SECTION TWO **(100 marks)**

Write answers to **ALL** questions on the ruled lines after each question or in the spaces provided within each table. Write your answers in blue or black ballpoint or ink pen.

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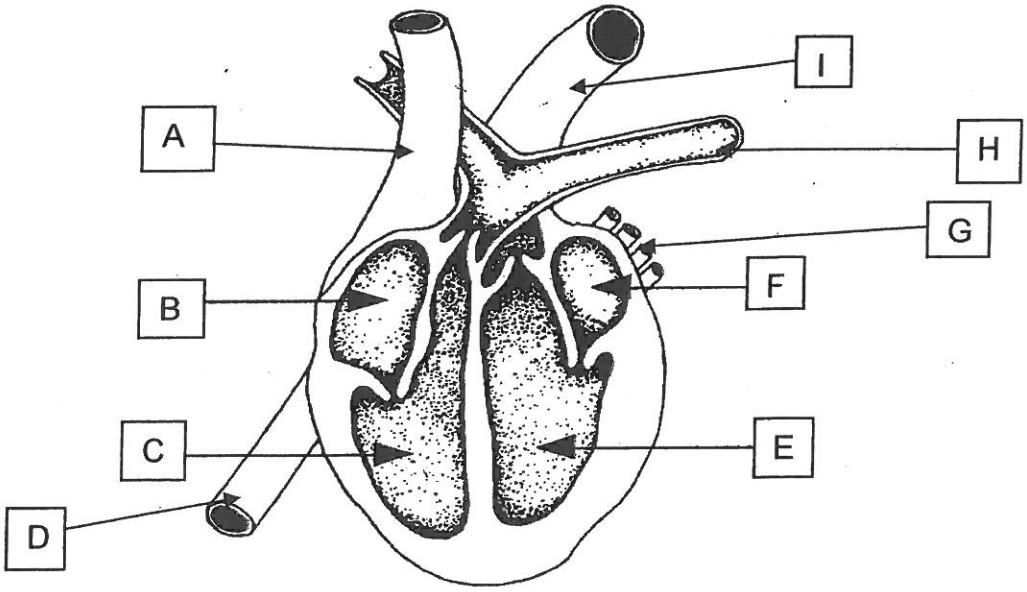
31. **(Total 22 marks)**

This question refers to the diagram below.



(a) Name the structures labelled

D INFERIOR VENA CAVA

G PULMONARY VEINS

(2)

(b) Name vessels H and I and explain the similarities and differences between the vessel types.

H = PULMONARY ARTERY/TRUNK (1)

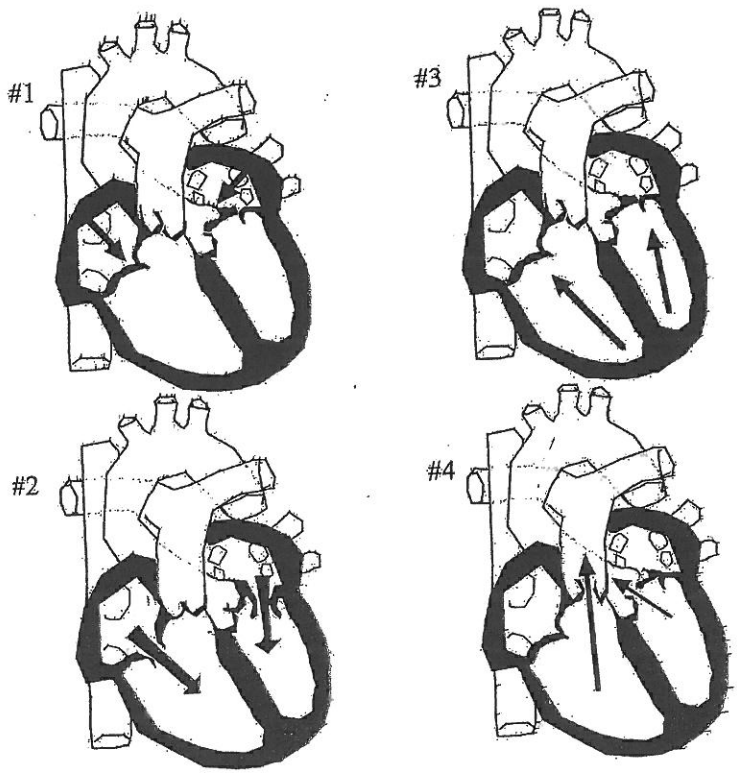
I = AORTA (1)

SIMILARITIES	DIFFERENCES
• BOTH LARGE ARTERIES BOTH ELASTIC (2)	• HIGHER BLOOD PRESSURE IN AORTA (2)
• BOTH CARRY BLOOD AWAY FROM THE HEART	• H = DEOXYGENATED BLOOD I = OXYGENATED BLOOD
• BOTH MORE MUSCULAR	• I = LARGER LUMEN

(6 MARKS)

(6)

(c) In 0.8s the human heart goes through four stages of activity. Each stage is illustrated below. Write a brief description of what is happening at each stage. Use appropriate scientific terminology.



Stage #1: THE RIGHT ATRIUM RECEIVES DEOXYGENATED BLOOD (1) FROM THE SUPERIOR AND INFERIOR VENA CAVA (1).

THE LEFT ATRIUM RECEIVES OXYGENATED BLOOD (1) FROM PULMONARY VEINS (1)

BOTH THE ATRIOVENTRICULAR (AV) VALVES AND SEMI-LUNAR VALVES ARE CLOSED (1). THE FILLING UP OF THE ATRIA IS KNOWN AS ATRIAL DIASTOLE (1)

MAX = (3)

Stage #2: BOTH ATRIA CONTRACT (1) AND BOTH AV VALVES OPEN (1) ALLOWING THE BLOOD TO ENTER INTO THE VENTRICLES (1). WHILE THE SEMI-LUNAR VALVES REMAINED CLOSED (1). THE EMPTYING OF THE ATRIA IS CALLED ATRIAL SYSTOLE (1) DURING THIS TIME THE RIGHT VENTRICLE RECEIVES THE DEOXYGENATED BLOOD FROM THE RIGHT ATRIUM (1), WHILE THE LEFT VENTRICLE RECEIVES THE OXYGENATED BLOOD FROM THE LEFT ATRIUM (1). BOTH VENTRICLES ARE RELAXED (1)

MAX (3)

(3)

Stage #3: THE AV VALVES CLOSE (1) AND PRESSURE IS EXERTED ON THE SEMI-LUNAR VALVES (1), WHICH ARE STILL CLOSED (1). THE VENTRICLE WALLS (ESP. THE LEFT VENTRICLE WALLS) START TO CONTRACT (1), THIS IS THE BEGINNING OF VENTRICULAR SYSTOLE (1)

MAX = (3)

Stage #4: THE SEMI-LUNAR VALVES BOTH OPEN (1). BLOOD FROM RIGHT VENTRICLE IS "PUMPED" UP INTO THE PULMONARY ARTERY (1), DIRECTING THE DEOXYGENATED BLOOD TOWARD THE LUNGS (1). WHILE BLOOD FROM THE LEFT VENTRICLE IS "PUMPED" UP INTO THE AORTA (1), THE MAIN ARTERY OF THE HUMAN BIOLOGY (1), WHICH DIRECTS OXYGENATED BLOOD TO THE SYSTEMIC CIRCULATION (1). ALSO REFERRED TO AS VENTRICULAR SYSTOLE (1)

MAX = (3)

(e) Name two factors that determine cardiac output.

CARDIAC OUTPUT = HEART RATE (1) x STROKE VOLUME (1)

CO = HR x SV.

(2)

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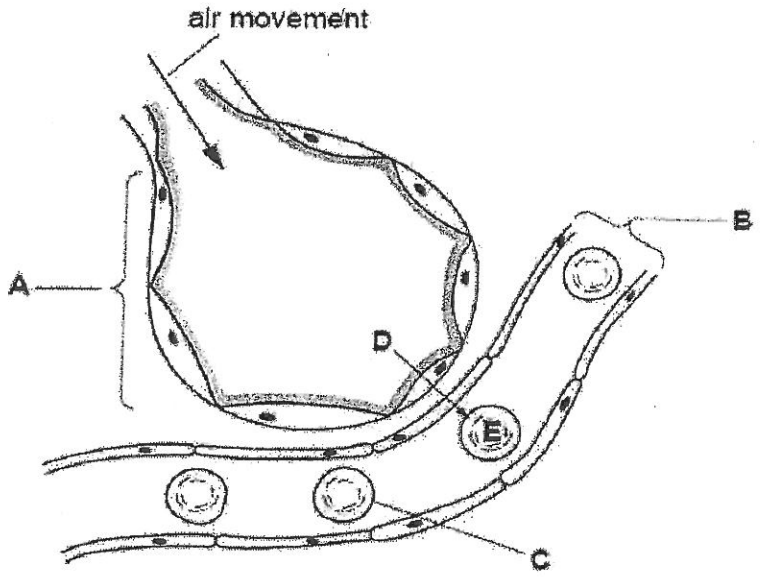
32. **(16 marks)**

Gas exchange of oxygen and carbon dioxide takes place in the alveoli. Oxygen from the inhaled air diffuses through the walls of the alveoli and adjacent capillaries into the red blood cells. The oxygen is then carried by the blood to the body tissues. Carbon dioxide produced by the body's metabolism returns to the lung via the blood. It then diffuses across the capillary and alveolar walls into the air to be removed from the body with expiration. The alveoli have a structure specialised for efficient gaseous exchange.

Source: http://www.curoservice.com/parents_visitors/lungs_circulation/structure_alveoli.asp

Refer to the diagram below:



Source:http://www.proprofs.com/quiz-school/story.php?title=human-nutrition-transpt-respiration-coordination

(a) Identify structures A, B and C.

A ALVEOLI (1)

B CAPILLARY (1)

C ERYTHROCYTE (RED BLOOD CELL) (1) (3)

(b) What process is occurring between D and E?

SIMPLE DIFFUSION (1)

(c) Describe this process and include all the elements involved.

PROCESS = PASSIVE (NO ENERGY REQUIREMENT) (1)

IE. HIGH CONCENTRATION → TO LOW CONCENTRATION

ELEMENTS = OXYGEN (1)

HAEMOGLOBIN (Hb) ON RBC (1)

OXYGEN COMBINES WITH Hb to FROM OXYHAEMOGLOBIN (2)

(d) Give four (4) characteristics of alveoli (and the surrounding environment) that aid in this process of gas exchange.

- WALLS ARE EXTREMELY THIN (diffusion easier - less distance)
- LARGE SURFACE AREA TO VOLUME (more material can diffuse)
- SURROUNDED BY FLUID (fluid ↑ diffusion)
- SURROUNDED BY NUMEROUS CAPILLARIES (as point)

(4)

(e) Complete the following table describing how each of the following assists in normal lung function.

Respiratory feature	How normal lung function is assisted
Cilia	Cilia move to sweep/clean foreign particles/excess mucus (1). Away from the alveoli/gasexchange surface (1)
Mucus Secretion	Mucus is sticky and foreign particles adhere to it (1). This prevents particles reaching the respiratory surface (1).
Epiglottis	This 'flap' of tissue closes the entrance to the trachea/respiratory system while eating/drinking (1). As a result, preventing food from blocking the respiratory passages (1). (6)

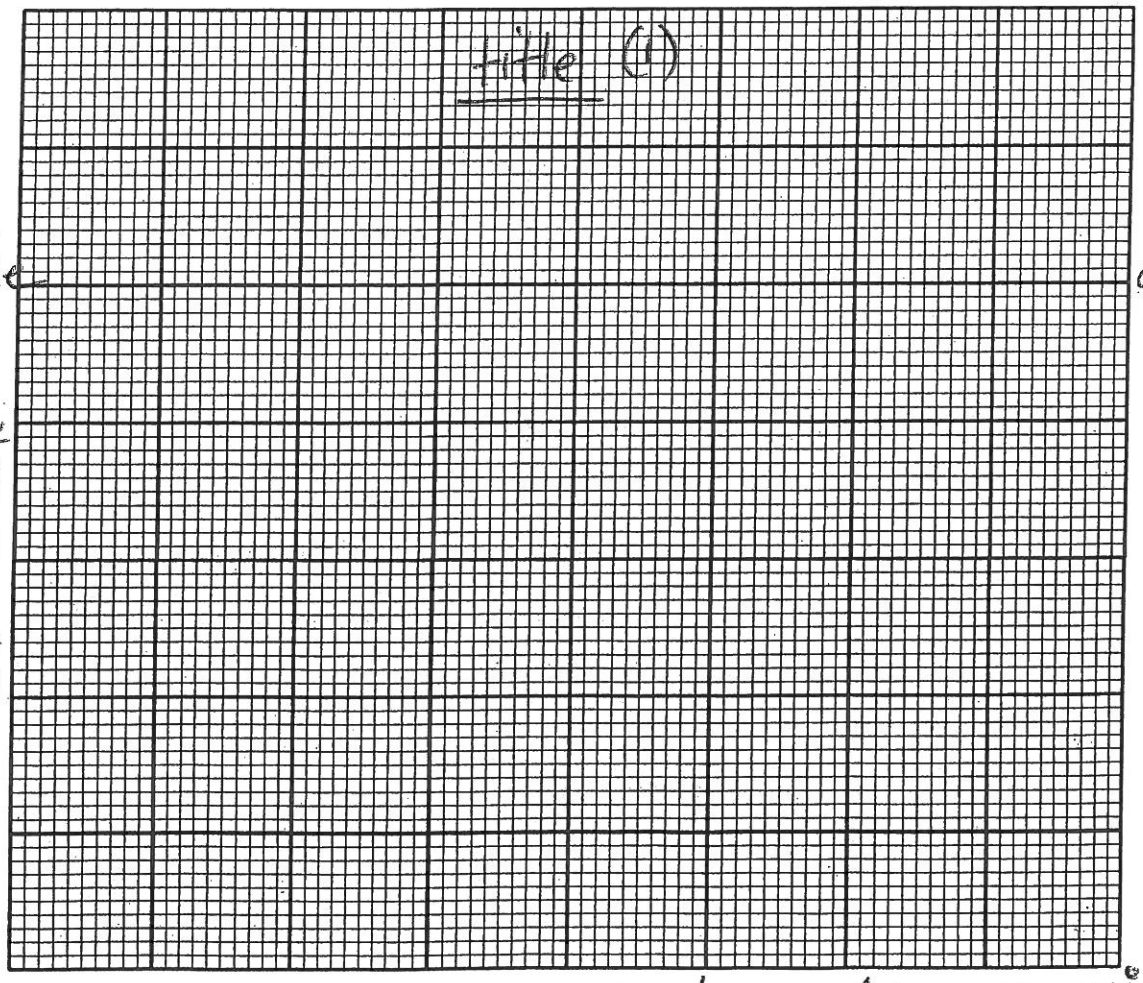
33. **(Total 21 marks)**

Three groups of students, A, B, and C, carried out an experiment to investigate the effect of temperature on the action of the enzyme sucrase. Sucrase breaks down cane sugar (sucrose). Each group of students set up seven test tubes. Each test tube was kept at a different temperature. The time taken for the sucrose to break down completely was recorded and the results from the three groups were averaged.
The results of the experiment are shown in the table below:

Test-tube	Temperature [°C] (independent/ manipulated var.)	Time taken for sucrose to break down completely [minutes]			
		Group A	Group B	Group C	Average (dependent/ responding var.)
1	0	49	53	51	**51.0**
2	10	15	14	16	**15.0**
3	20	10	6	9	**8.3**
4	30	4	5	4	**4.3**
5	40	4	7	6	**5.7**
6	50	26	30	28	**28.0**
7	60	90	140	100	**110.0**

(a) Graph the average results to best show the relationship (temperature) investigated. (6)

There is additional graph paper in the back of your booklet if needed.



(b) State one hypothesis that this experiment may have been designed to test.

IF CANE SUGAR (SUROSE) IS HEATED WITH INCREASING TEMPERATURE, THAN ITS BREAK DOWN WILL INCREASE (OF SUROSE)

(2)

(c) State the independent variable in your hypothesis.

TEMPERATURE

(1)

(d) State the dependent variable in your hypothesis.

BREAK DOWN OF SUROSE

(1)

(e) State why a well-designed experiment has only one independent variable.

ANY RESULTS OBTAINED MUST BE ASSIGNED TO THE MANIPULATING (INDEPENDENT) VARIABLE TO SUPPORT THE HYPOTHESIS (1). IF OTHER VARIABLES INFLUENCE OUTCOME CANNOT RETERMINE IF CHANGE DUE TO INDEPENDENT VARIABLE

(2)

(f) Identify two variables that must be controlled in this experiment.

AMOUNT/CONCENTRATION OF SUROSE (1) TYPE OF THERMOMETERS } ALL (1)
AMOUNT/CONCENTRATION OF ENZYME SUCRASE (1) TYPE OF TEST TUBES
TYPE OF TIME PIECES
ENVIRONMENTAL SETTING

(2)

(g) State how you would control two of these variables.

EQUIPMENT - USE SAME TYPE (1)
AMOUNT/CONCENTRATION OF SUCROSE (1) - SAME / ditto ENZYME (1)

(2)

(h) What is the advantage of calculating an average?

IT PROVIDES A QUICK IDEA ABOUT "CENTRAL TENDENCY" OF RESULTS AT THAT PARTICULAR TEMPERATURE
(DO NOT ACCEPT IMPROVES RELIABILITY / VALIDITY) (1)

(i) Using your understanding of enzyme controlled reactions, explain why the enzyme sucrase has no effect on milk sugar (lactose).

ENZYMES ARE SPECIFIC (1) SUCRASE SPECIALLY BREAKS DOWN SUROSE (1).
(THE ENZYME LACTASE WOULD SPECIFICALLY BREAK DOWN LACTOSE)

(2)

(j) Pancreatic lipase is another enzyme that plays an important role in digestion. Describe where it is produced and the role it plays.

PRODUCED IN PANCREAS (1) - IN PANCREATIC JUICE (1) INTO SMALL INTESTINE VIA PANCREATIC DUCT

ROLE BREAKS DOWN LIPIDS (1)

(2)

34. **(Total 8 marks)**

(a) What does the abbreviation DNA represent?

DEOXYRIBONUCLEIC ACID

(1)

(b) Where is DNA mainly found in the cell?

THE NUCLEUS

(1)

(c) The information in DNA is stored as a code made up of four (4) chemical bases represented by the letters A, G, C and T. Name these 4 bases (in order of the abbreviations given below).

A = ADENINE (1)

G = GUANINE (1)

C = CYTOSINE (1)

T = THYMINE (1)

(4)

(d) These bases pair up with each other A with T and C with G to form units called base pairs. Each base is also attached to a sugar molecule, and a phosphate molecule. Together, a base, sugar and phosphate forms what part of a DNA strand?

NUCLEOTIDE

(1)

(e) DNA can replicate. What does this mean?

IT CAN MAKE A COPY OF ITSELF

(1)

35. **(Total 13 marks)**

(a) Describe the role of salivary amylase.

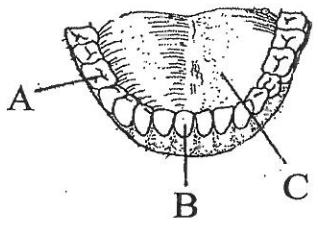
DIGESTS STARCH (1) BROKEN DOWN INTO MALTOSE (1)
IT IS AN ENZYME (1) WHICH SPEEDS UP THE REACTION (1)
OF STARCH BEING BROKEN DOWN TO MALTOSE

(4)

(b) State two other functions of saliva.

Moistens food (1), COATS SHARP EDGES ON FOOD WITH STICKY MUCUS (1), DISSOLVES SOLUBLE CHEMICALS (1), ENABLES FOOD TO STICK TOGETHER TO FORM BOLUS (1) MAX= (2)

(c) Answer this part of the question with reference to the diagram of the lower jaw below.



(i) State the 'type' of digestion that teeth perform in the body.

MECHANICAL / PHYSICAL DIGESTION (1)

(ii) Identify the two types of teeth labelled A and B above and explain how their structure is suited to the functions they perform.

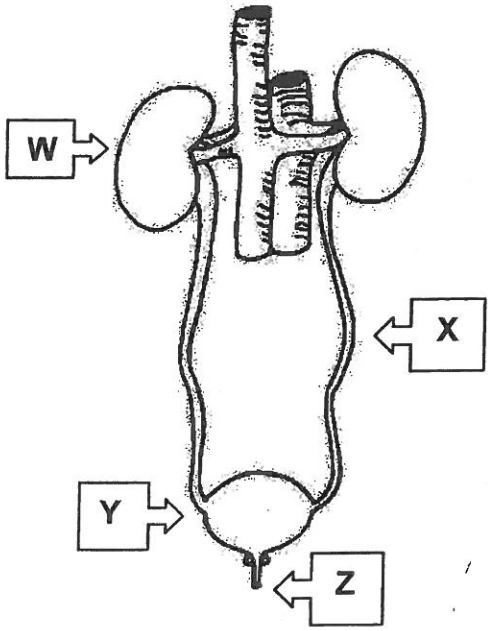
A: = MOLAR - BOARD / LARGE SURFACE (1) FOR GRINDING TOUGH FOODS (1)

B: = INCISOR - SHARP EDGE / BLADE PROFILE (1) FOR BITING OR TEARING OFF PIECE OF FOOD (1)

BOTH: ENAMEL / RESIST PHYSICAL DAMAGE, FOOD ACIDS + BACTERIAL ACTION WHICH CAUSE DECAY (6) (1)

36. **(Total 20 marks)**

(a) Refer to the diagram below:



(i) What body system does the diagram represent?

URINARY SYSTEM

(1)

(ii) Provide the names of the parts labelled:

W KIDNEY (1)

X URETER (1)

Y URINARY BLADDER (1) ACCEPT BLADDER

Z URETHRA (1)

(4)

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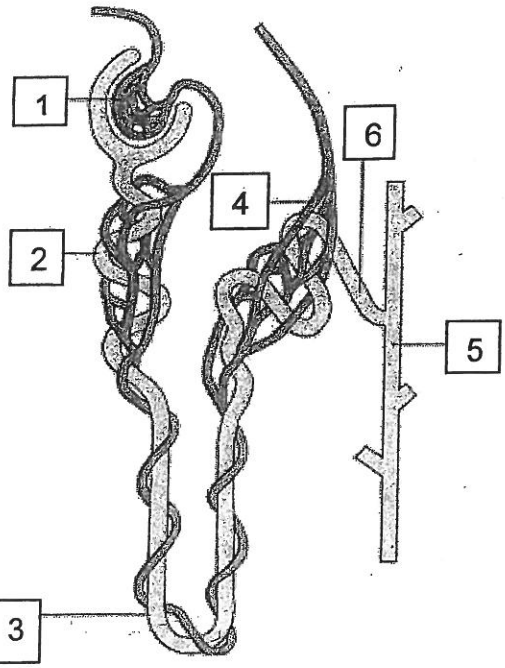
(b) There are about a million of these units (below) in the structure indicated as W, in the previous diagram.



(i) Name the various numbered parts of these units.

1. GLOMERULUS (1)
2. PROXIMAL CONVOLUTED (1) TUBULE
3. LOOP OF HENLE (1)
4. PERITUBULAR CAPILLARIES / CAPILLARY NEXUS (1)
5. COLLECTING DUCT / TUBULE (1)
6. DISTAL CONVOLUTED TUBULE (1)

(6)

(ii) These units carry three main processes. State what each process is named and give a brief description of each process.

Process 1: FILTRATION (1)

ACCEPT BOWMAN'S CAPSULE

BLOOD FILTERED FROM GLOMERULUS INTO GLOMERULAR CAPSULE (1)

LARGER SUBSTANCES (PLASMA PROTEINS) CANT CROSS GLOMERULAR SURFACE (1)

THEY CONTINUE INTO EFFERENT ARTERIOLE (1)

(3)

Process 2: REABORPTION (1)

REMOVAL OF H_2O + SOLUTES (1) WHEN REQUIRED BY THE BODY, FROM THE FILTRATE (1).

REABSORBED SUBSTANCES PASS FROM RENAL TUBULES (1) INTO PERITUBULAR FLUID (1) AND EVENTUALLY RE-ENTER BLOOD (1)

(3)

Process 3: SECRETION (1)

TRANSPORT OF SOLUTE FROM PERITUBULAR FLUID (1) INTO RENAL TUBULES (1). NECESSARY BECAUSE FILTRATION INADEQUATE (1)

BACKUP FOR FILTRATION THAT LOWERS PLASMA CONC. OF UNDESIRABLE SUBSTANCE (1)

(3)

END OF SECTION TWO

Process 3:**Secretion (1)**

Secretion involves the transport of solutes (1) from the peritubular fluid (1) into the tubular/renal fluids (1). Secretion is necessary because filtration does not force all the dissolved substances out of the plasma (1). Tubular secretion provides a backup for filtration that can further lower the plasma concentration of undesirable substances (1)

(3)

END OF SECTION TWO

SECTION THREE: (40 marks)

Answer **all parts** of **either** question 37 **OR** question 38. Illustrate your answers with diagrams where appropriate. Up to **TWO MARKS** may be deducted for poorly structured answers: that is, answers in point form or diagrams not explained in the text of your answers. **DO NOT WRITE ANSWERS IN PENCIL**. Write your answers on the lined paper in the separate answer booklet provided.

ANSWER EITHER QUESTION 37 OR QUESTION 38 – NOT BOTH

37. **(Total 40 Marks)**

(a) Blood is composed of both plasma and formed elements. Discuss the importance of blood to the body. (16)

Plasma 55% 1
Formed elements 45%

Plasma- 91% water 1
7% Proteins
2% other solutes

Proteins – examples like albumins, globulins, fibrinogen 1
Solutes – examples like food, cell wastes, gases, hormones, ions 1
(Max = 4)

Plasma functions:
Proteins involved in blood clotting 1
Antibodies involved in immune system 1
Ions and proteins contribute to osmotic balance – maintain water concentrations throughout the body 1
Carries oxygen to cells and CO_2 back to lungs 1
Carries food from intestines to cells 1
Carries hormones around body 1
Carries waste products from cells 1

(Max = 4)

Formed elements:

Erythrocytes – greatest number (4.3 – 5.5 million / ml)	1
Platelets (thrombocytes) – fewer (250 – 400 thousand / ml)	1
Leucocytes least - (5 – 10 thousand / ml)	1

(Max = 3)

Formed elements functions:

Erythrocytes:	
Carry oxygen from lungs to cells and CO_2 back	1
As oxyhaemoglobin and carbaminohaemoglobin	1
Leucocytes:	
Granular and Agranular	1
Defend the body against invading microorganisms by phagocytosis	1
Platelets:	
Formation of blood clots	1

(Max = 5)

(b) Cellular respiration is the process by which glucose is broken down in cells to produce energy that may be stored in adenosine triphosphate (ATP). Compare the **TWO** types of cellular respiration using a properly constructed table, include the reactants, where these processes occur, any waste substances produced and the relative amounts of energy produced. (12)

37b attached

	AEROBIC RESPIRATION (1)	ANAEROBIC RESPIRATION (1)
REACTANTS	glucose & oxygen (1)	glucose, no oxygen (1)
LOCATION	cytoplasm/mitochrondria (1)	Cytoplasm (1)
WASTE PRODUCTS	carbon dioxide % water (1)	lactic acid (1)
ENERGY	net 36ATP (1)	net 2 ATP (1)

'Comparison' as asked (1)
'Table' as asked (1) **(Max = 12)**

(c) Mitosis produces two identical cells from the parent cell.
(i) Explain how the different stages of mitosis contribute to achieving this result.
(ii) Why is this process essential to the human body?

(12)

(i) Interphase: DNA (1) and protein are synthesized (1)
Prophase: Chromosomes form (1) from chromatin (1)
Metaphase: Chromosomes migrate to the centre of the dividing cell (1)
Anaphase: Daughter chromosome pairs separate (1) and move to opposite poles (1) and cytokinese, pinching of the cytoplasm (1) in preparation of Telophase
Telophase: Chromosomes cordoned of into distinct new nuclei (1) and daughter cells are produced (1) both have genetic contents divided equally between them (1)

(Max = 6)

(ii) Mitosis is essential to the human body because it enables:
1. Growth to adult size (1) by adding new cells (1).
2. Repair of damaged tissues (1) by replacing damaged cells (1).

The cells themselves will have efficiency reduced if cell volume continued to increase (1). Cell division increases surface area to volume ratio (1) making exchange of substances between the cells and their surrounding environment more efficient (1). However, this ratio also limits the size of cells (1). At some point in its growth its SA/V becomes so small that its surface area is too small to supply its raw materials to its volume (1). At this point the cell cannot get larger (1). (Max = 6)

OR

38. **(Total 40 marks)**

(a) Use a properly constructed table to compare how the three different groups of **organic substances,** needed by cells, differ in their chemical structure and important uses. (12)

Organic Substance	Chemical Structure	Sources	Energy Value
Carbohydrates (1)	Two valid points: CHO monosaccharide rings form chains called polysaccharides Examples: sugar, glucose, starch glycogen (2)	May supply examples but not necessary to answer question	17kj/gm Readily available energy source (1)
Proteins (1)	Two valid points CHONS, amino acid units chains called polypeptides (2)	May supply examples but not necessary to answer question	17kj/gm Structural material, enzymes, hormones, antibodies, haemoglobin (1)
Lipids (1)	Two valid points CHO Glycerol and fatty acids, monoglycerides, diglycerides, triglycerides (2)	May supply examples but not necessary to answer question	37kj/gm Stored energy source/high energy, heat insulation, steroid hormones (1)

(b) (i) Explain how the products of digestion are **absorbed** in the small intestine.
(ii) Describe how the structure of the small intestine maximizes this absorption.

(16)

(i) Monosaccarides (1) – absorbed by active transport (1), through villi and into capillaries (1).

Amino acids (1) – absorbed by active transport (1), through villi and into capillaries (1)

Fatty acids & Glycerol (1) – absorbed by simple diffusion (1), in cells of villi form *chylomicrons* (1) and then enters the lacteals (1). MAX = 8

(ii) This is primarily achieved by increased surface area (1). This is due to:

1. **long length (1)**
2. **coiling, the *plicae circulares* (1)**
3. **folding of the mucosa layer (1)**
4. **the finger-like projections, the villi (1)**
5. **on the villi themselves, microvilli (1)**

In addition, each villus contains a lacteal, a lymph capillary (1) for the absorption of lipids (1).
Villi are also surrounded by capillaries (well vascularised) for carbohydrate (1), (monosaccarides) and protein (amino acids) absorption (1). MAX = 8

(c) There are three basic processes involved in the transport of materials across the cell membrane. Discuss these processes with reference to the structure of the membrane.

(12)

DIFFUSION is the movement of molecules so that they are evenly spread over the available space (1). Movement occurs from a higher concentration to a lower concentration (1).

Cell membranes are differentially/selectively permeable (1) which mean only some substances can pass through easily while others are unable to get through at all (1)

2 ways to diffuse across membrane:

- **Substances soluble in fat, like alcohol, steroids, fatty acids & oxygen and carbon dioxide (1) can diffuse through the lipid part of the membrane (1).**

- **Substances use membrane channels (1) formed by protein channels (1), like water-soluble molecules provided they are small enough (1) – such as water, sodium, calcium and chloride ions (1).**

Osmosis is a special case of diffusion – it is diffusion of water (1). That is, water moves from a higher water concentration to a lower water concentration (1).

Water moves through protein channels (1) due to its small size (1)

Both diffusion and osmosis are passive processes (1), meaning no energy is required to move substances across the membrane (1). MAX = 4

CARRIER-MEDIATED TRANSPORT proteins in the cell membrane bind to molecules to be transported and help their passage across the membrane (1).

There are 2 main types of carrier-mediated transport:

- **Facilitated diffusion (1) is a passive process in which substances move with the concentration gradient (1). That is, from the higher concentration side of the membrane to the lower concentration side of the membrane (1). The molecule to be transported attaches to the binding site (1) on the carrier protein. The carrier protein changes shape (1) and the molecule is released on the other side (1). For example, glucose and amino acids (1)**

- **Active transport (1) requires energy (1) because the molecule is transported across a concentration gradient (1). That is, from the lower concentration side of the membrane to the higher concentration side of the membrane (1). For example, certain ions, glucose and amino acids (1)** MAX = 4

<u>VESICULAR TRANSPORT</u> is the movement of substances across the cell membrane in membranous bags called vesicles (1). This is an active process (1).

- **Endocytosis is taking liquid or solids into the cell (1). The cell membrane folds around a droplet of liquid or solid, until droplet is completely enclosed (1). Vesicle forms, pinches off and is suspended in the cell's cytoplasm (1). If this involves a liquid it is referred to as pinocytosis (1), and if a solid phagocytosis (1).**

- **Exocytosis is when the contents of a vesicle inside the cell are passed to the outside (1). The vesicle migrates to the cell membrane and fuses with it (1). The contents of the vesicle are then pushed out into the extracellular fluid (1).** MAX = 4

END OF PAPER

Question 37.

(b) Cell Types Involved

- **Basophils** - float in bloodstream and goes to site of infection
  - releases histamine which causes inflammation and increases blood flow
  - this results in bringing neutrophils and monocytes to the infected area

- **Neutrophils** - also releases chemicals and is able to engulf and digest foreign Material *before* they enter bloodstream.
  - only active for less than 24 hours (but continuously replaced by marrow; dead neutrophils turn into pus/shows immune system working).
- **Monocytes** - once at the site turn into macrophages which can engulf and digest invading micro-organisms, including dead neutrophils and Other cellular debris.

Blood Proteins Involved

Thrombocytes and cells of blood walls release **thromboplastin** (or **thrombokinase**) an enzyme.
Thrombokinase causes **prothrombin** to be converted into **thrombin.** This reaction only occurs in the presence of calcium ions and vitamin K.

$$\text{Prothrombin} \xrightarrow[Ca^{2+} + \text{vitamin K}]{\text{Thrombokinase}} \text{Thrombin}$$

Thrombin is an enzyme that causes another substance dissolved in the plasma, **fibrinogen** (a plasma protein) to be converted to **fibrin.** Fibrinogen is soluble, whereas fibrin is insoluble.

$$\underset{\text{(soluble)}}{\text{Fibrinogen}} \xrightarrow{\text{Thrombin}} \underset{\text{(insoluble)}}{\text{Fibrin}}$$

Blood Flow

When the injury involves blood loss, the muscles in the small blood vessels constrict, immediately **restricting blood flow**.

As part of the inflammatory response (which initially **encourages increased blood flow**) plasma proteins are increased at the injury site.

Internal walls of the blood vessels are usually smooth. However due to injury, rough surfaces attract thrombocytes. These build up to form a 'plug' and **release vasoconstrictors (further restricting blood flow)**.

Formation of a Blood Clot (Haemostasis)

Development of a blood clot involves all of the above stages. For the more serious type of injuries (not day to day small tears) **blood clotting** or **coagulation** will occur.

Thrombocytes immediately adhere to rough (damaged) surfaces, and release chemicals to initiate more thrombocytes to the site of infection. This forms a **'platelet plug'.**

The **insoluble fibrin threads**, formed by the actions of plasma proteins (clotting factors), **stick together and seals the inside of the wound.**

The **fibrin network contracts**, becomes more dense as a result stronger, **pulling the edges of the damaged blood vessels together.** This causes serum to be squeezed out and the clot dries forming a scab over the wound, **preventing entry of infecting micro-organisms.**

Eventually the blood vessel heals and the clot dissolves.

NOTE: No need to mention every single clotting factor.
This section of Question 37 is worth 12 marks. Each part of this section is worth a maximum of three (3) marks. Give one (1) mark for one point reasonably explained.