G.C.S.E. PHYSICAL EDUCATION

Unit 1

Factors Affecting Participation and Performance

CARDIOVASCULAR AND RESPIRATORY SYSTEMS

Name:  ........................................

G.C.S.E. P.E. Teacher:  .................................

Winterhill Physical Education Department
By the end of this booklet you should:

- Be able to describe and explain how the circulatory and respiratory systems affect performance and participation levels, including lactic acid and oxygen debt tolerance, duration of activity and recovery rate.

- Be able to describe and explain how activity and exercise develop and affect the efficiency of the circulatory and respiratory systems.

- Be able to describe and explain the function of the different components of blood in relation to physical activity.

- Be able to describe and explain using examples, the difference between aerobic and anaerobic work and the effect that lactic acid has on performance.
THE CIRCULATORY SYSTEM

Blood is essential to all parts of the body. It carries essential nutrients and oxygen for energy release as well as removing waste products. The circulatory system ensures that blood is constantly supplied where needed throughout the body, and consists of:

- 
- 
- 

THE HEART

Using page 20 of GCSE PE for OCR, label the diagram of the heart.
The function of the heart is to pump blood around the body through a series of blood vessels called ....................... and ............................
The heart is the size of a closed fist, and is internally divided into four sections:

Two upper chambers, the .........................
Two lower chambers, the .........................

The heart pumps blood around the body in a series of blood vessels called ....................... and ............................ Some of the blood vessels are quite large but become much smaller as they reach the body's extremities, such as fingers and toes. Smaller arteries are known as arterioles and smaller veins are called venules. The smallest blood vessels of all are called capillaries.

Blood being pumped away from the heart flows through ......................... and blood returning to the heart does so in .........................

The blood picks up ......................... at the lungs and then goes straight to the heart, which pumps it around the rest of the body, delivering oxygen as it goes. By the time that the blood gets back to the heart there is no oxygen left. The heart pumps it back to the lungs where it picks up more oxygen and the process starts again. The left side of the heart pumps oxygenated blood around the body; the right side of the heart receives deoxygenated blood and pumps it back to the lungs.
Using page 21 of GCSE PE for OCR, label the main veins and arteries of the circulatory system on the diagram below:

De-oxygenated blood returns to heart via the veins and the Superior and Inferior Vena Cava

It is then pumped from the heart to the lungs where it is re-oxygenated

... blood finally leaves the heart via the Aorta to re-circulate the body

... and then back from the lungs to the heart as oxygenated blood

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THE COMPONENTS OF THE CIRCULATORY SYSTEM

1. a) The circulatory system has THREE main components. Name them:

   i)  
   ii)  
   iii) 

b) Blood pumped from the heart to the body transports two substances, needed for energy. Name them:

   i)  
   ii) 

c) What does blood remove from the cells of the body?

2. a) Match the number on the diagram to the component of the circulatory system.

b) Indicate with the tick the type of blood each component carried. The lungs and capillaries carry both and have been done for you.

c) Indicate on the diagram the direction of blood flow, using arrows.

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>COMPONENT</th>
<th>OXYGENATED</th>
<th>DEOXYGENATED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aorta</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Right side of heart</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capillaries in the lungs</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vena Cava</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Left side of heart</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capillaries in the body</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>Pulmonary vein</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pulmonary artery</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. The heart acts as a pump in a double circulatory system. Explain this statement.
THE RESPIRATORY SYSTEM

The respiratory system is made up of:

- the air passages
- the lungs
- the diaphragm

Air Passages
A series of air passages allow air and the oxygen it contains to be transferred to the blood stream, and also remove waste products such as ................. .................

The Lungs
The two lungs are found in the thorax. They are sac-like with thin walls, and are very flexible. The right lung is slightly larger with three sections, compared to the left lung which has two sections.

The Diaphragm
The diaphragm is a sheet of muscle which enclosed the bottom of the thorax. Contraction and relaxation of the diaphragm, combined with the intercostals muscles enables breathing.

THE RESPIRATORY SYSTEM AND THE CIRCULATORY SYSTEM

It is important that the cardiovascular system and the respiratory system work together in order for the oxygen to be pumped around the body. Every cell in our body needs oxygen and nutrients to produce energy. Cells use oxygen to break down the nutrients we get from the food we eat to release energy (respiration). During this process waste products are produced. These waste products must be removed or the cells would eventually stop working.
The respiratory and circulatory systems are responsible for delivering oxygen and food to all the cells of the body. The respiratory system brings the oxygen into the body and releases much of the waste product produced by respiration.

Oxygen comes into the body from breathing in

Air travels down into the lungs and from the lungs into the bloodstream

The blood delivers the oxygen to the cells and picks up the waste products (e.g. carbon dioxide)

The blood takes waste products to the organs in the body that dispose of them (e.g. carbon dioxide is taken back to the lungs and released when we breathe out)

An efficient respiratory system ensures that the maximum amount of oxygen reaches the lungs and gets into the bloodstream. An efficient circulatory system ensures that this maximum amount of oxygen then gets pumped to the muscles and other organs allowing them to work more effectively.

More efficient respiratory and circulatory system = better performance and participation in sport and physical activity
Circulation and Respiration: Participation and Performance

Using pages 22 & 23 in GCSE PE for OCR, answer the following questions:

Lactic Acid

1) What do our muscles need in order to work? ..............................................................
2) When this supply becomes insufficient for the amount of work, where do the muscles get their energy from? ..............................................................
3) What exactly is this substance? ............................................................................................
4) When our muscles work anaerobically (without oxygen) they produce a waste product. What is this called? ..............................................................
5) What is this product and why is it harmful? ..............................................................
6) As muscles continue to work without oxygen, what exactly happens to them? And how is it overcome? ..............................................................
7) Lactic acid is slowly processed by the body and turned into .............................................................. and ..............................................................
8) Does lactic acid build up faster in short, all out effort activities, or in longer, endurance based activities? ..............................................................
9) Explain the reason for this ......................................................................................................

Oxygen Debt

1) Explain the term oxygen debt ......................................................................................................
2) How is the oxygen debt repaid? ......................................................................................................
Duration

1) What does the duration of an activity affect? ...........................................
   .............................................................................................................

2) Explain how the onset of fatigue differs with aerobic and anaerobic activities ..........................................................
   .............................................................................................................
   .............................................................................................................
   .............................................................................................................
   .............................................................................................................

Recovery Rate

1) How long does it take a sprinter to recover from a race? ...............  

2) What happens in this recovery time? .................................................  
   .............................................................................................................

3) How do sprinters develop their body’s capacity to recover from work more quickly? .........................................................

4) Activities of longer duration, e.g. long distance running will take longer to recover from. Explain how oxygen is used in the recovery process .............................................................
Tolerance

1) Explain the term tolerance .................................................................

2) How can tolerance be increased? .....................................................

3) What will improved tolerance delay? ..............................................

The Benefits of Exercise: The Circulatory System

Stronger Cardiac Muscle

As a result of regular activity and exercise, the cardiac muscle becomes stronger. As it grows stronger, the heart also increases in size. It is not uncommon for trained athletes, e.g., to have significantly larger hearts than the average person.

Increased Stroke Volume

Stroke Volume is the amount of blood pumped from the heart during a single beat. It is normally measured when an athlete is resting. Stroke volume may be considerably improved by an extended period of training, particularly in endurance athletes.

The greater the stroke volume, the greater the amount of blood pumped around the body. This should mean that more oxygen can be delivered to the muscle and the body organs, improving performance.

Increased Cardiac Output

Cardiac output means the amount of blood the heart pumps out. Cardiac output is measured in terms of the total volume of blood pumped from the heart during one minute.

Cardiac Output = stroke volume x beats per minute

Calculate the cardiac output (litres per minute) of a person at rest with a stroke volume of 75ml per beat, and a heart rate of 70 beats per minute.
Lower Resting Heart Rate

A stronger, larger heart pumps more blood around the body each time it beats. This means that it has to work far less hard to achieve the same results as before - it works efficiently.

Resting heart rates vary between individuals but they are normally between 60 beats per minute (bpm) and 80 bpm. People who exercise regularly tend to have resting heart rates of between 50-60 bpm. Very fit individuals can achieve extremely low resting heart rates. Sir Steven Redgrave has a resting heart rate of between 40-45 bpm.

To calculate your own resting heart rate calculate your pulse over 15 seconds and then multiply by 4 to give beats per minute.

There are a number places to measure your pulse - the most common ones being on the inside of your wrist (radial pulse) and on your neck (carotid pulse).

My resting pulse is ..................... bpm
Task

The figures below give the heart rate of a person’s heart rate before, during and after a period of intense exercise.

<table>
<thead>
<tr>
<th>Time (Mins)</th>
<th>Heart Rate (BPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>60</td>
</tr>
<tr>
<td>1</td>
<td>64</td>
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<td>2</td>
<td>68</td>
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<td>14</td>
<td>64</td>
</tr>
<tr>
<td>15</td>
<td>60</td>
</tr>
</tbody>
</table>

Using the graph paper, plot a line graph.

- Time on the horizontal axis
- Heart rate on the vertical axis
- Draw a smooth line through the curve
- Give your graph a title
Describe what happens to the person’s heart rate throughout the 15 minutes.
IMPROVING PERFORMANCE: The Respiratory System

Gaseous Exchange

- Air breathed into the lungs contains Oxygen.
- In the lungs the oxygen passes into the bloodstream.
- At the same time Carbon Dioxide from the blood is transferred into the lungs.

As both Oxygen and Carbon Dioxide are both gases this process is called the Gaseous Exchange.

Using page 26 in GCSE PE for OCR make notes (under the appropriate headings) on how this gaseous exchange occurs and label the diagram.

Surface area of the lungs

What the lungs are made of

The process
THE BENEFITS OF EXERCISE: The Respiratory System

Regular exercise and training can improve the efficiency of the lungs in three main ways:

•
•
•

Increased Vital Capacity

The Vital Capacity of the lungs is the total volume of air that you can move in and out of the lungs in one breath. For a trained athlete, increased vital capacity is important because the volume of oxygen that can be inhaled and the amount of carbon dioxide breathed out are both factors that influence performance.

An increased oxygen supply ..........................................................................................................
..................................................................................................................................................
An increased amount of carbon dioxide expelled .................................................................
..................................................................................................................................................

Tidal Volume

Tidal volume is the amount of air entering and leaving your system with each breath. If you increased the capacity of your lungs through regular exercise, you will also increase your tidal volume. This means that you will be able to deliver more oxygen to and remove carbon dioxide from your blood more quickly. The quicker you remove carbon dioxide, the quicker the blood can take up fresh oxygen again.
**Oxygen Debt Tolerance**

Increasing both the oxygen-carrying capacity of the blood and the vital capacity of the lungs means that the body is more able to tolerate oxygen debt during exercise. In endurance activities (aerobic exercise) an athlete will be able to perform for longer and athletes working anaerobically will be able to maintain their performance for slightly longer.

**CIRCULATORY SYSTEM**
(Blood flow to and from the heart)

**ACTIVITY & EXERCISE**
(Improves blood flow and cardiac capacity)

**GASEOUS EXCHANGE**
$O_2$ into lungs - $CO_2$ out via lungs

**ACTIVITY & EXERCISE**
(Improves lung capacity and efficiency)

**RESPIRATORY SYSTEM**
(Oxygen intake and removal of $CO_2$ and waste products)
THE BLOOD AND PHYSICAL ACTIVITY

Blood has three main functions:
- transportation
- protection
- regulation

Using page 28 in GCSE PE for OCR, complete the table below.

<table>
<thead>
<tr>
<th>Transport</th>
<th>Blood transports $O_2$ from the lungs to the body's tissues and $CO_2$ back to the lungs to be exhaled.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

| Protection | Blood contains clotting agents that help stop bleeding when we cut ourselves. |
|            | Blood also contains white blood cells that protect us from infection. |
|            | Platelets |
|            | Haemophilia is a disease which reduces the body's ability of the blood to clot. People with this condition rarely participate in activities such as contact sports where they may be at risk. |

<table>
<thead>
<tr>
<th>Regulation</th>
<th>Blood helps to regulate the body's temperature. Veins and capillaries close to the skin expand in order to lose heat and contract when necessary to retain heat to keep warm. Skin temperature affects blood temperature in the vessels close to the surface of the skin and this temperature change is then circulated through the body.</th>
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</table>
COMPONENTS OF BLOOD

Blood is made up of several different components:

- Red Blood Cells:
  - Carry oxygen to where the body needs it.
  - Contain Haemoglobin which attracts O₂.
  - The more red blood cells you have the more O₂ you are able to deliver to your muscles.

- White Blood Cells:
  - Fight disease and infection.
  - Swallow up bacteria and viruses and digest them.
  - Produce antibodies that protect the body from infection.

- Platelets:
  - Help the blood to clot.
  - When a blood vessel is cut the platelets swell up and become sticky, clogging up the cut.

- Plasma:
  - Is a liquid mainly made up of water.
  - Allows the blood to flow.
  - Carries digested food in soluble form and hormones such as insulin and adrenaline. It also carries waste products.
THE BLOOD VESSELS AND BLOOD

1. a) There are THREE types of blood vessel. Name them:

   i) ........................................
   ii) ........................................
   iii) ........................................

b) Give TWO characteristics of each vessel:

   i) ........................................
   ........................................
   ........................................
   ........................................

   ii) ........................................
   ........................................
   ........................................
   ........................................

2. EXCHANGE OF SUBSTANCES takes place in the capillaries. Explain this term using the diagram below.

   ![Diagram of capillaries with exchange of substances]

   ........................................
   ........................................
   ........................................
   ........................................

3. a) Your blood consists of FOUR components. Name them:

   i) ........................................
   ii) ........................................
   iii) ........................................
   iv) ........................................

b) Give TWO characteristics of each component:

   i) ........................................
   ........................................
   ........................................
   ........................................

   ii) ........................................
   ........................................
   ........................................
   ........................................
AEROBIC AND ANAEROBIC ACTIVITY

The circulatory and respiratory system work together to supply the body with oxygen and take away waste products. Activity which involves the use of oxygen is called AEROBIC ACTIVITY.

It is possible for muscles to work for a short period of time without oxygen. This activity is called ANAEROBIC ACTIVITY. The muscles use glycogen to work as the demands made on the muscles are greater than the ability of the circulatory and respiratory systems to supply them with oxygen. As a result lactic acid builds up very quickly in the muscles.

Endurance Events (most aerobic)
In endurance events e.g. ...................................................... the body must work at a level that allows the removal of waste products (including lactic acid) at a greater rate than they build up. The way to delay the oxygen debt and the build up of lactic acid is to improve the cardiovascular fitness so that the heart can pump blood more effectively; improve the capacity of the lungs, so more oxygen can be delivered with less effort; and improve the ability of the blood to carry oxygen.

Speed and Power Events (mostly anaerobic)
Anaerobic activity involves performing without oxygen. Activities such as sprinting, throwing and jumping events in athletics and weightlifting require maximum effort, which pushes muscle into working anaerobically for a sort period of time.

Aerobic and Anaerobic
Team games such as ...................................................... require short bursts of maximum energy at time, such as sprinting to reach a pass. At other times players may be moving at a slower pace when they are not directly involved in the game. The amount of time that a person can work anaerobically is approximately 40 seconds and then the aerobic energy system takes over. This is known as the anaerobic threshold. In team games the body must be able to switch from one type of energy system and back again several times.
Training

Endurance activities and speed/power activities require specific training. This will increase the amount of oxygen reaching the muscles for aerobic activities, and will increase the body’s ability to cope with the oxygen debt for anaerobic activities. Sports that require both energy systems will require a mixture of training.

Complete the table below listing activities that use the aerobic, anaerobic or both energy systems.

<table>
<thead>
<tr>
<th>AEROBIC</th>
<th>ANAEROBIC</th>
<th>BOTH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>
CIRCULATORY SYSTEM MIND MAP
CIRCULATION AND RESPIRATION

1. Insert the labels below in the correct places on the diagram of the circulatory system on the right.
   - jugular vein
   - inferior vena cava
   - carotid artery
   - brachial artery
   - femoral vein
   - superior vena cava
   - aorta
   - femoral artery

2. Explain the difference between arterial and venal blood.
   …………………………………………………….
   …………………………………………………….
   …………………………………………………….
   …………………………………………………….
   …………………………………………………….

3. Insert the labels below in the correct places on the diagram of the heart on the right.
   - aorta
   - inferior vena cava
   - pulmonary artery
   - septum
   - superior vena cava
   - left atrium
   - right atrium
   - pulmonary vein
   - left ventricle
   - right ventricle
   - cardiac muscle

4. What is meant by the term anaerobic threshold?
   …………………………………………………….
   …………………………………………………….
   …………………………………………………….
   …………………………………………………….
   …………………………………………………….
GASEOUS EXCHANGE

1. Describe the process of gaseous exchange.

2. Insert the following names in the appropriate places on the diagram of the lungs on the right.
   - ribs
   - bronchioles
   - trachea
   - alveoli
   - bronchi

3. Describe how improved gaseous exchange aids the process of recovery from physical activity.

4. Complete the diagram on the right, inserting a suitable activity in each box.

5. Why are red blood cells particularly important in physical activity?

6. Why is it important for games players to include both aerobic activity in their training programmes?
Homework/Extension Tasks

Below are a number of homework tasks. All works should be handed in on time and fully completed. *You may be asked to complete this work on separate sheets of paper in this booklet*.

Use this booklet, your text book, the Internet and any other resources to help you research and answer the question.

**ICT Tasks**

1) Locate the following website GCSE PE Revision – How The Body Obtains Its Energy, and answer the follow question 2 a), b), c) and d). Print out upon completion.

2) Locate the following website GCSE PE Revision – How The Body Obtains Its Energy and answer Question 4 a), b), c) and d).

3) Find 3 - 4 websites relating to either the Circulatory or Respiratory System and add them to the list on the sheet entitled "Using the Internet".
# KEY WORDS SECTION

<table>
<thead>
<tr>
<th>WORD</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Aerobic exercise</td>
<td></td>
</tr>
<tr>
<td>2) Anaerobic exercise</td>
<td></td>
</tr>
<tr>
<td>3) Aerobic Threshold</td>
<td></td>
</tr>
<tr>
<td>4) Oxygenated blood</td>
<td></td>
</tr>
<tr>
<td>5) Deoxygenated blood</td>
<td></td>
</tr>
<tr>
<td>6) Platelets</td>
<td></td>
</tr>
<tr>
<td>7) Plasma</td>
<td></td>
</tr>
<tr>
<td>8) Red blood cells</td>
<td></td>
</tr>
<tr>
<td>9) White blood cells</td>
<td></td>
</tr>
<tr>
<td>10) Bone marrow</td>
<td></td>
</tr>
<tr>
<td>11) Cardiac output</td>
<td></td>
</tr>
<tr>
<td>12) Circulatory system</td>
<td></td>
</tr>
<tr>
<td>13) Gaseous exchange</td>
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</table>

Winterhill Physical Education Department
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>14</td>
<td>Glycogen</td>
</tr>
<tr>
<td>15</td>
<td>Haemoglobin</td>
</tr>
<tr>
<td>16</td>
<td>Lactic acid</td>
</tr>
<tr>
<td>17</td>
<td>Oxygen debt</td>
</tr>
<tr>
<td>18</td>
<td>Respiratory system</td>
</tr>
<tr>
<td>19</td>
<td>Stroke volume</td>
</tr>
<tr>
<td>20</td>
<td>Tidal volume</td>
</tr>
<tr>
<td>21</td>
<td>Vital capacity</td>
</tr>
<tr>
<td>22</td>
<td>Pulse</td>
</tr>
</tbody>
</table>
USING THE INTERNET

Below are a number of useful website addresses to help you research this topic in more detail. (Add on any other sites you find).

www.GCSEPERevision – How the body works

www.globalclassroom.org/hemo.html

www.freezone.co.uk

www.Teachpe.com