EMS) arrived, they administered epinephrine subcutaneously, which seemed to relieve most of the symptoms. In the emergency center, the boy was diagnosed with an anaphylactic reaction from the bee sting.

- a) What type of muscle is present in the bronchi of the lungs? [1 mark]
.....
.....
.....
~~Smooth muscle~~ (01)
- b) Mention four sites where this muscle type can be found [2 marks]
.....
.....
.....
.....
~~- Liver~~ (02)
~~- Intestines~~
~~- Stomach~~
~~- Lining...of blood vessels~~
- c) How is contractile activity in this muscle type initiated? [1 mark]
.....
~~Impulses are generated by the nerves~~ (X 00)
- d) Give two differences each between this muscle type and the other muscle types

Muscle type 1: [2 marks]

Difference 1:
.....
~~They are not striated and action is involuntary~~

Difference 2:
.....
~~They are single nucleated (single nucleus)~~

Muscle type 2: [2 marks]

Difference 1:
.....
~~They are striated~~

Difference 2:

They have multiple nucleus

60

- e) Give one similarity each between this muscle type and the other muscle types

Muscle type 1:

[1 mark]

Similarity:

They use calcium for contraction

60

Muscle type 2:

Similarity:

They have myosin binding sites

- f) Describe the excitation-contraction coupling in this muscle type [5 marks]

In smooth muscle impulses are generated by the nervous system. When an action potential is generated it travels across the axon terminal. The impulse causes the influx of calcium in the axon terminal which leads to the release of Acetylcholine in the neuromuscular junction of the smooth muscle. The release of Acetylcholine causes the opening of N-type channels and also generates an action potential along the muscle of the cell. This causes the release of Ca²⁺ inside the cell which binds to Calmodulin. Then Calmodulin causes the opening of the myosin binding sites. Myosin binds to the sites forming cross bridges.

2. A 35 years old gentleman Mr PP was having pain in his back. He is a veteran NATO soldier of Ukraine- Russia border. 2 years back, he had a surgery of hipbone injury. Now he is complaining of severe back muscle spasms and pain. At local clinic, on examination, his heart rate was 55 per minute, blood electrolytes were disturbed. All other data were normal.

Based on the above vignette, answer the following questions.

- a) Discuss briefly the physiology [function] of anchoring proteins and regulating proteins at level of filaments in skeletal muscles. [5 M]

..... Anchoring proteins attach the cells to neighbouring cells.
..... Examples of anchoring proteins we have Desmosome, Hemidesmosomes, and focal adhesions.
..... Regulating proteins are proteins that switch on and off the contraction of muscles -

Q

- b) Discuss succinctly the types of IV fluids [with examples] that are needed to correct his electrolyte imbalance based on tonicity. [5 M]

The following are some of the IV fluids or intramembranous fluids that are given to correct the electrolyte imbalance.

Q

- * Sodium IV fluids
- * Dextrose Solution
- * Calcium IV fluids
- * Potassium IV fluids

- c) The word BALANCE doesn't necessarily mean equality. Internal environment got to be in balance to stay HEALTHY. Elucidate the [malevolent] role of Donnan effect and how is it corrected back naturally, in restoring the cell size and body fluid electrolytes. [5 M]

The Donnan effect is the difference of electrolytes between the plasma membrane.

- The donnan effect helps to keep the balance of electrolytes by not allowing the flow of oppositely charged ions to move out or inside the cell. Electrolytes like Sodium, Calcium and Chloride are maintained outside while electrolytes like Potassium and others are maintained inside the cell. This helps to maintain the resting membrane potential of the cell membrane.

28

THE END