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THE COPPERBELT UNIVERSITY

MCS SCHOOL OF MEDICINE

SESSIONAL DEFERRED EXAMINATIONS - OCTOBER 2019

MBS 210 - PHYSIOLOGY

STUDENT NUMBER: 17120238 **PROGRAMME:** MBChB

TIME ALLOWED: 3 HOURS

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)**

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SECTION A: MULTIPLE CHOICE QUESTIONS. UNLESS OTHERWISE SPECIFIED, CHOOSE THE SINGLE BEST ANSWER. ANSWER ALL QUESTIONS.

1. In a healthy individual breathing spontaneously, which of the following pressures is positive with reference to atmospheric pressure?
   a) Alveolar pressure during inspiration
   b) Alveolar pressure during expiration
   c) Intrapleural pressure during inspiration
   d) Intrapleural pressure during expiration
   e) None of the above

2. What type of epithelium would you expect to find lining the lumen of the nasal cavity?
   a) Squamous ciliated epithelium without goblet cells
   b) Transitional epithelium with goblet cells
   c) Stratified squamous epithelium
   d) Pseudostratified epithelium
   e) None of the above

3. What test measures the amount of gas expelled when one takes a deep breath and exhales maximally and rapidly?
   a) Forced expiratory volume test
   b) Forced vital capacity test
   c) Forced residual capacity test
   d) Forced internal thoracic volume assessment
   e) None of the above

4. The largest volume of gas that can be moved into and out of the lungs in one minute by voluntary effort is called:
   a) Respiratory minute volume
   b) Minute ventilation
   c) Maximal voluntary ventilation
   d) Vital capacity
   e) Total lung capacity

5. Constriction of bronchial smooth muscle is mediated by activation of:
   a) α_1 receptors
   b) α_2 receptors
   c) M_1 receptors
   d) β_2 adrenoceptors
   e) M_2 receptors

6. Which of the following produces bronchoconstriction? Tick all that apply
   a) VIP
   b) Substance P

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c) Leukotriene B_4
d) Epinephrine
e) Acetylcholine

7. Type I alveolar cells:
   a) Form the wall of the alveoli.
   b) Secrete pulmonary surfactant: Type II
   c) Contract during expiration to force air out of the alveoli.
   d) Both (a) and (b).
   e) (a), (b) and (c)

8. Which of the following is not a function of the respiratory system?
   a) Transports O_2 to the tissues.
   b) Contributes to maintenance of normal acid-base balance.
   c) Provides a route for heat and water elimination.
   d) Enables speech, singing, and other vocalization.
   e) Removes, modifies, activates, or inactivates various materials passing through the pulmonary circulation.

9. T-lymphocytes gain immunocompetence in the:
   a) Thymus
   b) Thymus for T-helper cells and bone marrow for T-killer cells
   c) Thymus for T-killer cells and bone marrow for T-helper cells
   d) Bone marrow
   e) Thymus and bone marrow

10. Antigen challenge usually occurs in the:
   a) Spleen and thymus
   b) Spleen and bone marrow
   c) Lymph nodes and thymus
   d) Spleen and lymph nodes
   e) Lymph nodes and bone marrow

11. Vaccinations are an example of:
   a) Naturally-acquired active immunity
   b) Artificially-acquired active immunity
   c) Naturally-acquired passive immunity
   d) Artificially-acquired passive immunity
   e) All of the above

12. Only ____ and _____ are able to activate complement
   a) IgG and IgA
   b) IgE abd IgG
   c) IgG and IgM
   d) IgG and IgD
   e) All of the above

13. _____ are activated by antigen fragments complexed with MHC-1 proteins
    a) CD_8 T cells
    b) CD_4 T cells
    c) CD_8 B cells
    d) CD_4 B cells
    e) CD memory cells

14. An endocardial cell from the mitrial valve of the heart would be expected to exhibit:
    a) Class I MHC proteins
    b) Class II MHC proteins
    c) Class III MHC proteins
    d) All of the above
    e) None of the above

15. Which of the following antibodies is able to confer natural passive immunity?
    a) IgD
    b) IgE
    c) IgG
    d) IgM
    e) IgA

16. Macrophages are examples of:
    a) Antibody-secreting T lymphocytes
    b) Antigen-presenting cells
    c) Activated plasma cells
    d) All of the above
    e) None of the above

17. Which of the following are involved in B cell activation? Tick all that apply
    a) Antigen
    b) T-helper cell
    c) Cytokine
    d) All of the above
    e) None of the above

18. Which of the following is true of cytotoxic T cells?
    a) They release a chemical similar to those released by NK cells
    b) They can release tumor necrosis factor
    c) In order to function, they require co-stimulation
    d) All of the above
    e) 'a' and 'b'

19. If the V/Q ratio of a lung region decreases, the alveoli in that region will have a:
    a) Higher PO_2 and higher PCO_2.
    b) Lower PO_2 and lower PCO_2.

c) Higher PO_2 and lower PCO_2.
d) Lower PO_2 and higher PCO_2.
e) Lower PO_2 and unchanged PCO_2.

The following information applies to Questions 20 and 21:

F_{IO_2}	0.5
P_B	760 mm Hg
Pa_{O_2}	50 mm Hg
Pa_{CO_2}	30 mm Hg
Respiratory exchange quotient	0.8
Solubility of O_2 in blood	0.003 ml O_2/100 ml blood/mm Hg
Solubility of CO_2 in blood	0.07 ml CO_2/100 ml blood/mm Hg

20. The patient's A - a gradient is closest to:
    a) Zero
    b) 20 mm Hg
    c) 60 mm Hg
    d) 270 mm Hg
    e) 280 mm Hg

21. If all values remain identical except that FIO_2 is lowered to 0.21, the A - a gradient will be:
    a) Increased
    b) Decreased
    c) Unchanged
    d) None of the above
    e) All of the above

22. Pulmonary capillary blood from which lung unit has the lowest PO_2?
    a) V = 2 L/min; Q = 0.2 L/min
    b) V = 2 L/min; Q = 2 L/min
    c) V = 0.2 L/min; Q = 2 L/min
    d) V = 0; Q = 2 L/min
    e) None of the above

23. A patient with a right-to-left cardiac shunt who is breathing room air at sea level has the following values:

P_{AO_2}	100 mm Hg
Pa_{O_2}	50 mm Hg
Pv_{O_2}	30 mm Hg
Cardiac output	5 L/min
O_2-binding capacity of blood	20.1 ml O_2/100 ml blood
Solubility of O_2 in blood	0.003 ml O_2/100 ml blood

What percentage of the cardiac output is the shunt?

a) Zero
b) 38%
c) 50%
d) 62%
e) 100%

24. Which person is expected to have an increased A-a gradient?

a) Left-to-right cardiac shunt
b) Hypoventilation
c) High altitude
d) Pulmonary fibrosis
e) Asthma

25. Which cause of hypoxia is corrected best with supplemental O_2?

a) High altitude
b) Right-to-left intrapulmonary shunt
c) Right-to-left cardiac shunt
d) Anemia
e) Decreased cardiac output

26. Compared to the apex of the lung, at the base of the lung:

a) Blood flow is lowest
b) Ventilation is lowest
c) V/Q is highest
d) Alveolar PCO_2 is highest
e) Alveolar PO_2 is highest

The following information applies to Questions 27, 28 and 29.

Tidal volume	=	450 ml
Breaths/minute	=	14/minute
Arterial P_{CO2}	=	45 mm Hg
Arterial P_{O2}	=	55 mm Hg
Alveolar P_{O2}	=	100 mm Hg
Expired P_{CO2}	=	25 mm Hg
Cardiac output	=	5.0 L/minute

27. Calculate alveolar ventilation for this person:

a) 6.3 L/min
b) 4.8 L/min
c) 3.5 L/min
d) 2.5 L/min
e) 2.0 L/min

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28. What fraction of each tidal volume is physiologic dead space, and how does this value compare to normal?
    a) 0.06; decreased
    b) 0.3; decreased
    c) 0.3; normal
    d) 0.44; decreased
    e) 0.44; increased

29. What is the average value for V/Q in this person?
    a) 1.3
    b) 1.3 L
    c) 0.7
    d) 0.7 L
    e) 0.8 L

30. The activity of which contractile protein is altered to regulate smooth muscle contraction?
    a) Actin
    b) Myosin
    c) Calmodulin
    d) Tropomyosin
    e) Titin

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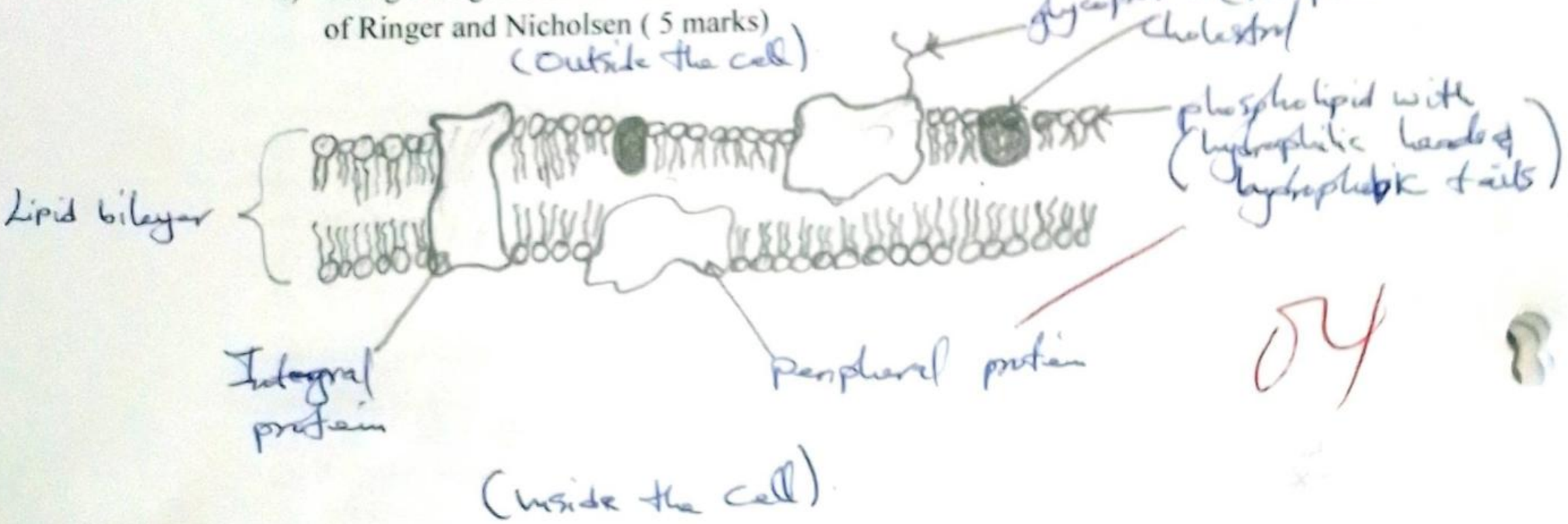
SECTION B: SHORT STRUCTURED ESSAY QUESTIONS

1. CONCERNING THE CELL

a) Using a diagram ONLY describe the cell membrane according the fluid mosaic model of Ringer and Nicholsen (5 marks)



b) List five functions of membrane proteins (5 marks)

* Selectively permeable bilayer (controls what goes in and out the cell)
* Gives shape to the cell and supports it.
* It contains proteins that have receptors for signalling from hormones or other chemical messengers.
* Integral proteins embedd in it function as channels or pores that allow specific molecules to move in or out of the cell.
* It forms a protective layer between the intracellular fluid (ICF) and the extracellular fluid

c) Mention five characteristics of facilitated transport (5 marks)

* Facilitated transport uses membrane channels.
* It does not require the use of ATP energy for transportation of materials.
* It moves material down an electro-chemical gradient.
*
- It does not require energy
- movement is up hill
- use carrier protein for transport
- Ion channel (with passage for ions)

d) List five functions of the smooth endoplasmic reticulum (5 marks)

*Important in Steroid production.
*Also important in detoxification.
* Production of lipoproteins
* Storage of Ca^{2+}.
*Lipid Synthesis

- protein synthesis
- Transport of protein.
- protein folding
- lipid synthesis
- steroid synthesis.
- calcium storage
- carbohydrate metabolism.

2. CONCERNING EXCITABLE TISSUES

a) State the "All or None law" and state three structures that obey this law (5 marks)

*This is a law that states that in order to generate an action potential the threshold for the particular excitable tissue has to be reached or no action potential will be generated or produced (no depolarization).

(i) Smooth muscle
(ii) Cardiac muscle
(iii) Neuron

b) Define a chronaxie and mention its importances (4 marks)

*Chronaxie: This is the streguth of cause the membrane reach threshold formation of the action potential.

maximum time required for an electric current to double the strength of the stimulus to stimulate a muscle resulting in the or nerve

Membrane proteins functions

- Transportation of molecules across all membrane
- Enzymatic functions
- Signal transduction.
- cell recognition.
- inter cellular doing.
- attachment.

c) The resting membrane potential (RMP) of the nerve is – 70mV. State and explain two factors responsible for producing the RMP (6 marks).

* K^+-Leaking channels: After depolarization the Na^+ channels became inactivated and K^+ efflux is initiated and K^+ rapidly moves from the intracellular fluid to the extracellular fluid and the efflux of K^+ brings the membrane potential to rest.

* Na^+/K^+ ATPase: This is responsible for maintance of the RMP, it actively exchanges the $2K^+$ from the ECF for $3Na^+$ from the ICF and this gradually returns the membrane potential towards -70mV.

*The resting membrane potential is maintained by the free movement of the K^+ ion across the membrane through the leaky channels and remains at -70mV until disturbed.

d) Briefly describe the mechanism of neuromuscular transmission (5 marks)

*The neuromuscular transmission occurs at the point where a neuron meets the muscle it innervates (supplies).
*Action potentials from the neuron causes the release of a neurotransmitter (Acetylcholine) at the synaptic terminal buttons ends of the neuron into the synaptic cleft.
*The neurotransmitter then binds to the receptors on the muscle fibre and this causes some conformational changes and the membrane of muscle becomes permiable to Na^+ due to the open of the Na^+ channels and this causes depolarization of the muscle fibre.

receptors on muscle.
terminal button (neuron).
neurotransmitter (Acetylcholine)
muscle membrane.
10 Synapic cleft.

Neuromuscular Junction.

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e) Briefly explain the mechanism of skeletal muscle relaxation (5 marks)

* Skeletal muscle relaxation is due to a decrease in the cytosolic Ca^{2+} and the Ca^{2+} that was bound to troponin C (TnC) is released cause the covering of the active sites and myosin detaches from actin and this cause the thin and thick filaments to return to their resting state causing muscle relaxation

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3. CONCERNING BLOOD AND BODY FLUIDS

a) Briefly describe the composition of extracellular fluid (5 marks)

* The extracellular fluid (ECF) 20% of the total body weight and it is composed of the interstitial fluid, transcellular fluid and blood plasma.
* The interstitial fluid is the fluid that is extracellular space or the interstitium and constituted about 15% of the body weight this together with other components form the ground substance.
* Transcellular fluid only makes up a very small portion of the ECF and it's about 0.5 litres and this is e.g (Synovial fluid, pancreatic juice).
* plasma, this is the fluid portion of blood that circulates in the cardiovascular system and makes up the remaining portion of the ECF.

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b) Give three reasons why infants and children are more vulnerable to develop dehydration than adults (3 marks)

*This is because infants have a large volume of fluid (water) of about 80%. Loss of fluids in these infants can be fatal.

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(i) Large volume of fluid of about 80% of the body weight
(ii) Lack of fluid replacement

c) Mention five manifestations of dehydration (5 marks)

* Dry lips and low production of saliva
* Headaches
* Highly concentrated Urine.
* Dry skin with or without lesions.
* Constipation.

B

d) What is hematocrit? Mention three physiological factors that affect hematocrit (5 marks)

* Hematocrit: This the concentration of blood cells in plasma (e.g the concentration of hemoglobin).

Ratio of RBC to the total volume of blood

(i) Aplastic anemia (Bone marrow status)
(ii) Climate (people that live in high altitude).
(iii) Level of physiological activity (Athletes)

- Dehydration
- Excitement.
- polycythemia.
- Anemia.
- kidney failure.

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e) Mention five consequences of hypoalbuminemia (5 marks)

* Edema (due to imbalance of the oncotic pressure)
* Reduced blood viscosity
* Reduced transportation of lipid soluble substances
* Imbalance of fluids in the ECF and ICF
*

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- Oedema or anasarca.
- muscle inflexibility
- Fatigue
- muscle cramps
- poor appetite.

f) Briefly explain the anticoagulation mechanism of heparin (5 marks)

* Heparin works by activating the antithrombin III enzyme which blocks the the the activated forms of Xa and other thrombin dependent factors, this inturn cause blood not to clot.

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Acts on antithrombin III by accelerating the rate of the neutralisation of certain activated coagulation factors by antithrombin.
- It binds to and enhance the inhibitory activity of the plasma protein antithrombin against several serine proteases of

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g) Explain the fibrinolytic system (10 marks)

-Damage to tissue cause the activation of

plasminogen activator

↓

plasminogen ⟶ plasmin

↓

Fibrin – Fibrin degradation products

h) List the twelve clotting factors in order (6 marks)

(i) Fibrinogen
(ii) prothrombin
(iii) Thromboplastin
(iv) calcium (Ca^{2+})
(v) Labile factor
(vii) proconvertin
(viii) Antihemolytic
(ix) Christmas factor
(x) Stuart power factor
(xi) Hageman factor
(xii) Thrombin stabilizing factor