Duncanrig Secondary School
S3 Biology Course
Title: Keeping the Body in Balance

Pupils’ Activity Booklet
Body Systems and Cells — Body Balance

What you should know by the end of this unit:

- The nervous system gathers information, processes it and makes responses to increase survival chances.
- Nervous system consists of brain, spinal cord and nerves.
- Central Nervous System (CNS) consists of brain and spinal cord.
- Information travels along nerves as impulses.
- Sensory nerves carry information from sense organs to CNS.
- Motor nerves carry information from CNS to muscles.
- Reflex actions by-pass the brain so that responses are very rapid.
- Information is gathered via the senses, so that appropriate responses can be made.
- The sense of touch allows much information to be gathered about the environment.
- Body temperature in humans is 37°C.
- If the temperature drops below 37°C, the body has 4 responses it makes to correct this - Blood flow near the surface is restricted; Sweating is reduced; Skin hairs stand on end; Shivering occurs.
- If the temperature rises above 37°C, the body has 2 responses it makes to correct this - Blood flows nearer to surface; Sweating increases.
- Heatstroke and hypothermia are life-threatening conditions caused by extreme temperature changes to the body.
- The pancreas monitors blood sugar level as the blood flows through it.
- Excess sugar can be stored in the liver or converted into fat.
- Diabetes is a disease in which the blood sugar level is not controlled properly.
- Diabetes can be controlled by diet, exercise or insulin injections.
- The body maintains a water balance, even although our intake varies every day.
- There are 3 ways for the body to gain water (drink, food & chemical reactions) and 4 ways in which it is lost (sweat, breathe, urine & faeces).
- The kidneys are part of the urinary system and are the main organs in water regulation.
- Blood enters the kidneys through renal arteries.
- Blood is filtered and then useful substances are reabsorbed.
- Blood returns to the rest of the body through the renal veins.
- Waste travels to the bladder in the ureters.
- If the kidneys fail to work, dialysis or kidney transplant can take place.
There are advantages and disadvantages with both; dialysis is restricting in lifestyle but can get the person well enough for a transplant: transplant means fewer hospital visits, but there is the possibility of rejection.

Organs can be donated for transplant, but there are moral and ethical issues with this.

Skills that you should be able to carry out by the end of this unit are:
- Construct a table
- Investigate reflex actions
- Investigate the sense of touch
- Calculate an average
- Work in partnership to write a passage about heat stroke and hypothermia
- Research diabetes and how to treat it
- Calculate water balance in the body
- Working in partnership, explain the advantages and disadvantages of kidney dialysis and kidney transplant
- Working in partnership, through discussion, give reasoned arguments on moral and ethical issues around organ donation
- Write up experiments with an aim, method, results and conclusion.
- Work as part of a group and take responsibility to support the work of the group.
The Nervous System

The human body constantly gathers information from its surroundings, processes this information, and makes appropriate responses to increase chances of survival and decrease chances of injury.

Key Questions (Answer in sentences)

- Working with a partner, try to answer the following questions.

1. Make a list of the five senses, one below each other.
2. Opposite each sense write down where it is located.
3. Which part of the body processes the information coming in from the senses?
4. How does the information get from the sense organs to the processing centre?

- Your teacher will discuss your ideas with you and with the rest of the class.

The Nervous system consists of three parts—Brain, Spinal Cord and Nerves.

The Brain and Spinal cord make up the Central Nervous System (CNS). A series of nerves connect the CNS with all parts of the body. Information can be passes along these nerves in the form of electrical impulses.

Information is sent along nerves from the sense organs to the brain where it is processed. Another set of nerves send information from the brain to the muscles to make some sort of response.

- Collect a copy of the ‘Nervous System’ diagram.
- Label the brain and spinal cord.
- Draw and label the nerves.
- Glue the diagram into your jotter.
The Nervous System contd.

Your Central Nervous System acts a bit like a computer which controls a factory. Information flows in and out of it and decisions are made depending on the type of information received.

Nervous System

- Sensory Nerves which carry impulses from the sense organs to the CNS.
- Motor Nerves which carry impulses from the CNS to the muscles.

Nerves

Nerves can only send impulses in one direction, so separate nerves are needed to bring information into the CNS from the ones which send it out. Two different types of nerves are:

1. Sensory Nerves which carry impulses from the sense organs to the CNS.
2. Motor Nerves which carry impulses from the CNS to the muscles.

Copy and complete the following table, using the information above and from the previous page.

<table>
<thead>
<tr>
<th>Part of nervous system</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain</td>
<td></td>
</tr>
<tr>
<td>Spinal cord</td>
<td></td>
</tr>
<tr>
<td>Nerves</td>
<td></td>
</tr>
</tbody>
</table>

Copy and complete the following table, to show the type of nerve and its function.

- Put appropriate headings for each column.

<table>
<thead>
<tr>
<th>Heading 1</th>
<th>Heading 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Nervous System contd.

Your sense organs detect information from your surroundings. The information is the stimulus which triggers a nerve impulse. The impulse is carried along a sensory nerve to the CNS. The information is sorted out in the CNS and another impulse is sent out along a motor nerve to those muscles which make the appropriate response, e.g. the muscle contracts to bring about movement. This is called the response.

- Collect a ‘Nerve Transmission Flow Chart’ which shows how information travels to and from different parts of the body.
- Use the passage above to complete the missing words on the diagram at the points marked 1-4.
- Glue the diagram into your jotter.

Reflexes

Some actions are carried out in the body so quickly that the brain does not get involved. Therefore there is no thinking process and the action takes place ‘automatically’. These are actions which prevent the body from being harmed and are known as reflexes. Two examples of this are:
1. Lifting your hand from an object which is very hot.
2. Changing the size of the pupils in your eyes in response to light levels.

Experiment 1: Pupil Reflex

Working with a partner, follow the instructions below.

Instructions

- Decide who is Person A and who is Person B.
- Person A should sit with their eyes closed and their hands covering them for about 30 seconds.
- Person B should look carefully at what happens to the size of their pupils as person A then takes their hands away.
- Person A then looks at a bright light and as they do so, person B again looks at the change in their pupils.
- Now swap roles and repeat the experiment.
- Write a few sentences to explain what you did and what you found out.
The sense of touch allows a person to detect many things in their environment such as different textures, pressures and temperatures. Touch can give an impression of a complete three-dimensional shape and can allow blind people to read using a system of raised dots known as Braille. Touch receptors are not evenly spread out over the body surface.

Experiment 2: Touch receptors

Working with a partner, follow the instructions below.

Instructions
- Carry out one of the touch experiments, following the instructions on the card carefully.
- Write a few sentences in your jotter to explain what you did and what you found out.
- Repeat this for all of the experiments, or until your teacher tells you to stop.

Key Questions (Answer in sentences)
- Working with your partner, try to answer the following questions.
  1. Which part of the body do you think is the most sensitive to touch?
  2. Which part of the body do you think has the most touch receptors packed closely together?
- Your teacher will discuss your ideas with you and with the rest of the class.
Body Systems and Cells — Body Balance

Body Temperature
The human body is capable of maintaining a constant temperature at its core. Even if your hands, feet and head feel cold, deep inside your body remains warm.

Experiment 3: Body Temperature

♦ Your teacher will show you how to use a thermometer to find the temperature of your own body.
♦ Copy the following table.
♦ Record your temperature in the table for three readings and calculate an average.

<table>
<thead>
<tr>
<th>Try</th>
<th>Temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
</tr>
</tbody>
</table>

♦ Now measure your temperature in three different environments, recording in a table where you were and the temperature of your body.

The core temperature of a healthy human being is 37°C. It should not change. The body does not function properly if the temperature rises or falls more than a degree or two.

Key Questions (Answer in sentences)
♦ Working with a partner, try to answer the following questions.
1. Under what conditions might the body temperature become too low?
2. What name is given to the condition of extremely low temperature?
3. Under what conditions might the body temperature become too high?
4. What name is given to the condition of extremely high temperature?
♦ Your teacher will discuss your ideas with you and with the rest of the class.
Controlling Body Temperature

The balancing act of temperature control is achieved by a temperature monitoring centre in the brain which detects changes in the temperature of the blood. Whenever a change takes place, the monitoring centre makes adjustments in the body to lose or gain heat and return the temperature to 37°C. These responses are made by sending impulses along nerves to the skin and muscles.

1. Blood vessels in the skin become narrower, restricting blood flow near the surface of the skin. This reduces heat loss.
2. Sweating is reduced.
3. Hairs on the surface of the skin stand on end to trap a layer of insulating air.
4. Shivering starts, generating heat from muscle movement.

If the temperature drops below 37°C, the following heating up responses occur to raise the temperature.

If the temperature rises above 37°C, the following cooling down responses occur to raise the temperature.
Controlling Body Temperature (continued)

1. Make a table in your jotter with the following headings:
2. Use the information in the previous passages to complete your table.
3. Collect diagrams of ‘Blood flow to the skin’ which show blood flow close to and further away from the skin’s surface. Glue each under the correct column of your table.
4. Write a sentence to explain why a person’s face looks red when they are hot.

<table>
<thead>
<tr>
<th>Heating up Responses</th>
<th>Cooling Down Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Extreme Conditions

Heat Stroke: If the body temperature rises above 40°C, a person may suffer heat stroke and may need urgent medical attention to cool them down. Heat stroke may result in convulsions, coma and death. When the body is fighting an infection, the heat generated may cause a rise in temperature to 40°C or more. This causes the person to have a fever and may need medical treatment.

Hypothermia: If the body temperature drops below 35°C, a person suffers hypothermia and may need urgent medical treatment to warm them up again. Hypothermia may result in come and death. Babies and the elderly are particularly at risk.

♦ Watch the videos.
♦ Working with a partner, write a short passage explaining what heat stroke and hypothermia are, and why they are extremely dangerous.
Control of Blood Sugar Levels

When you eat food that is digested to glucose, it passes from your intestines into your bloodstream. As the blood flows through your pancreas, the sugar monitoring part of it detects the level of sugar present.

If the sugar level has risen beyond the normal, the ‘extra’ sugar is removed and stored in the liver or converted into fat, returning the level back to normal.

If the sugar level has dropped below the normal, some of the stored sugar in the liver is released into the bloodstream, bringing the level back to normal.

Key Questions (Answer in sentences)

♦ Working with a partner, answer the following questions.

1. How does glucose get into your bloodstream?
2. Where in the body is the glucose monitoring centre?
3. What happens to extra sugar that the body does not require at that time?

If the control of blood sugar level goes wrong, a disease called diabetes occurs.

♦ Find out about this condition by either researching it from books or the internet or by brainstorming with the rest of the class to share your knowledge.
♦ Make brief notes in your jotter to summarise what you have found out.
Control of Blood Sugar Levels (contd)

People who suffer from diabetes either don’t make any or enough of a hormone called insulin.

The disease can be controlled by some or all the following:
- Careful planning of diet to regulate sugar & starch intake
- The right type of regular exercise
- Taking insulin

It is a careful balancing act to maintain the correct levels of glucose in the bloodstream at all times.

Collect a copy of the ‘Control of Blood Sugar Level’ diagram.
- Glue it into your jotter.
**Water Balance**

The human body is capable of maintaining a constant water balance. It manages this difficult task even though the volume of liquids consumed vary greatly every day.

Water is taken in through drinking liquids and also in food. Very few foods are completely dry and the amount of water contained varies greatly between different foods.

To maintain water balance, the body has a number of ways to gain and lose water.

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**Experiment 4: Water Loss**

1. Collect a piece of cobalt chloride paper and sellotape it to the inside of your palm.
2. Note the colour of the paper, then leave it there for the next 5 or 10 minutes.
3. While you are waiting, breathe out onto a cold surface such as a mirror or piece of glass.
4. What do you see on the cold surface?
5. Look at the paper on your hand. Has it changed colour? What could have caused the change?

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**Controlling Water Balance**

The balancing act of keeping the water in the body at the correct level is a difficult one and is controlled by varying the output of water (urine production) according to the level of input.

The body gains water in three ways—drink, food and chemical reactions. The body loses water in four ways—sweat, breath, urine and faeces.

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1. Put the information about water gain and water loss into a table.
2. Collect a 'Water Balance' worksheet and calculate the missing values.
3. Glue the worksheet into your jotter.
**Water Balance**

The main organs used to control water balance are the **kidneys**. They are part of the **urinary system**, and are located at about waist level towards the back of the body.

Water balance is brought about by altering the volume of urine produced in response to the volume of water in the blood. Blood arrives at the kidney in the **renal artery**. As it passes through the kidney, substances are filtered from it, useful substances are reabsorbed, and waste products are collected. The blood then returns to the rest of the body in the **renal vein**.

The waste materials which collect in the kidney are called urine and are taken to the **bladder** by tubes called **ureters**.

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1. Collect a diagram which shows the parts of the urinary system and their location in the body.
2. Label the diagram, then glue it into your jotter.
Body Systems and Cells — Body Balance

1. Copy the table below.
2. Using resources available, fill in the function of each part of the Urinary system.

<table>
<thead>
<tr>
<th>Part of Urinary System</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>kidney</td>
<td></td>
</tr>
<tr>
<td>renal artery</td>
<td></td>
</tr>
<tr>
<td>renal vein</td>
<td></td>
</tr>
<tr>
<td>ureter</td>
<td></td>
</tr>
<tr>
<td>bladder</td>
<td></td>
</tr>
</tbody>
</table>

♦ Your teacher will show you how the kidney works by looking at a model of the inside of the kidney. Listen to the explanation then copy the summary information and table from the box below.

How the Kidney Works

When the blood enters the kidney it is under high pressure (like a garden hose on full). This causes substances which are small enough to pass from the blood into the kidney. This is the first stage and is known as filtration. However, some of these small particles are useful to the body and should not be allowed to pass out in the urine.

A second stage therefore takes place. It is called reabsorption and allows all useful substances to return to the blood, leaving only waste products behind. This is now urine and can be passed to the bladder for storage.

<table>
<thead>
<tr>
<th>Substances Filtered</th>
<th>Substances Reabsorbed</th>
<th>Substances in Urine</th>
</tr>
</thead>
<tbody>
<tr>
<td>water</td>
<td>lots of water</td>
<td>water</td>
</tr>
<tr>
<td>glucose</td>
<td>all of the glucose</td>
<td>no glucose</td>
</tr>
<tr>
<td>salts</td>
<td>some salts</td>
<td>salts</td>
</tr>
<tr>
<td>urea</td>
<td>no urea</td>
<td>all of the urea</td>
</tr>
</tbody>
</table>
What happens if the Kidneys Fail to Work?

If the kidneys stop working completely because of disease or damage, then the person will die. This is known as kidney failure. A person can live with only one kidney, but cannot survive if both fail.

There are two ways of dealing with kidney failure:
1. **Kidney Dialysis (artificial kidney machine)**
2. **Kidney Transplant.**

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**Watch the video.**

*Working with a partner, copy and complete the following table by giving two benefits and two disadvantages of artificial kidneys and kidney transplants. (Make the table large enough to be able to write short sentences in it.)*

<table>
<thead>
<tr>
<th>Kidney Dialysis (Artificial Kidney)</th>
<th>Kidney Transplant</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benefits</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
</tr>
</tbody>
</table>

*Write a sentence or two to explain how your life would be changed if your kidneys became diseased or damaged.*
Organ Donation

Organ donation and transplantation is the process of removing an organ from one person and transplanting it into another. The organ being removed must be 'gifted'. In Britain every year, about 3500 people get a new lease of life following a transplant.

Kidney transplants are the most common, but transplants are also carried out on heart, liver, lungs, pancreas, and intestines.

Tissues such as eyes, heart valves, skin, bone and tendons can also be donated and transplanted.

Many thousands of people in Britain are waiting for a transplant that could save or dramatically improve their quality of life.

- Watch the short film about organ donation and transplantation.

- Your teacher will divide you into groups of four to carry out the following task.

  - Collect a set of ‘Ethical Dilemma’ Cards.
  - Pick a card at random and discuss the questions on it.
  - Do you all agree?
  - Can you explain the reasons behind your decisions?
  - Take brief notes on your decisions to report back to the rest of the class.
  - Repeat for the other cards.