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## Support Pack | Grade 11

CAPS

# Life Sciences

## Life processes in plants and animals

This support pack for the **Life processes in plants and animals** strand in the **Life Sciences Grade 11 CAPS curriculum** provides practice exercises. All exercises have the answers provided. Learners can work through these individually at home or these could form the basis of a catch-up class or online lesson. You have permission to print or photocopy this document or distribute it electronically via email or WhatsApp.

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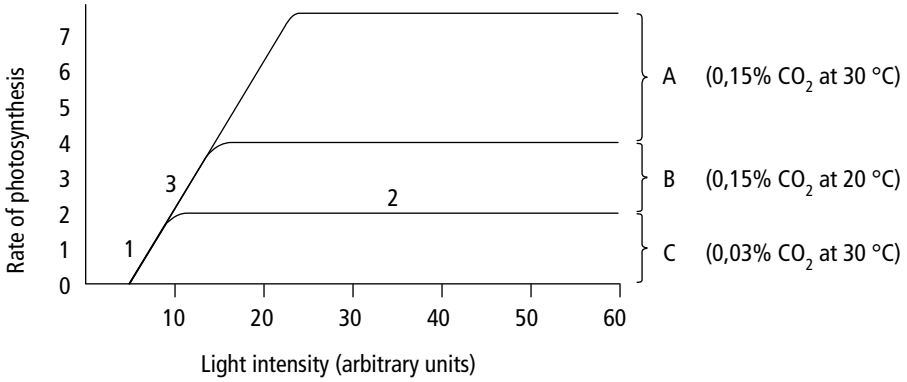
# WORKSHEET 4: Photosynthesis

**1.** The graph below shows the results of an investigation to determine the effects of different light intensities on the rate of photosynthesis of a plant under different temperatures and carbon dioxide concentrations.




**1.1** Describe the effect of different light intensities on the rate of photosynthesis.

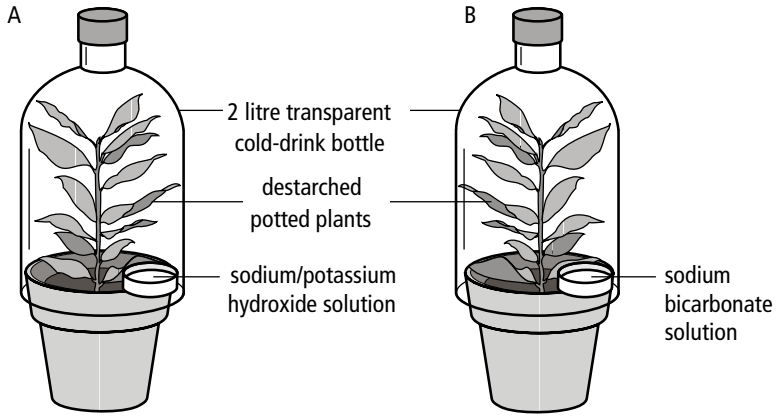
**1.2** Suggest a reason for the curve not starting at point zero on the *x*-axis.

**1.3** What external factor was controlling the rate of photosynthesis at each of the points 1, 2 and 3? Give a reason in each case.

**1.4** What effect does temperature have on the rate of photosynthesis?

**1.5** At what light intensity does the plant reach its optimum rate of photosynthesis under the above conditions?

**2.** The diagram below represents a set of apparatus used in an investigation. Answer the questions based on it.




**2.1** State **one** possible hypothesis that is being investigated.

**2.2** Suggest **one** aim of this investigation.

**2.3** What is the purpose of having two sets of apparatus, namely A and B?

**2.4** Name **one** factor that is being controlled in this investigation.

**2.5** Name **one** environmental factor that must remain constant in this investigation.

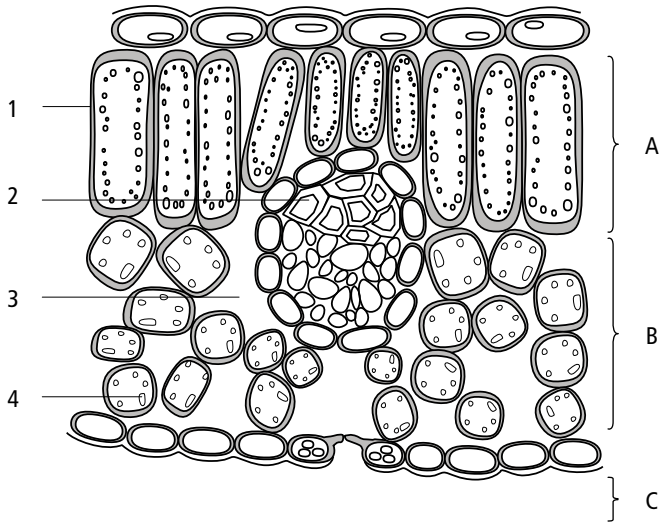
**2.6** State the functions of:

**i** The hydroxide solution

**ii** The bicarbonate solution

**2.7** Describe the expected results in the above investigation.

**3.** Study the following diagram and then answer the questions that follow.




**3.1** Name the parts numbered 1, 2, 3 and 4.

**3.2** Explain **three** ways in which the region marked B is adapted for photosynthesis.

**3.3** Atmospheric air contains 21% oxygen, 0,04% carbon dioxide and 78,96% nitrogen and other gases.

The table below shows the possible composition of dry air in regions A, B and C.

| | % oxygen | % carbon dioxide | % nitrogen and other gases |
|---|---|---|---|
| 1 | 20,98 | 0,06 | 78,96 |
| 2 | 21,00 | 0,04 | 78,96 |
| 3 | 23,00 | nil | 78,96 |
| 4 | 21,02 | 0,02 | 78,96 |

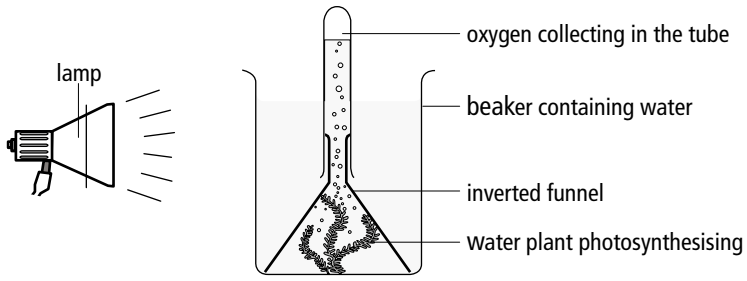
Which of the numbers 1, 2, 3 or 4 represents the most probable composition of air in:

**i** A, at 14:00? State a reason for your answer.

**ii** B, at 02:00? State a reason for your answer.

**iii** C, if the air at C is constantly blown away by wind? State a reason for your answer.

**4.** The diagram shows an apparatus that is used to investigate the rate of photosynthesis in a submerged plant. The light intensity to which the plant is subjected was decreased at regular intervals by moving the light source away from the plant. The average number of bubbles released per minute was counted and recorded for each distance.




The results obtained are shown in the table below.

| Distance from lamp (cm) | 5 | 10 | 20 | 25 | 35 | 40 | 50 |
|---|---|---|---|---|---|---|---|
| Number of bubbles per minute | 70 | 65 | 40 | 25 | 15 | 5 | 2 |

**4.1** What is the aim of this investigation?

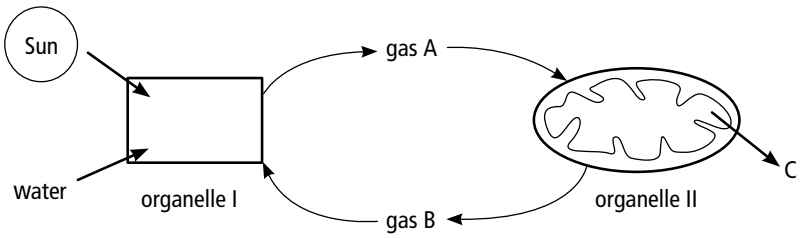
**4.2** Name the gas released by the submerged plant.

**4.3** Describe a test to verify your answer for Question **4.2**.

**4.4** Describe the relationship between gas release and light intensity.

**4.5** Name **two** other environmental factors, except light intensity, which you think could alter the rate of bubble production.

**5.** Two organelles in the green parts of plants are responsible for different but closely related processes. Study the flow diagram below and then answer the questions that follow.




**5.1** Name:

**i** Organelle I

**ii** Gases A and B, respectively

**iii** The processes occurring at organelle I and organelle II, respectively

**iv** Product C

**5.2** Draw and label organelle I.

**5.3** Explain **two** structural adaptations of organelle I for its function.

# MEMORANDUM FOR WORKSHEET 4

**1.1** As light intensity increases, the rate of photosynthesis increases until optimum light intensity is reached. At this point the photosynthetic rate is at its maximum. Further increases in light intensity do not bring about any further increases in the rate of photosynthesis.

**1.2** Light is a requirement for photosynthesis, so a certain amount of light must be available to start with. For this plant, it was an arbitrary 5 units.

**1.3** 1 – Light, because increasing the light intensity increases the rate of photosynthesis.
2 – $CO_2$, because increasing the light intensity has no effect on the rate of photosynthesis unless the concentration of $CO_2$ is raised.
3 – Light, because increasing the light intensity increases the rate of photosynthesis.

**1.4** Most plants function best at optimum temperatures between 20 °C and 35 °C. As the temperature increases, the rate of photosynthesis increases, except at low levels of $CO_2$. Any further increases in temperature above optimum temperature can cause a drop in the rate of photosynthesis because enzymes become denatured. If the temperature is too low, enzymes are not active.

**1.5** The optimum rate of photosynthesis is reached at 23 units of light intensity.

**2.1** Plants in the presence of $CO_2$ will produce carbohydrates in the presence of light and water.

**2.2** To determine whether $CO_2$ is required for photosynthesis.

**2.3** One set serves as a control to compare and verify the results of the experiment.

**2.4** $CO_2$

**2.5** Any one of these factors is correct:

- Light intensity
- Temperature
- Water.

**2.6** **i** Absorbs the $CO_2$.

**ii** Provides/is a source of $CO_2$.

**2.7** When tested for the presence of starch, the leaves of B will be positive while those of A will be negative.

**3.1** 1 – palisade cell; 2 –xylem of leaf vein; 3 –intercellular air space; 4 –chloroplast in spongy cell

**3.2**
- Numerous chloroplasts occur in the mesophyll cell, thus increasing the surface area for photosynthesis.
- Spongy mesophyll contains a number of intercellular air spaces that facilitates rapid diffusion of gases and water.
- Mesophyll cells are thin walled, moist and allow rapid diffusion of gases and water.

**3.3**
**i** 3 – photosynthesis starts at optimum rate, all $CO_2$ is absorbed and plenty of $O_2$ is released.

**ii** 1 – $O_2$ is used up for cellular respiration and $CO_2$ is given off.

**iii** 2 – fresh air will contain the normal percentages of gases.

**4.1** The aim of this investigation is to determine the effect of light intensity on the rate of photosynthesis.

**4.2** Oxygen

**4.3** Immerse a glowing splint into the tube in which the gas is collected. If the splint bursts into flames, it shows that oxygen is present.

**4.4** The higher the light intensity, the greater the amount of gas released.

**4.5** Temperature and carbon dioxide concentration.

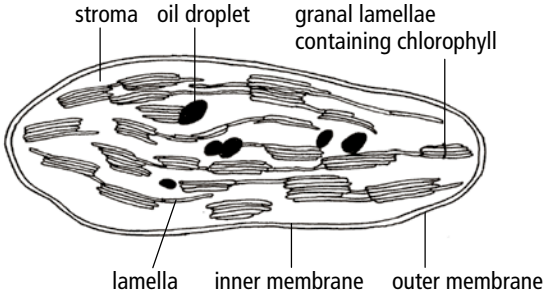
**5.1**
**i** Chloroplast

**ii** A – oxygen; B – carbon dioxide

**iii** I – photosynthesis; II – cellular respiration

**iv** Energy/water

**5.2** Diagram of a chloroplast




**5.3** Any two of these adaptations is correct:
- Numerous lamellae that increase the surface area for photosynthesis
- Chlorophyll present in between the lamellae to trap radiant energy for photosynthesis
- Enzymes present in the stroma for the reactions of photosynthesis
- Double membrane is permeable to allow water and carbon dioxide to diffuse into it for photosynthesis.

# WORKSHEET 5: Animal nutrition (mammals)

**1.** Answer the following questions based on human nutrition.

**1.1** Name the parts of the human alimentary canal in the correct sequence, beginning at the mouth.

**1.2** List the functions of each part.

**1.3** State how each part is suited for the function(s) it performs.

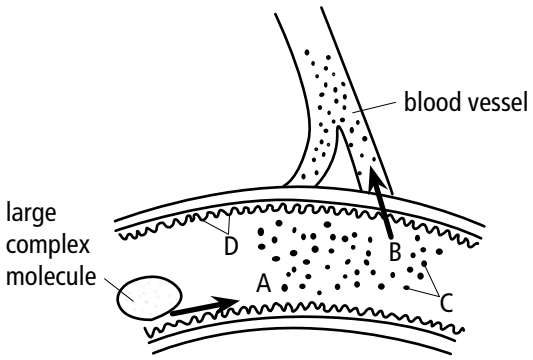
**1.4** Assume that you have just eaten an egg.

**i** Describe the digestion of the egg.

**ii** Describe the absorption of the products of digestion of the egg.

**1.5** Explain why carbohydrates, proteins, fats, vitamins and minerals are all necessary for good nutrition.

**2.** Study the diagram below and then answer the questions.




Diagrammatic representation of
a portion of the digestive system

**2.1** Name the processes represented by arrows:

**i** A

**ii** B

**2.2** Explain the role of water in process B.

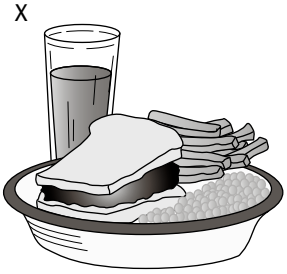
**2.3** Identify the finger-like projections found at D.

**2.4** If the large, complex molecule is a protein, name molecule C.

**2.5** Explain what happens to an excess of molecules of C in the body.

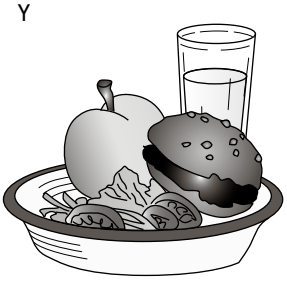
**3.** Study the information provided in the diagrams and the table below, which show the composition of three different meals.

X



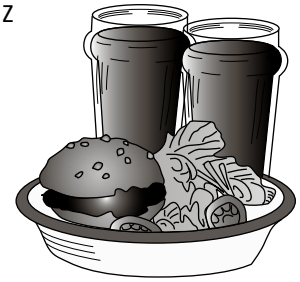
Coke
white bread with hamburger patty
potato chips
peas

Y



milk
whole-wheat roll with meat
lettuce and tomato
apple

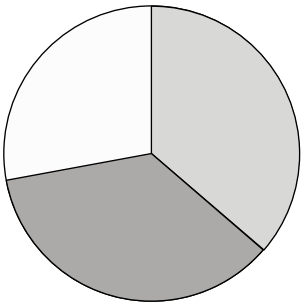
Z



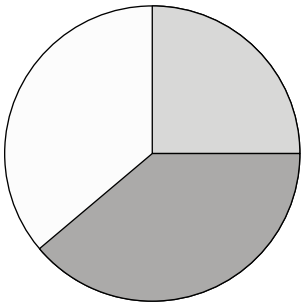
two glasses of bitter beer
brown bread roll with meat
lettuce and tomato

**Analysis of different components of each meal**

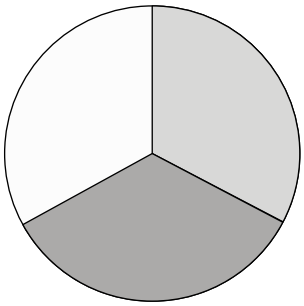
nutrient content of meal X



nutrient content of meal Y



nutrient content of meal Z



Key: carbohydrates lipids proteins

| Content of energy, vitamin C and calcium in each meal | | | |
|---|---|---|---|
| **Meals** | **Energy in kJ** | **Vitamin C in mg** | **Calcium in mg** |
| X | 2 900 | 25 | 70 |
| Y | 2 100 | 47 | 265 |
| Z | 2 600 | 40 | 170 |

Answer these questions.

**3.1** Name **two** sources of carbohydrates in meal X.

**3.2** Which meal will:

**i** Provide the greatest source of energy

**ii** Be least suitable for sailors who are prone to the condition of scurvy

**iii** Be most suitable for providing an insulating layer against cold in the human body

**iv** Be most suitable for the development of healthy teeth and bones?

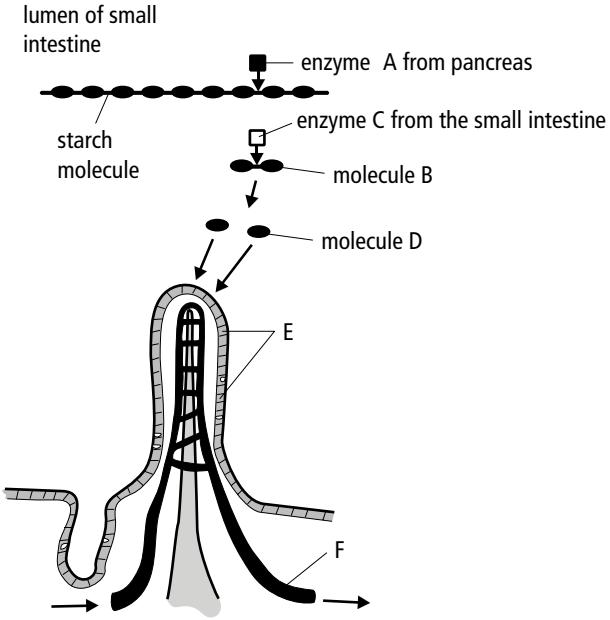
**3.3** Meal Z is relatively low in lipids, yet it has a high energy content. Which of the food components in Z provide the energy?

**3.4** Trypsin is a substance found in the digestive system.

**i** Where in the digestive tract is trypsin active?

**ii** Which meal provides the greatest amount of substrate for trypsin? Give a reason for your answer.

**4.** Study the diagram below, which represents the digestive process in a part of the small intestine. Answer the questions based on it.




**4.1** Identify:

**i** Enzymes A and C

**ii** Molecules B and D

**iii** Parts labelled E and F

**4.2** Which molecule is also needed for the digestive process to take place?

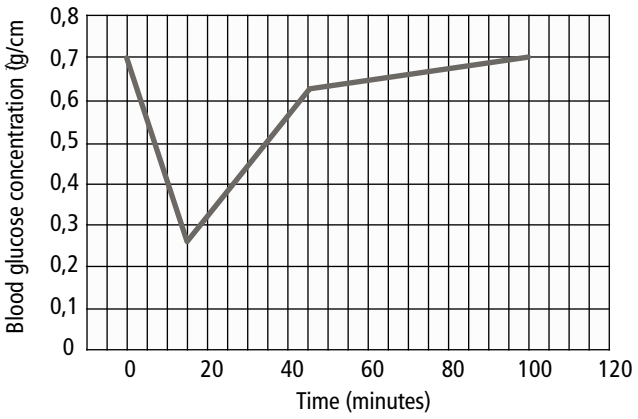
**4.3** Describe how molecule D will pass into cells E.

**4.4** Explain how the optimum pH level that is needed for enzymes A and C to function effectively is maintained.

**4.5** Name the vessel that will transport D to the liver after it has been absorbed into F. Describe also its final fate in the cells.

**4.6** List **three** adaptations of the small intestine for digestion and absorption.

**5.** The graph below shows the changes in the blood glucose level of a healthy person after an injection of insulin. Study the graph and answer the following questions.




**5.1** Give the amount of glucose (in grams/cm$^3$) that was present in the person's blood:

**i** shortly before the insulin was injected

**ii** 10 minutes after the insulin was injected

**5.2** **i** How much glucose (grams/cm$^3$) was removed from the blood 10 minutes after the injection?

**ii** How long after the injection was the blood glucose normal again?

**5.3** **i** Precisely where in the body is insulin formed?

**ii** Into which compound was glucose changed after the injection?

**iii** In which organ of the body is the compound formed?

**5.4** After 15 minutes, which hormone started the important function of restoring the blood glucose level to normal?

**5.5** Name an organ in the human body where the homeostatic processes that control the blood glucose concentrations take place.

# MEMORANDUM FOR WORKSHEET 5

**1.1** A mouth – pharynx – oesophagus – stomach – small intestine – large intestine – rectum – anus

**1.2** Mouth: ingestion of food takes place here. The teeth, tongue, palate, and saliva secreted by the salivary glands help to digest the food.
Pharynx: leads to the oesophagus and during swallowing, the glottis is closed by the epiglottis.
Oesophagus: conducts food to the stomach.
Stomach: digestion of proteins takes place here.
Small intestine: allows for digestion and absorption of food.
Large intestine: most water is absorbed here.
Rectum: temporary store of undigested wastes.
Anus: egestion of undigested wastes.

**1.3** *Mouth*: consists of teeth, tongue, palate and salivary glands.*Pharynx*: consists of the epiglottis, which prevents food from being regurgitated. *Oesophagus*: muscular walls for peristalsis. *Stomach*: muscular, bag-like, with valves, secretes hydrochloric acid and proteases secreted by gastric glands. *Small intestine*: long and muscular, has numerous folds containing villi, secretes enzymes, well supplied with blood vessels and lacteal. *Large intestine*: long, for absorption of water. *Rectum and anus*: muscular.

**1.4**
**i** The egg consists of protein and protein digestion begins in the stomach. Hydrochloric acid softens the egg, denaturing the protein, and breaking down the large protein molecules into smaller molecules. From the stomach, the broken-down proteins move into the small intestine. In the small intestine the proteins are finally broken down into amino acids. Intestinal juice and pancreatic juice contains protein-digesting enzymes that are secreted into the small intestine.

**ii** The absorption of amino acids occurs either passively by diffusion or through active transport against a concentration gradient. During active transport, energy is used. Carrier molecules are generally required. The amino acid molecules then diffuse into the capillary network of the villus.

**1.5** Carbohydrates, lipids and proteins are a source of energy. Vitamins are required in small quantities and each play an important role in the body, contributing to the overall metabolism. Minerals may be either macronutrients or micronutrients. These perform a variety of functions.

**2.1**
**i** Digestion/hydrolysis

**ii** Absorption

**2.2** Water acts as a solvent to dissolve the nutrients and it facilitates easy diffusion between the absorptive surfaces.

**2.3** Villi

**2.4** Amino acids

**2.5** Excess amino acids (molecule C) cannot be stored in the body. They are broken down in the liver by the process of deamination into glucose and urea. The glucose is oxidised to release energy, while the urea is excreted by the kidneys.

**3.1** Coke, white bread, potato chips.

**3.2**
- **i** X
- **ii** X
- **iii** Y
- **iv** Y

**3.3** Carbohydrates: brown bread and bitter beer.

**3.4**
- **i** Small intestine.
- **ii** Y, because it contains a high protein content.

**4.1**
- **i** A – amylase; C – maltase
- **ii** B – maltose; D – glucose
- **iii** E – columnar epithelium;
  F – venule

**4.2** Water

**4.3** Through passive diffusion/with a diffusion gradient or active transport/ against the diffusion gradient when there is a higher concentration of glucose in the epithelium cells than in the intestine. This uses energy.

**4.4** Bile neutralises the acid of the stomach, as do bicarbonate ions secreted by the Brünner's glands and found in the pancreatic juice.

**4.5** The hepatic portal vein. Molecule D is:
- Stored as glycogen
- Used during cellular respiration to form ATP
- Converted into fats.

**4.6** Any three of the following are acceptable:
- Very long small intestine
- Surface area is increased/by folds of the mucosa/millions of villi and microvilli
- Movement of the intestine wall and villi ensures close contact of food with absorption area
- Absorption surface is thin-walled/only a single layer of columnar epithelium cells
- Absorption surface is moist because of the digestive juices and mucin
- Well supplied with blood capillaries/lacteals.

**5.1**
- **i** 0,7 g/ℓ
- **ii** 0,4 g/ℓ

**5.2**
- **i** 0,3 g/ℓ
- **ii** 95 minutes

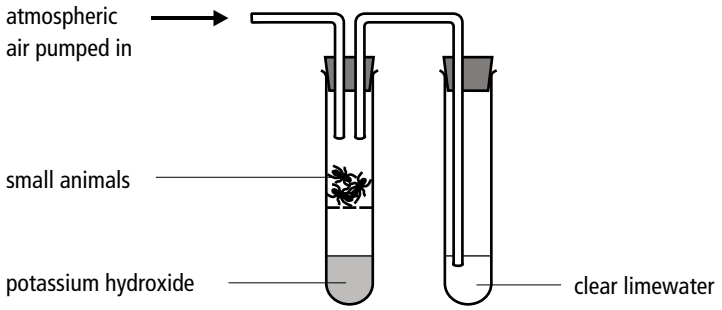
**5.3**
- **i** In the beta cells of the Islets of Langerhans
- **ii** glycogen
- **iii** the liver

**5.4** Glucagon

**5.5** The liver

# WORKSHEET 6: Cellular respiration

**1.** A group of Grade 11 learners designed an investigation as illustrated below. Study the diagram and then answer the questions that follow.




**1.1** Name the biochemical process that the learners intended to investigate.

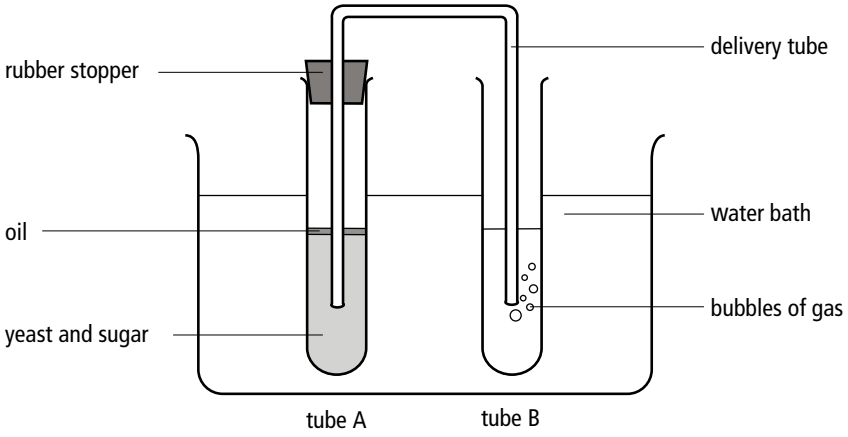
**1.2** State **one** function of each of the following:

**i** Potassium hydroxide

**ii** Clear limewater.

**1.3** Explain **two** ways in which the experimental design should be improved to obtain valid and reliable results.

**2.** A test tube containing some yeast and sugar solution was placed in a water bath as shown in the diagram below. After ten minutes the rate of bubble production in tube B was measured.




This experiment was then repeated with the water bath at different temperatures. The results are recorded in the table below.

| Temperature (°C) | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|
| Number of gas bubbles produced per minute | 4 | 10 | 18 | 24 | 27 | 12 |

**2.1** State **one** function of the oil.

**2.2** Give **one** reason why the apparatus was left for ten minutes at each temperature before any bubbles were counted.

**2.3** Name the process taking place in the yeast cells, which produces the gas.

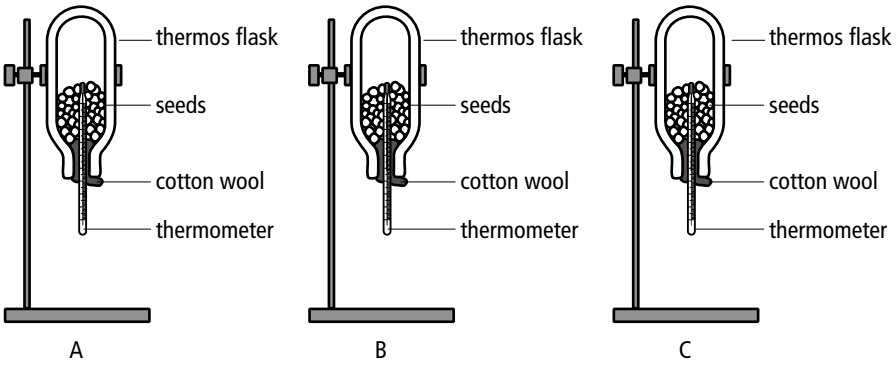
**2.4** Name the gas that is produced.

**2.5** Why did the number of bubbles decrease at 60 °C?

**2.6** Suggest **one** reason why the yeast cells would die in tube A after about a week at 40 °C.

**2.7** State **two** ways in which humans have taken advantage of the process shown in the diagram.

**3.** Study the following experimental setup in which three thermos flasks were used.




Flask A contained moist germinating seeds.

Flask B contained seeds that had been boiled.

Flask C contained boiled seeds sterilised in formalin solution.

The results obtained, i.e. the changes in temperature in °C, in the different thermos flasks are recorded in the table below.

| | | | | | |
|---|---|---|---|---|---|
| Flask A | 20,0 | 20,1 | 22,6 | 23,0 | 23,3 |
| Flask B | 20,0 | 20,0 | 25,0 | 21,3 | 22,0 |
| Flask C | 20,0 | 20,0 | 20,1 | 20,1 | 20,1 |

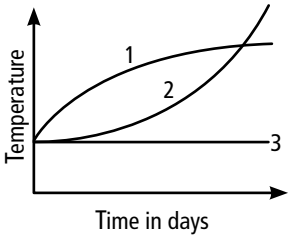
**3.1** Suggest an aim for this investigation.

**3.2** State **two** reasons why the flasks were turned upside down.

**3.3** Why is cotton wool used instead of a rubber stopper?

**3.4** What caused the difference in temperatures that were recorded in the reading between 36 and 60 hours in each of the different flasks?

**3.5** Because the seeds in flasks B and C were treated, a chemical process that normally generates energy in living cells could not take place. Name the process that is referred to.

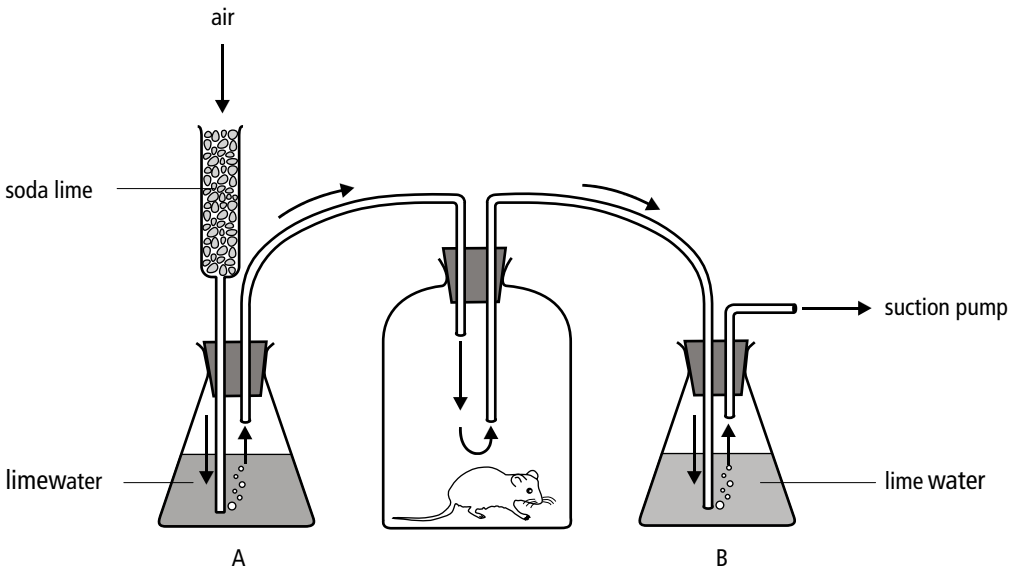



**3.6** After a few days, the temperature in flask B began to increase. Suggest a reason for this.

**3.7** Which of the curves, 1, 2, or 3, in the figure on the left indicates the results obtained for flask A?

**3.8** Which flask, A, B, or C, served as the control?

**4.** Study the diagram below and then answer the questions that follow.




**4.1** Suggest an aim for the above investigation.

**4.2** State the function of the soda lime.

**4.3** Explain the difference in the purposes of the limewater in flask A and in flask B.

**4.4** State the expected results in the above investigation.

**4.5** Explain **two** ways in which the above experimental design could be improved to achieve more valid and reliable results.

# MEMORANDUM FOR WORKSHEET 6

**1.1** Cellular respiration

**1.2** **i** Absorbs $CO_2$.

**ii** Indicates the presence/absence of $CO_2$.

**1.3** Any two of the following are acceptable:

- The atmospheric air that enters the apparatus contains $CO_2$. This needs to be eliminated by filtering it through a filter that contains a substance such as potassium hydroxide.
- Potassium hydroxide and the organisms are in the same container, therefore potassium hydroxide should be removed from this container.
- Add an outlet to the second tube to let air flow out through the apparatus.

**2.1** The oil prevents the entry and exit of gases.

**2.2** To allow time for the yeast to acclimatise to the different temperatures.

**2.3** Anaerobic respiration/fermentation

**2.4** $CO_2$

**2.5** It is possible that respiration slowed down drastically at this temperature because the very high temperature could have denatured the respiratory enzymes.

**2.6** The sugar content will be depleted and so there is not enough food for respiration or the size of the yeast population could have increased drastically and so competition for space would have decreased respiration.

**2.7** The production of wine and beer and other alcoholic drinks and baking.

**3.1** To show that heat energy is released by germinating seeds.

**3.2** Any two of the following are acceptable:

- So that the thermometer could be read and the temperature recorded.
- Because carbon dioxide is heavy, turning the flask upside down allows the gas to escape, which will prevent respiration slowing down.
- Hot air rises and so turning the flask upside down will limit loss of heat through the plug.

**3.3** To allow the oxygen to enter the flask so that the germinating seeds can respire and to allow the carbon dioxide to escape, otherwise respiration will slow down.

**3.4**

- In flask A cellular respiration occurred in the germinating seeds.
- In flask B bacteria and fungi released energy in the form of heat due to anaerobic respiration.
- In flask C no respiration occurred since there were no living organisms in it.

**3.5** Aerobic respiration

**3.6** Bacteria and fungi begin to grow and heat is a product of respiration.

**3.7** Curve 1

**3.8** B and C

**4.1** To determine whether $CO_2$ is released during cellular respiration.

**4.2** It absorbs $CO_2$ from incoming air.

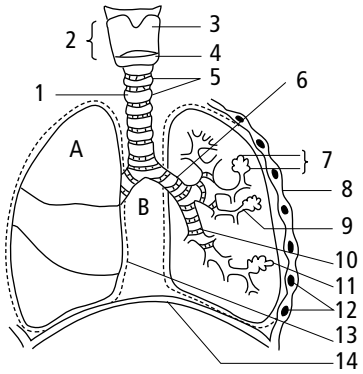
**4.3** In flask A, the limewater is used to show that there is no $CO_2$ coming in from the atmosphere. In flask B, the limewater is used to determine whether or not the animal has released $CO_2$.

**4.4**
- The limewater in flask B will turn milky.
- In Flask A the limewater will stay clear.

**4.5**
- Set up a control without the mouse/set up a similar investigation with different living organisms to verify results.
- Set up a number of samples/repeat the experiment.

# WORKSHEET 7: Gaseous exchange

**1.** The diagram shows the human respiratory system. Answer the following questions using the diagram.




**1.1** Is part A the left or the right lung?

**1.2** Which organ is situated in position B on the diagram?

**1.3** Identify the parts numbered 1 to 14.

**1.4** There is a high diffusion gradient in the lungs favouring the passage of oxygen from part number 11 to the blood.

**i** Explain the term diffusion gradient.

**ii** How is the diffusion gradient between part number 11 and the blood maintained?

**1.5** Write down the number and name of a tube:

**i** Lined with ciliated epithelium

**ii** Kept open by O-shaped cartilaginous rings

**iii** Kept open by C-shaped cartilaginous rings

**1.6** Write down the number and name of the structure that:

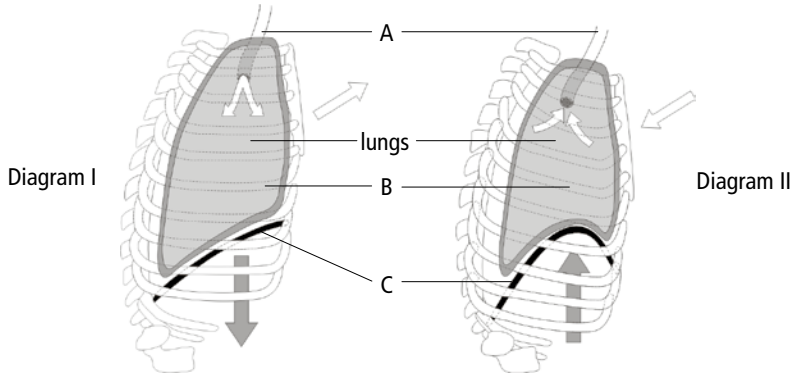
**i** Moves downwards during inhalation

**ii** Consists of bone

**1.7** State **six** requirements for efficient gaseous exchange in organisms.

**1.8** State the function of the mucous membrane with cilia in the air passages.

**2.** Study the diagrams below and then answer the questions that follow.




Side views of the chest region of the human breathing system

**2.1** Label the parts A, B and C.

**2.2** State the function of the part labelled B.

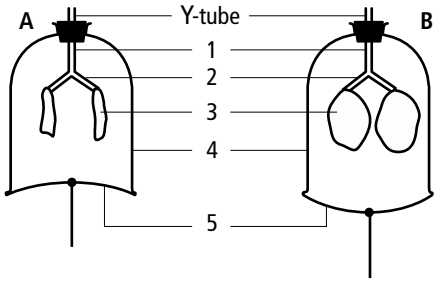
**2.3** Name two muscles that are involved during breathing.

**2.4** Which diagram illustrates the process of inhalation?

**2.5** Describe **two** observable features on the diagram to support your answer in Question **2.4**.

**2.6** Describe the relationship between pressure and volume in diagram II.

**3.** Study the diagram of the apparatus used to demonstrate the mechanism of breathing and then answer the questions.




**3.1** Name the parts numbered 4 and 5.

**3.2** Which human structures are represented by the parts numbered 1 to 5?

**3.3** Which apparatus (A or B) represents exhalation? Give a reason for your answer.

**3.4** Give **two** reasons why the part numbered 4 is a poor representation of a structure in the human body.

**3.5** State what would happen to th part numbered 3 if the part representing the rib cage was punctured.

**3.6** Briefly describe the mechanism of exhalation.

**4.** The composition of inhaled and exhaled air, shown as a percentage, is given in the table below.

| | Inhaled air (%) | Exhaled air (%) | Alveolar air (%) |
|---|---|---|---|
| Oxygen | 20,36 | 16,25 | 14,45 |
| Carbon dioxide | 0,04 | 5,05 | 5,05 |
| Nitrogen and other gases | 79,60 | 79,70 | 80,05 |

**4.1** Name a component of the other gases named in the table that is essential for the functioning of the cells of the alveoli.

**4.2** Why is the percentage of nitrogen and other gases almost the same in all three cases?

**4.3** Account for the difference in the percentage of oxygen in inhaled and exhaled air.

**4.4** Explain the difference in the carbon dioxide level in exhaled air and alveolar air.

**5.** The average number of red blood cells in the blood of people living at different altitudes (height above sea level) is shown in the table below. Each reading is the average for ten adult men who have lived at that altitude for at least four months.

| Altitude (metres) | Average number of red blood cells (millions/mm$^3$ of blood) |
|---|---|
| 0 | 5,1 |
| 1 500 | 5,3 |
| 3 000 | 5,4 |
| 4 500 | 5,6 |
| 6 000 | 5,9 |
| 7 500 | 6,2 |

The winning times in three different events at the Olympic Games held in different cities around the world are shown in the table below. Each city is located at a different altitude.

| Cities | Altitude (metres) | Events | | |
|---|---|---|---|---|
| | | 800 m | 5 000 m | 10 000 m |
| TOKYO | 200 | 1 min 45,1 sec | 13 min 44,8 sec | 28 min 24,4 sec |
| MEXICO CITY | 2 240 | 1 min 44,3 sec | 14 min 28,4 sec | 29 min 27,9 sec |
| MUNICH | 52 | 1 min 45,9 sec | 13 min 26,4 sec | 27 min 38,4 sec |

**5.1** State **one** generalisation that can be made from the first table about the average number of red blood cells and altitude.

**5.2** Why was the average number of red blood cells for ten individuals used rather than the red blood cell count of only one person?

**5.3** Describe the general relationship between performance by athletes and altitude.

**5.4** Which events are greatly influenced by the altitude?

**5.5** During the Mexico City Games, athletes from East Africa (which is 2 000 m above sea level) were more successful than their competitors from the lower altitudes. Suggest a physiological explanation for this.

# MEMORANDUM FOR WORKSHEET 7

**1.1** Right lung.

**1.2** The heart.

**1.3**
1 – trachea
2 – larynx
3 – thyroid cartilage
4 – cricoid cartilage
5 – C-shaped cartilaginous rings
6 – bronchus
7 – alveolar sacs of the lungs
8 – intercostal muscles
9 – vestibulum
10 – bronchiole
11 – alveolus
12 – ribs
13 – pleural membrane
14 – diaphragm

**1.4**
**i** The concentration of oxygen is always higher in the alveolus than in the blood surrounding the alveolus. Oxygen diffuses down a concentration gradient from the air in the alveolus into the blood of the lung capillaries and the rate of diffusion increases.

**ii** By inhaled oxygen and deoxygenated blood, which reached the alveolus. Blood reaching the alveolus has a lower oxygen pressure than alveolar air.

**1.5**
**i** 1 – trachea; 6 – bronchus

**ii** 6 – bronchus

**iii** 1 – trachea

**1.6**
**i** 14 – diaphragm

**ii** 12 – ribs

**1.7** Surface must be large for exchange of gases and kept moist continuously for gases to dissolve. Efficient transport medium must be available. Efficient ventilation mechanism must be present. Must be protected against mechanical injury.

**1.8** Mucus secreted by goblet cells moistens inflowing air and prevents delicate lung membranes from drying out. Epithelium richly supplied with blood, which also warms inflowing air. Mucus is antiseptic and is part of the barrier to micro-organisms entering the respiratory tract. Dust particles and micro-organisms are trapped in the moist mucus and moved to the exterior by the movement of the cilia.

**2.1** A – trachea; B – ribs; C – diaphragm.

**2.2** Protection/ventilation

**2.3** Any of: diaphragm/internal intercostal muscles/external intercostal muscles.

**2.4** Diagram I

**2.5**
- The ribs are lifted up/the chest cavity expands/moves outwards.
- The diaphragm contracts/flattens/move downwards.

**2.6** The decreased volume of the chest cavity results in increased pressure.
OR
Pressure is indirectly proportional to volume.

**3.1** 4 – bell jar
5 – rubber sheet

**3.2** 1 – trachea
2 – bronchus
3 – lungs
4 – thoracic wall
5 – diaphragm

**3.3** A – rubber sheet moves up to its original position. Pressure inside bell jar increases, causing balloons to collapse and air is forced out of Y-tube.

**3.4** Bell jar representing thoracic wall is static and can't indicate the movement of ribs/impossible to show action of intercostal muscles.

**3.5** The balloons will remain collapsed even if the rubber sheet moves up and down.

**3.6** This is the passive phase of breathing. Diaphragm relaxes and returns to convex position. External intercostal muscles relax and internal intercostal and abdominal muscles contract. Ribs and sternum move inwards and downwards. Volume of thoracic cavity decreases. Pressure inside thoracic cavity increases. This causes increasing intrapleural pressure. Pressure on lungs increases and air rich in carbon dioxide is forced out of the lungs through bronchi and trachae.

**4.1** Water vapour

**4.2** They are not used in gaseous exchange.

**4.3** Oxygen in the alveolar air diffuses into blood capillaries surrounding alveoli, thus exhaled air contains less (4,11%) oxygen.

**4.4** Carbon dioxide diffuses constantly into residual air in the alveolus from the blood and from here it diffuses into tidal air and is then exhaled.

**5.1** The higher the altitude, the greater the average number of red blood cells per volume of blood.

**5.2** Taking an average of results minimises the error factor that is found when only one result is used.

**5.3** For the shorter distance races like the 800 m, there is no significant difference in the time. However, for the longer distances like the 5 000 m and 10 000 m, there is a significant difference at higher altitudes and the running time becomes longer.

**5.4** The longer distance events – e.g. 5 000 m and 10 000 m

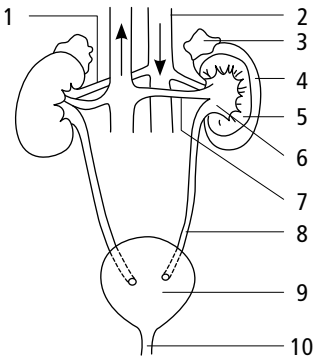
**5.5** Many of these athletes are acclimatised to high altitudes. Hence their bodies were already adjusted to the lower oxygen content of the air. A person who normally lives at a height of over 1 000 m differs from a person who lives below 300 m in the following ways:

- His/her breathing is deeper.
- The volume of his/her blood increases from about 5–6,5 litres.
- The number of red blood cells in his/her blood increases from about 5 million per $mm^3$ to about 7 million per $mm^3$.

Hence, these athletes suffered less muscle fatigue because of their ability to pay off their oxygen debt and were therefore more successful.

# WORKSHEET 8: Excretion in humans

**1.** Study the diagram of the urinary system and its blood supply and then answer the questions.




**1.1** Identify the parts numbered 1 to 10.

**1.2** **i** Which part of a nephron occurs in the region numbered 4?

**ii** What happens to blood in that part of a nephron mentioned in Question **1.2 i**?

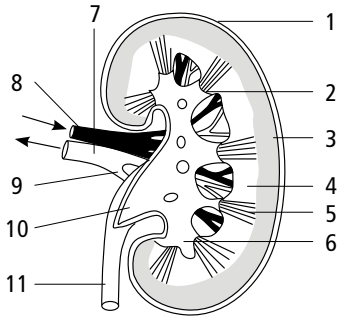
**1.3** **i** Which part of a nephron occurs in the region numbered 5?

**ii** Name **two** functions performed by the nephron in the region mentioned in Question **1.3 i**.

**1.4** Name **two** ways in which the blood in the part numbered 1 differs from that in the part numbered 7.

**1.5** Briefly describe the function of the kidneys.

**2.** Study the diagram of a longitudinal section through the human kidney and then answer the questions.




**2.1** Identify the parts numbered 1 to 11.

**2.2** Name the function of the tube numbered:

**i** 7

**ii** 8

**iii** 11

**2.3** In which numbered part do the:

**i** Malpighian bodies and

**ii** Loops of Henle occur?

**2.4** Name the **two** components making up a Malpighian body.

**2.5** In which numbered part do the ducts of Bellini occur?

**2.6** Mention **three** processes, other than filtration, which take place in the kidney.

**3.** The table below shows the concentration of substances in the blood plasma, glomerular filtrate and in the urine.

| Substance | % in plasma | % in filtrate | % in urine |
|---|---|---|---|
| Water | 90–93 | 99–100 | 97,5 |
| Proteins | 7,0 | 0 | 0 |
| Glucose | 0,1 | 0,1 | 0 |
| Salts | 0,35 | 0,35 | 0,5 |
| Urea | 0,03 | 0,03 | 2,0 |

**3.1** Which substances that were present in the blood plasma did not filter through into Bowman's capsule? Give a reason for this phenomenon.

**3.2** Give an explanation for each of the following:

**i** No glucose in the urine

**ii** A higher concentration of salts in the urine

**iii** A much higher concentration of urea in the urine

**3.3** Give **two** possible reasons why glucose is sometimes found in human urine.

**4.** The main function of the body is to help maintain homeostatic control in the body. The table below compares the concentration of different substances: blood plasma, the filtrate in Bowman's capsule and urine in a person.

| Substance | Blood plasma (g/100 $cm^3$) | Glomerular filtrate (g/100 $cm^3$) | Urine (g/100 $cm^3$) |
|---|---|---|---|
| Proteins | 7,00 | 0 | 0 |
| Glucose | 0,10 | 0,10 | 0 |
| Urea | 0,03 | 0,03 | 2,0 |
| Uric acid | 0,002 | 0,002 | 0,03 |
| Sodium | 0,32 | 0,32 | 0,60 |
| Phosphates | 0,003 | 0,003 | 0,18 |
| Sulphates | 0,003 | 0,003 | 0,12 |
| Water | 92,00 | 98,00 | 96,00 |

**4.1** Explain the term homeostasis.

**4.2** Using the information in the table, what can you work out about the way that the kidney maintains homeostasis?

**4.3** How do the kidney and the brain function together to bring about a stable osmotic environment in the body?

**4.4** Name **two** substances, other than those listed in the table, that may be present in urine.

**4.5** Briefly explain why:

**i** Glucose is present in the glomerular filtrate but absent in the urine

**ii** In some cases glucose may appear in the urine

**iii** No protein is found in the filtrate even though it is present in the blood plasma

**4.6** **i** Suggest a reason for the increased concentration of urea in urine.

**ii** Which substance in urine is the most important nitrogenous waste? Explain, without biochemical details, where and how this waste product is formed in the body.

**4.7** Account for the high percentage of phosphates and sulphates in the urine compared to the glomerular filtrate.

**4.8** How would you expect the composition of human urine to differ from that indicated in the table above:

**i** After strenuous exercise

**ii** After a high-protein meal?

**4.9** Suggest explanations for the following:

**i** Desert mammals have a long loop of Henle

**ii** Heart failure often results in renal failure

**5.** Study Figures A, B and C below and then answer the questions that follow.

**Figure A:** Graph showing the relationship between tubular reabsorption of water in the kidney and the level of ADH

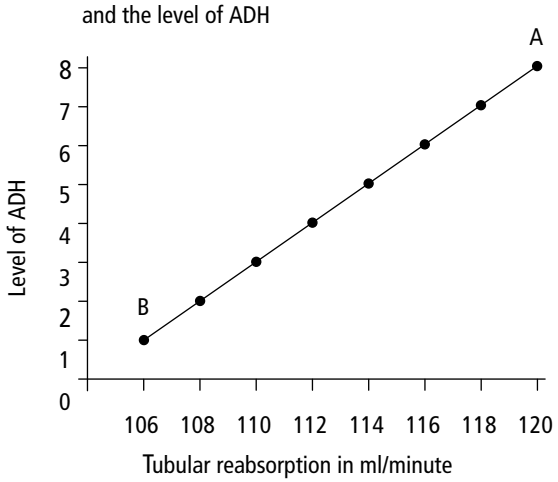



**Figure B:** The water balance on hot and cold days

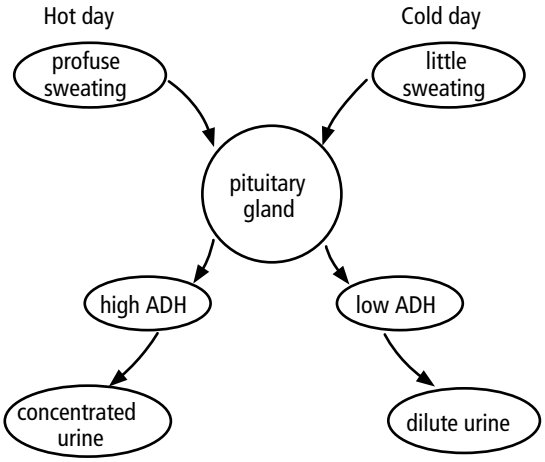
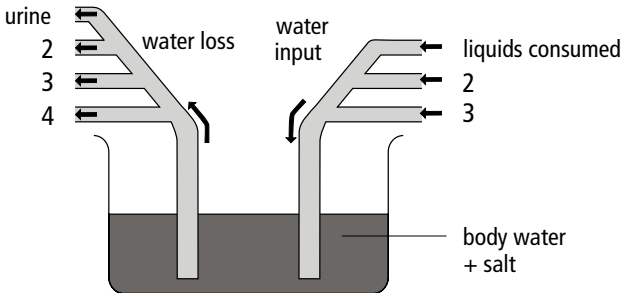



**Figure C:** Water and salt balance in the human body




**5.1** What relationship exists between the level of ADH and tubular reabsorption of water?

**5.2** What effect does increased ADH have on the renal tubules?

**5.3** What would you expect the circumstances of the body to be at A on the graph in Figure A?

**5.4** With reference to Figure B, explain why ADH levels may be relatively low on a cold day?

**5.5** What are the **two** other sources of water and the **three** other methods of losing water that are not listed in Figure C?

**5.6** Which **three** organs of the body are responsible for loss of salt?

**5.7** Describe how the salt balance is maintained in the body.

**5.8** The composition of urine depends on a number of factors. Suggest what would be the effect of the following factors on the composition of urine:

**i** Drinking a lot of water in a short period of time

**ii** Eating a very salty meal

**iii** Eating a high-protein diet

**iv** Living in a hot desert

# MEMORANDUM FOR WORKSHEET 8

**1.1** 1 – renal artery; 2 – aorta; 3 – adrenal gland; 4 – cortex; 5 – medulla; 6 – pelvis; 7 – renal vein; 8 – ureter; 9 – urinary bladder; 10 – urethra

**1.2** **i** Malpighian body

**ii** Blood is under pressure and ultra-filtration of substances takes place.

**1.3** **i** Renal tubule

**ii** Tubular reabsorption and tubular excretion.

**1.4** The blood in 1 – the renal artery – contains more waste products, e.g. urea and mineral salts than the blood in 7 – the renal vein. The blood in 1 contains more water than the blood in 7.

**1.5** The kidneys excrete waste products, e.g. urea, uric acid, creatinine and drugs. They perform an osmoregulatory function and regulate the water content of body fluids. They play a role in maintaining the osmotic pressure of body fluids by excreting excess salts and by retaining water and glucose. They regulate the pH of blood plasma, i.e. they control the acid-base equilibrium in the blood.

**2.1** 1 – renal capsule; 2 – renal papilla; 3 – cortex; 4 – medulla; 5 – renal pyramid; 6 – calyx; 7 – renal vein; 8 – renal artery; 9 – hilum; 10 – pelvis; 11 – ureter

**2.2** **i** Transports purified blood away from the kidneys.

**ii** Transports blood with waste products toward the kidneys.

**iii** Transports urine to the urinary bladder.

**2.3** **i** 3

**ii** 4

**2.4** The glomerulus and Bowman's capsule.

**2.5** In 5.

**2.6** Any three of:

- Reabsorption of water (passive absorption) and useful substances, e.g. glucose, amino acids (active absorption) from the convoluted tubules and the loops of Henle
- Tubular excretion of creatinine, penicillin and hippuric acid from blood into the renal tubules
- Synthesis of ammonia by the cells lining the renal tubules and excreted directly into tubules
- Osmoregulation.

**3.1** Proteins, because protein molecules are too large to filter through the slit pores of the podocytes in Bowman's capsule.

**3.2** **i** Glucose is a useful substance and is an important source of energy, so it will not be excreted in normal physiology and it is reabsorbed in the proximal convoluted tubule and the loop of Henle. Glucose is actively reabsorbed by the cuboidal cells with their brush border of microvilli.

**ii** The salt concentration of the blood is regulated by excretion and reabsorption, and is controlled by aldosterone. Sodium and potassium

ions play a role in maintaining the extracellular fluid. When there is too much sodium in the body, the secretion of aldosterone is inhibited and less sodium is reabsorbed, and more is excreted in the urine. The secretion of potassium into the distal convoluted tubules and collecting ducts is enhanced by aldosterone, which lowers the potassium levels in the blood.

**iii** Urea is a nitrogenous waste and must be eliminated from the body. The cells of the distal convoluted tubules have a brush border with microvilli and numerous mitochondria. Urea from the surrounding tissue fluid and capillaries is actively secreted into the tubules and the collecting ducts (tubular excretion).

**3.3**
- If glucose appears in urine, it is due to malfunctioning of the kidneys.
- It could be due to an abnormally high concentration of glucose in the blood as a result of insufficient insulin secretion by the pancreas.

**4.1** Homeostasis is the maintenance of a constant internal body environment.

**4.2** The kidney excretes excess water through osmoregulation. It also excretes nitrogenous wastes such as urea and uric acid (excretion) and excess mineral salts (ionic regulation). The kidney also regulates the pH of the body fluids (acid-base balance).

**4.3** The pituitary gland reacts to the amount of water in the blood and secretes the hormone ADH, which controls the permeability of the walls of the distal convoluted and collecting tubules. A high water content inhibits ADH secretion, the permeability of the walls of the distal convoluted and collecting tubules decreases and little or no water is reabsorbed and more is excreted.

**4.4** Creatinine in humans and hippuric acid in herbivorous mammals

**4.5** **i** Glucose is conserved because it is used for energy in the body and it is reabsorbed in the loop of Henle.

**ii** Glucose may appear in the urine because:
- There is a kidney malfunction
- The pancreas is failing to produce insulin, or the body is resistant to insulin and so glucose is not taken up by the body cells.

**iii** Protein molecules are too large to pass through the pores in the endothelial layer of Bowman's capsule.

**4.6** **i** Large amounts of protein in the diet result in deamination in the liver, resulting in the production of urea and so the concentration of urea in the blood and urine rises.

**ii** Urea, which is produced by deamination in the liver, in which an amino group is removed from excess amino acids and metabolised into urea.

**4.7** This is the result of tubular excretion. These substances are acidic salts and are actively taken out of the blood and added to the filtrate. Their excretion maintains the slightly alkaline medium of the blood.

**4.8** **i** After exercise the blood is relatively dehydrated because of sweating.

**ii** The concentration of urea will increase as a result of deamination in the liver.

**4.9** **i** A long loop of Henle will allow more water to be absorbed and so conserve water.

**ii** In heart failure the heart is no longer pumping efficiently, dropping the pressure of the blood circulating through the kidneys, which reduces the pressure in the glomerulus where filtration takes place, so resulting in renal failure.

**5.1** There is a linear or directly proportional relationship, i.e. the level of ADH rises and tubular reabsorption increases proportionally.

**5.2** Increased ADH has the following effect on the renal tubules:

- ADH increases the number of water-selective channels in the plasma membrane of the distal convoluted tubule and the collecting duct.
- This increases the permeability of the cell membranes to water.
- This causes more water to leave the tubules by osmosis and to enter the medulla of the kidney.
- The water in the medulla is reabsorbed by the blood capillaries that surround the tubule (peritubular capillaries).
- The amount of water in the blood increases, so more concentrated urine is produced and less water is excreted from the body.

**5.3** If the body is losing a lot of water through sweat, more ADH will be produced to compensate and so reduce the amount of water lost in urine. In hot conditions, less and more concentrated urine is produced than on a cold day. If a person is not able to drink for a long period of time, high ADH levels will conserve as much water as possible and the volume of urine will be reduced.

**5.4** ADH levels may be low on a cold day because:

- Very little water is lost through sweat.
- The kidney will need to lose more water to maintain water balance and so less ADH is secreted.

**5.5** Other sources of water are: moisture in food and metabolic water from cellular respiration. Other sources of water loss are: sweating, expired air, faeces and tears.

**5.6** The skin (sweat), the kidneys (urine) and the eyes (tears).

**5.7** Salt balance is maintained by the uptake of sodium ions in the loop of Henle, which is controlled by the hormone aldosterone (produced in the adrenal cortex). The adrenal cortex is under the control of the pituitary gland, which detects salt levels in the blood and stimulates the adrenal cortex to produce the necessary amount of aldosterone.

**5.8**

**i** Drinking a lot of fluid will make the blood and body fluids more dilute and this excess liquid will be removed by the kidneys, which will form a large amount of dilute urine.

**ii** Excess salt must be excreted in solution, so that the kidneys can produce more urine to remove the salt. This can result in a relative shortage of water inside the body cells, which stimulates thirst.

**iii** A high-protein diet will lead to high amino acid levels and the excess is converted into urea in the liver. This is excreted by the kidneys, so the urine will have a high urea concentration.

**iv** Living in a hot desert will increase sweating and so water loss and the kidneys will conserve water, forming a highly concentrated urine.