EXCRETION WORKBOOK

Name:___________________

Tutor Group:_____________
Transport and Water Relations

3. (WASTE PRODUCTS OF BODY FUNCTIONS ARE REMOVED BY) THE KIDNEYS

1. **OBJECTIVES:**
   - Why do animals need an excretory system?
   - What parts make up the excretory system?
   - How does a kidney work?
   - What can be done if the system does not function?

   By the end of this topic you should:
   - (a) Know that the kidneys regulate the water content of the blood and remove waste products from the blood.
   - (b) Recognise and label a given diagram of the human excretory system to show: kidneys, renal artery, renal vein, ureters, urethra, and bladder.
   - (c) Know that the waste, a solution containing urea and excess salts called urine, passes from the kidneys in the ureters to the bladder where it is stored before being passed out of the body. Interpret data about the level of substances present in urine and during passage through the kidney.
   - (d) Observe gross structure of a section through a kidney
   - (e) Recognise and label a given diagram of a section through a kidney to include: cortex, medulla, pelvis, ureter and position of nephrons.
   - (f) Recognise and label a given simplified diagram of a nephron and its associated blood supply to show: capillary knot, Bowman's capsule, tubule, collecting duct, capillary network.
   - (g) Understand the process of filtration under pressure and know that selective reabsorption of glucose, some salts, and much of the water takes place in the tubule.
   - (h) Know that the kidneys regulate the water content of the blood by producing dilute urine if there is too much water in the blood or concentrated urine if there is a shortage of water in the blood.
   - (i) Know that kidney failure may be treated by a transplant or by a dialysis machine and compare the advantages and disadvantages of the use of these methods.
   - (j) Know that a diseased kidney may be replaced by a healthy one by transplant from a donor of a similar 'tissue type' to the recipient. The donor kidney may be rejected, attacked by the immune system, unless anti-rejection drugs are taken.
   - (k) Understand that in a dialysis machine a person's blood flows between selectively permeable membranes. It is important that useful substances in the blood, such as glucose and salts, are not lost. To prevent this, the dialysis fluid contains the same concentration of these substances as blood plasma. This ensures that only urea and excess salts and water diffuse into the dialysis fluid. This treatment has to be carried out at regular intervals.

2. Look at the video, OR MSS presentation OR PowerPoint presentation, OR read your textbook on THE KIDNEYS. Discuss the kidneys & excretory system with your teacher. If possible, examine a sheep or pig's kidney, OR a kidney model, OR computer images of a kidney.

   Use the labels to complete the diagrams below showing the position of the kidneys in the body, gross structure of the kidney and fine structure of a nephron:
1. **Position of kidneys in the body.**

*Labels:* aorta, bladder, kidneys, renal artery, renal vein, ureters, urethra, vena cava.

2. **Gross structure of the Kidney.**

*Labels:* cortex, medulla, pelvis, (position of) nephrons, renal artery, renal pyramids, renal vein, ureter.
3. **Fine structure of a nephron.**

*Labels:* Bowman's capsule, capillary knot (glomerulus), capillary network (x2), collecting duct, renal artery (branch of), renal vein (branch of), tubules (x2).

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3. **Functions of the kidney.**

**Answer the following questions:**

a. What are the 2 main functions of the kidneys?

b. What are the 3 main components of urine?

c. What is the source of urea?

d. Which blood vessel carries blood into the kidney under high pressure?

e. Blood enters each glomerulus under high pressure. What happens to most of the small molecules in the blood?
f. LIST the main small molecules filtered out of the blood from the glomerulus into the kidney tubules.

g. Why are red & white blood cells, platelets and large plasma proteins NOT filtered out of the blood from the glomerulus?

h. What happens to useful materials (i.e. glucose, most water & most salts) in the tubules?

i. Useful materials are reabsorbed into the blood by ACTIVE TRANSPORT, which needs energy from respiration in tubule cells. Why is it necessary to use this process, rather than just diffusion, which requires no energy?

j. What happens to the urea, water and salts NOT reabsorbed back into the blood?

4. **Controlling body water.**

In the spaces below, explain how the kidneys control the level of water in the blood,

a. **when the blood is too dilute:**
b. when the blood is too concentrated:

5. If you have finished....
Explain the role of ADH in controlling the level of water in the blood:

6. Look at the video, OR MSS presentation OR PowerPoint presentation, OR read your textbook on KIDNEY FAILURE. Discuss kidney failure & treatment with your teacher. If possible, examine kidney dialysis units.
   a. Describe how a kidney transplant takes place:
b. Complete the diagram showing how kidney dialysis works:

A greatly simplified diagram of an artificial kidney. The dialysing membrane may be in the form of flat sheets lying parallel with each other, or it may be rolled up like a swiss roll, or it may consist of lots of narrow tubes. The idea is to create a large surface area in the smallest possible space.
c. Complete the table comparing the advantages & disadvantages of transplant & dialysis:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transplant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dialysis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Well done! You have now completed the Excretion topic. Now you need to revise your work in preparation for the Excretion test.

8. Useful web links:

http://www.bbc.co.uk/schools/gcsebitesize/biology/humansasorganisms/6homeostasisrev5.shtml
http://www.biotopics.co.uk/human2/homkid.html
http://www.s-cool.co.uk/topic_quicklearn.asp?subject_id=17&Topic_ID=8&Quicklearn_ID=4&loc=ql
http://www.purchon.com/biology/kidney.htm
http://www.squashedfrogs.co.uk/resources/2006/1/the_kidney_-_how_it_works.ppt
http://www.revisionworld.co.uk/gcse/biology?q=category/export/html/18 (general revision site)
<table>
<thead>
<tr>
<th></th>
<th><strong>Glossary. (Muddled – sort them out!)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ADH</td>
</tr>
<tr>
<td>2</td>
<td>Aorta</td>
</tr>
<tr>
<td>3</td>
<td>bladder</td>
</tr>
<tr>
<td>4</td>
<td>Bowman's capsule</td>
</tr>
<tr>
<td>5</td>
<td>capillary knot (glomerulus)</td>
</tr>
<tr>
<td>6</td>
<td>capillary network</td>
</tr>
<tr>
<td>7</td>
<td>collecting duct</td>
</tr>
<tr>
<td>8</td>
<td>cortex</td>
</tr>
<tr>
<td>9</td>
<td>dialysis fluid</td>
</tr>
<tr>
<td>10</td>
<td>dialysis machine</td>
</tr>
<tr>
<td>11</td>
<td>filtration</td>
</tr>
<tr>
<td>12</td>
<td>kidney</td>
</tr>
<tr>
<td>13</td>
<td>medulla</td>
</tr>
<tr>
<td>14</td>
<td>nephron</td>
</tr>
<tr>
<td>15</td>
<td>pelvis</td>
</tr>
<tr>
<td>16</td>
<td>renal artery</td>
</tr>
<tr>
<td>17</td>
<td>renal vein</td>
</tr>
<tr>
<td>18</td>
<td>selectively permeable membranes</td>
</tr>
<tr>
<td>19</td>
<td>selective reabsorption</td>
</tr>
<tr>
<td>20</td>
<td>transplant</td>
</tr>
<tr>
<td>21</td>
<td>tubule</td>
</tr>
<tr>
<td>22</td>
<td>urea</td>
</tr>
<tr>
<td>23</td>
<td>ureter</td>
</tr>
<tr>
<td>24</td>
<td>urethra</td>
</tr>
<tr>
<td>25</td>
<td>urine</td>
</tr>
<tr>
<td>26</td>
<td>Vena cava</td>
</tr>
</tbody>
</table>

12. **Additional Notes:**
13. **QUESTIONS ON EXCRETION**

The diagram shows a simple version of a kidney machine. The patient’s blood is separated from the dialysis fluid by a partially permeable membrane.

![Diagram of kidney machine](image)

a) By what process do chemical wastes pass from the blood into the dialysis fluid?

b) Why do proteins not pass out of the blood?

c) Why would the presence of protein in the urine indicate kidney damage?

d) Why should the presence of glucose in the urine cause concern?

b) Match each part with one of these functions:
1. Stores urine.
2. Filters urea and other waste chemicals out of the blood.
3. Carries blood with a high concentration of urea.
4. Carries urine down to the bladder.

The graph shows how the quantities of sweat and urine vary with temperature:

![Graph showing sweat and urine production](image)

a) At what temperature is the amount of sweat and urine the same?

b) What happens to the amount of sweat as the temperature rises? Explain why this happens.

c) What happens to the amount of urine as the temperature rises? Explain why this happens.

d) Name the parts of the excretory system A to D:

<table>
<thead>
<tr>
<th>Substance</th>
<th>Blood entering kidney</th>
<th>Nephron</th>
<th>Urine</th>
</tr>
</thead>
<tbody>
<tr>
<td>urea</td>
<td>0.4</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>glucose</td>
<td>1.5</td>
<td>1.5</td>
<td>0</td>
</tr>
<tr>
<td>amino acids</td>
<td>0.8</td>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td>salts</td>
<td>8.0</td>
<td>8.0</td>
<td>16.5</td>
</tr>
<tr>
<td>protein</td>
<td>82</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

a) Which substances pass from the blood into the nephron?

b) How do they pass into the nephron?

c) Which substances are reabsorbed into the blood from the nephron? Explain why this happens.

d) Explain the results for protein.
The diagram shows the mean daily input and output of water for an adult.

```
<table>
<thead>
<tr>
<th>Water Gain</th>
<th>Water Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>food 1000 cm³</td>
<td>exhaled air 350 cm³</td>
</tr>
<tr>
<td>drink 1200 cm³</td>
<td>skin 500 cm³</td>
</tr>
<tr>
<td>respiration in all cells 300 cm³</td>
<td>urine</td>
</tr>
<tr>
<td>faeces 150 cm³</td>
<td></td>
</tr>
</tbody>
</table>
```

a) Respiration is a source of water.
Copy and complete the equation for respiration
sugar + .... → water + .... + energy [2]
b) The kidneys keep the water content of the body constant by controlling the volume of water passed out in the urine.
i) Use data from the diagram to calculate the mean daily output of water in the urine. Show your working. [2]
ii) Describe how the amount of water in the body is controlled by the kidneys. [3]
c) Sometimes kidneys fail. Two ways of treating kidney failure are the use of a dialysis machine and kidney transplants.
Describe what happens to the composition of a patient’s blood as it passes through a dialysis machine. [3]
d) In the treatment of kidney failure:
i) Give two possible advantages of using a kidney transplant rather than a dialysis machine. [2]
ii) Give two possible disadvantages of using a kidney machine rather than a dialysis machine. [2] (AQA)

The kidneys remove waste materials from the liquid part of the blood. The table overleaf shows the concentration of certain substances:
* in the liquid part of the blood
* in the liquid that has just been filtered from the blood in the kidneys
* in the solution in the bladder.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Concentration (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in liquid part of</td>
</tr>
<tr>
<td>protein</td>
<td>7.0</td>
</tr>
<tr>
<td>salt</td>
<td>0.35</td>
</tr>
<tr>
<td>glucose</td>
<td>0.1</td>
</tr>
<tr>
<td>urea</td>
<td>0.03</td>
</tr>
</tbody>
</table>

a) i) Which one of these substances does not pass into the liquid that is filtered in the kidneys? [1]
ii) Suggest one reason why this substance does not pass out of the blood. [1]
b) Explain why the concentration of urea in the liquid in the bladder is much greater than the concentration of urea in the liquid that is filtered in the kidneys. [1]
c) i) Describe how a kidney dialysis machine works. [3]
ii) Use the data in the table to suggest the concentration that the salt in the dialysis fluid should be. Explain your answer. [2] (AQA)

Below is a simplified diagram of a nephron.

```
A

B

X

C
```

a) Name the parts labelled A, B and C. [3]
b) Name two substances which are filtered out of the blood at X. [2]
c) What feature do substances have which makes it easy for them to filter out of the blood at X? [1]
d) Name two substances which are re-absorbed into the blood from the tubule. [2]
e) Name **three** substances which are present in urine. [3]

f) Where is the urine stored before it is expelled from the body? [1] (WJEC)

The diagram shows some of the processes which control the composition of blood.

![Diagram of brain and kidney with annotations for gland X, ADH, and changes in composition of blood.]

a) i) Name gland X. [1]

ii) What is the stimulus which causes gland X to produce ADH? [1]

iii) What type of substance is ADH? [1]

b) Describe the effect of an increase in ADH production on the kidney and on the composition of the urine. [3] (AQA)