
SOFTWARE COMMUNICATIONS LTD.

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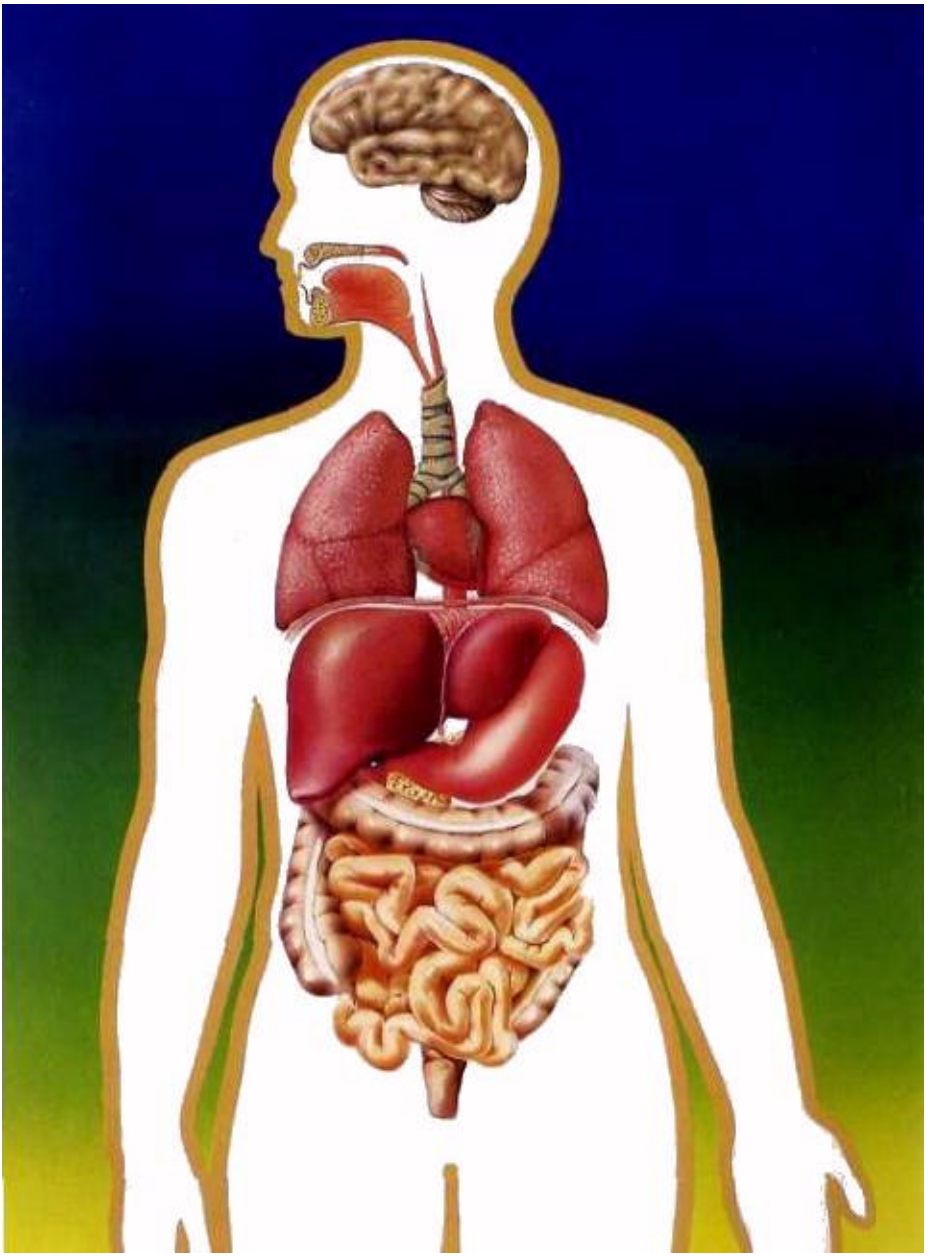


# INTRODUCTION

How well do you know your body?
We expect you are familiar with surface organs and tissues like your skin, hair, nails, eyes, nose and mouth. Because they are on the outside of your body, their main jobs are:

**1** To detect what is going on around you
**2** To protect you
**3** To keep you warm

As these structures come in different sizes, shapes and colours, YOU have a unique combination which means you are different from everyone else on the planet.
But how about your internal organs - often lying deep under layers of skin, fat, muscle and bone? Do you know where they are and what they are doing? Just as a flight simulator allows you to try your hand at flying a plane, the computer programs in this package have been designed to let you take control of some of the workings of your internal body systems. How well you pilot your body will depend, not only on your skill, but also on your understanding of how your body works.

> “ You often hear strange noises and feel pulses and movements coming from inside your body, but you have little control over what is going on. ”

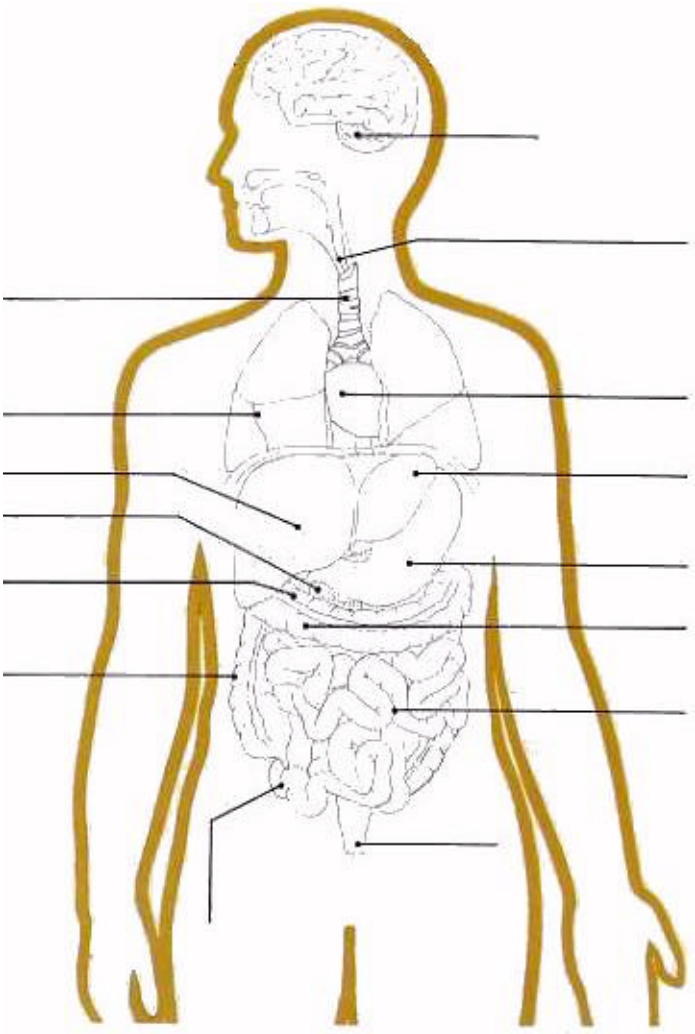
Before you can successfully take control of your body, you must find out what all the components are called and where they are found in your body, Some are very complex and have many complicated jobs to do, so it is vital that you understand their main functions.

The BRAIN, for example, is positioned at the top of your head, inside a protective layer of bone called the skull. This fantastic organ, consisting of approximately 100,000,000,000 individual cells, is in full control of your internal body systems, as well as being the centre of your conscious thoughts, awareness, memories and decision-making abilities.

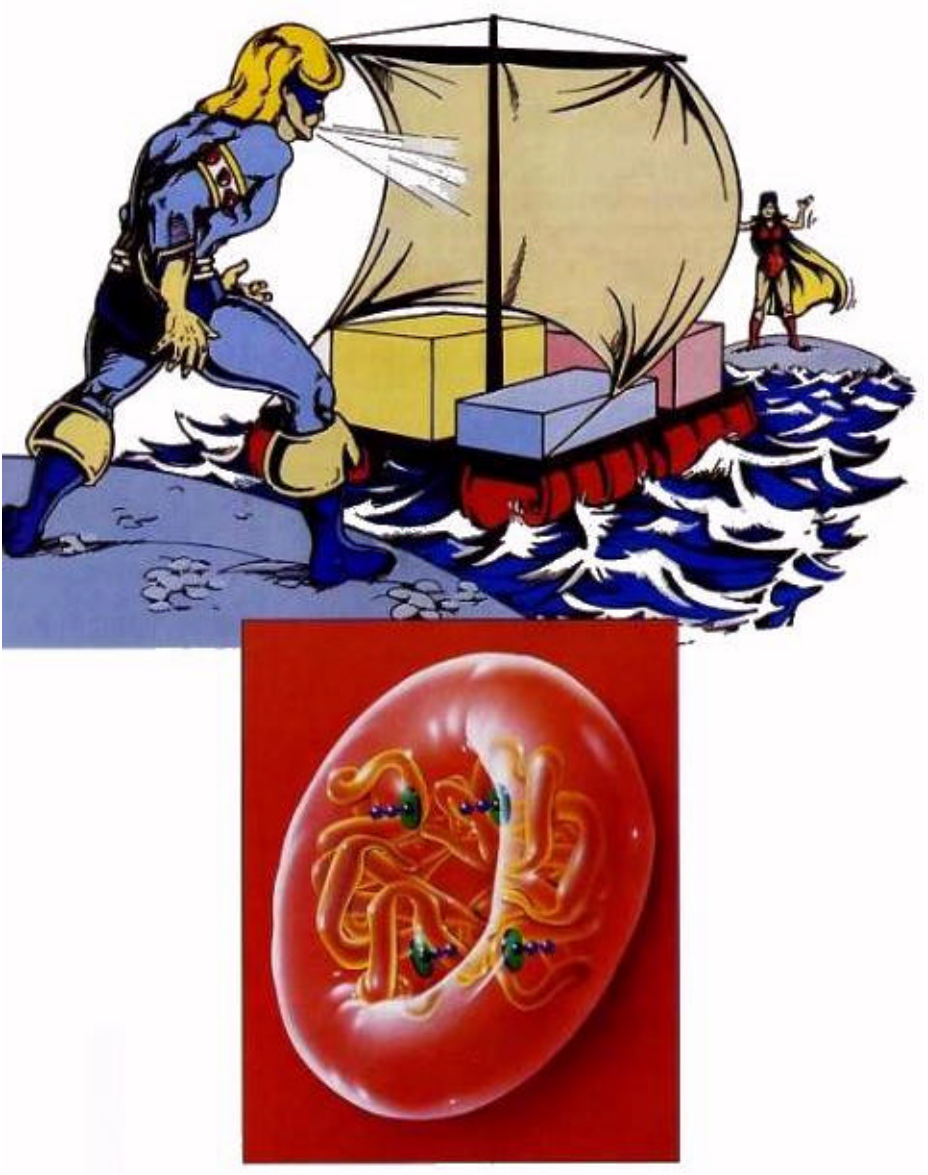
Provided you keep your brain supplied with food and oxygen and do not poison it with chemicals like drugs and alcohol, it should continue to keep you going for many years to come.

**PROGRAM 1: GETTING TO KNOW YOUR INSIDES**

Refer to the program instruction booklet. As you discover the names, label the diagram (right).



❝ Look at this diagram and compare it with the picture on the previous page. Shade in the organs in really bright colours so that you can understand their shapes clearly. Because the liver is the largest organ in the body, the kidneys are hidden by it. ❞



# BLOOD

Your body is made up of working organs and tissues, built from countless millions of microscopic living cells. All these cells need a steady supply of FOOD and a gas found in air, called OXYGEN. In order to carry this food and oxygen to every single cell, your body is filled with a fluid called blood.

Viewed with the naked eye, blood appears to be a simple red liquid. When you look at it under a microscope, however, you can see that blood consists of a number of different cells suspended in a clear, watery fluid called plasma.

Some of these cells help to keep the body healthy and free from germs and harmful bacteria. They are called WHITE BLOOD CELLS. Other, smaller structures, called PLATELETS, help to repair the body when it is damaged. But RED BLOOD CELLS are far and away the most numerous. They can attach the gas oxygen to themselves and release it to *every* living cell in your body. They are bright red when carrying oxygen and dark red when they are not.

“ Blood is the body's transport system (top left). It carries food and oxygen to living cells and takes waste products away. Red blood cells (left) contain a molecule called haemoglobin. This is the molecule which allows red blood cells to carry oxygen. ”

# THE CIRCULATORY SYSTEM

To reach every part of your body, blood flows through an incredibly intricate network of tubes. Since blood cannot move on its own, a large muscular pump called the HEART is situated at the centre of this system.

Blood, flowing through your lungs in minute tubes called CAPILLARIES, becomes oxygenated when you breathe in.

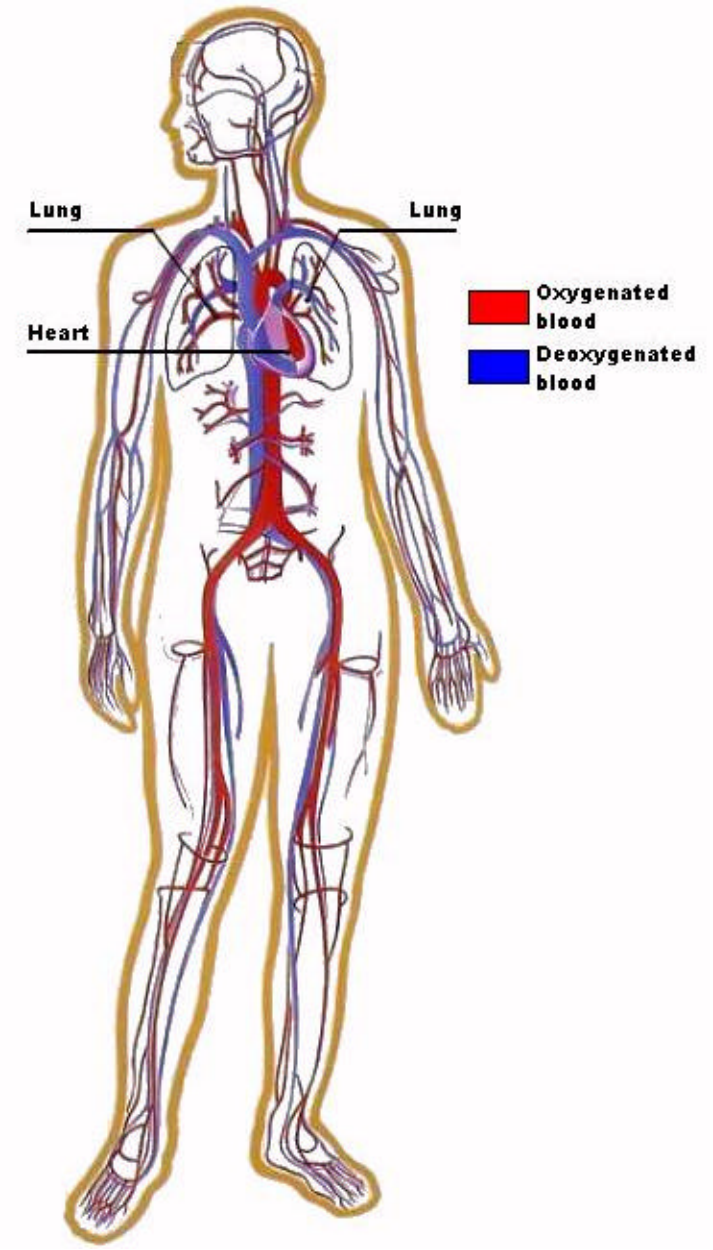
Oxygen gas attaches itself to a molecule called haemoglobin in the red blood cells. This oxygenated blood drains through large tubes called VEINS into the heart and is then pumped out again at high pressure into thick, walled tubes called ARTERIES. Blood is always brought back to the heart in veins and leaves the heart again in arteries. These arteries eventually divide into capillaries, reaching every part of the body.

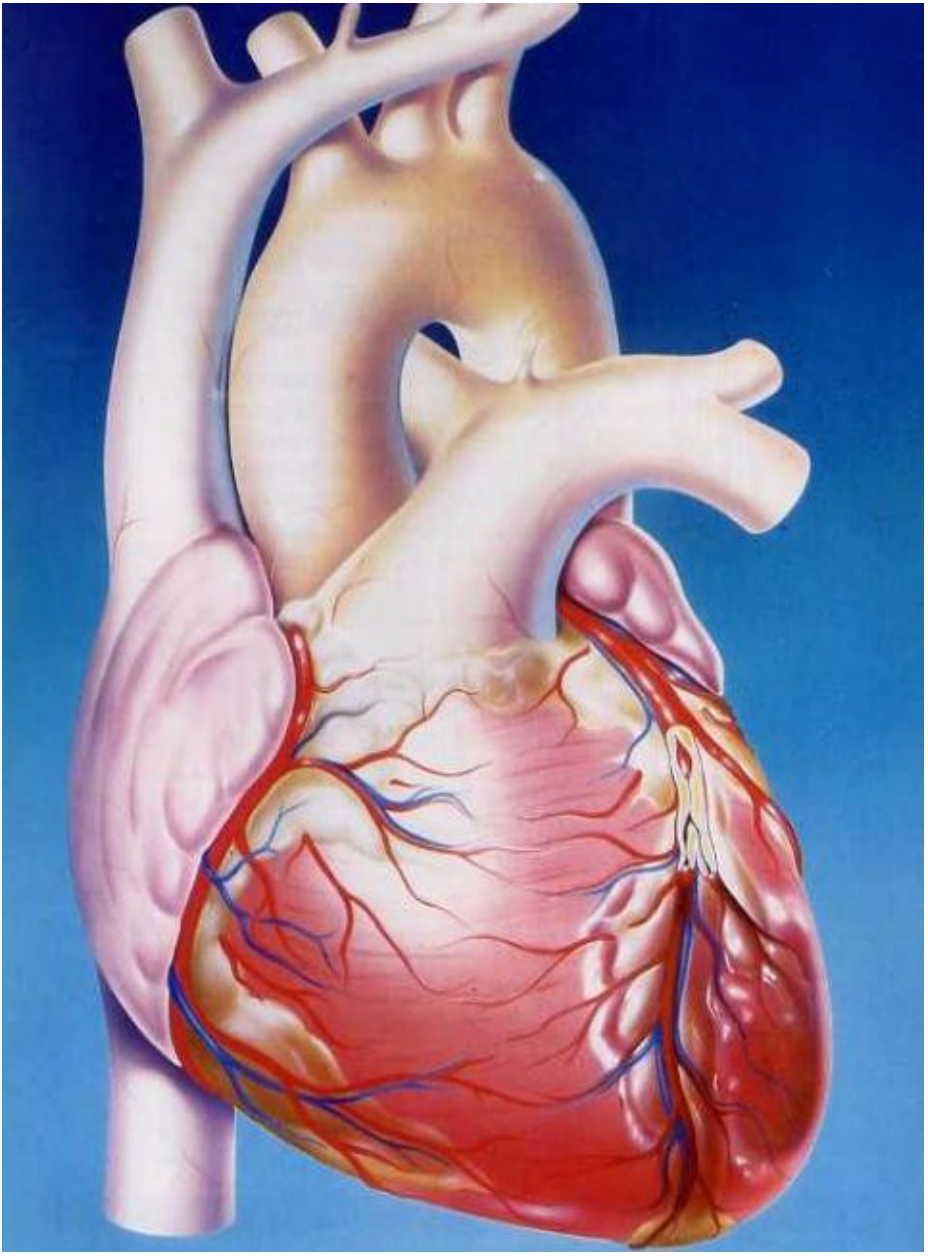
Once the red blood cells have given up their oxygen (become deoxygenated), the blood drains back into the heart where it is pumped to the lungs to pick up fresh oxygen. The circle is then repeated.

The heart is really two pumps; one half receiving deoxygenated blood from the body and then pumping it to the lungs, the other half receiving oxygenated blood from the lungs and then pumping it around the body.

**PROGRAM 2: BUILDING A BLOOD SYSTEM**

In this program, you will have a chance to try building a blood system which works in the same way as the one outlined above. Please refer to your program instruction booklet.


Lung
Lung
Heart
Oxygenated blood
Deoxygenated blood

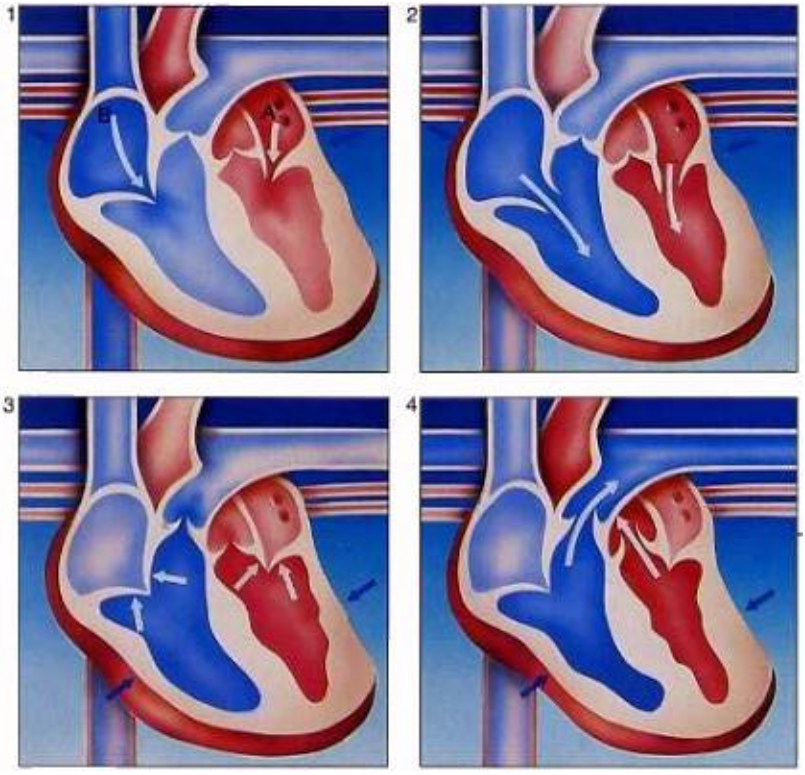


# YOUR HEART

Your heart is a powerful, muscular organ which must pump your blood efficiently throughout your lifetime. Your heart has to receive and then pump two types of blood - so it is divided into two halves. Each half has two chambers; one to receive blood, called the ATRIUM, and one to pump blood, called the VENTRICLE. Therefore, there is one atrium and one ventricle on each side of your heart, separated by a valve so that blood cannot flow back into a chamber once it has left it. When the tough, muscular walls of these chambers contract (clench), the blood is pushed out. When they relax, blood rushes in to fill the chambers.

Veins bring two different types of blood into your heart which must be kept apart. One type has come from your lungs and is full of oxygen ready to be pumped to every living cell. The other type has given up most of its oxygen and is carrying carbon dioxide - a waste gas produced by all living cells in your body. This blood is pumped through two arteries into your lungs so that it can be oxygenated again. Oxygen is taken from the fresh air in your lungs and exchanged for the carbon dioxide which is then breathed out.

> “ There are few man-made machines as strong as your heart. It is estimated that your heart will beat about 2,500,000,000,000 times in your lifetime. ”




**1** Oxygenated blood from the lungs (red) enters the left atrium (A). At the same time, deoxygenated blood (blue) returns to the right atrium (B), after being pumped around the body.
**2** The atrium walls contract, the atrioventricular valves open and blood is forced downwards into the ventricles.
**3** The atrioventricular valves close as the ventricles begin to contract. Blood is prevented from flowing back into the atria.
**4** The ventricle walls contract, forcing the blood upwards and out of the heart.

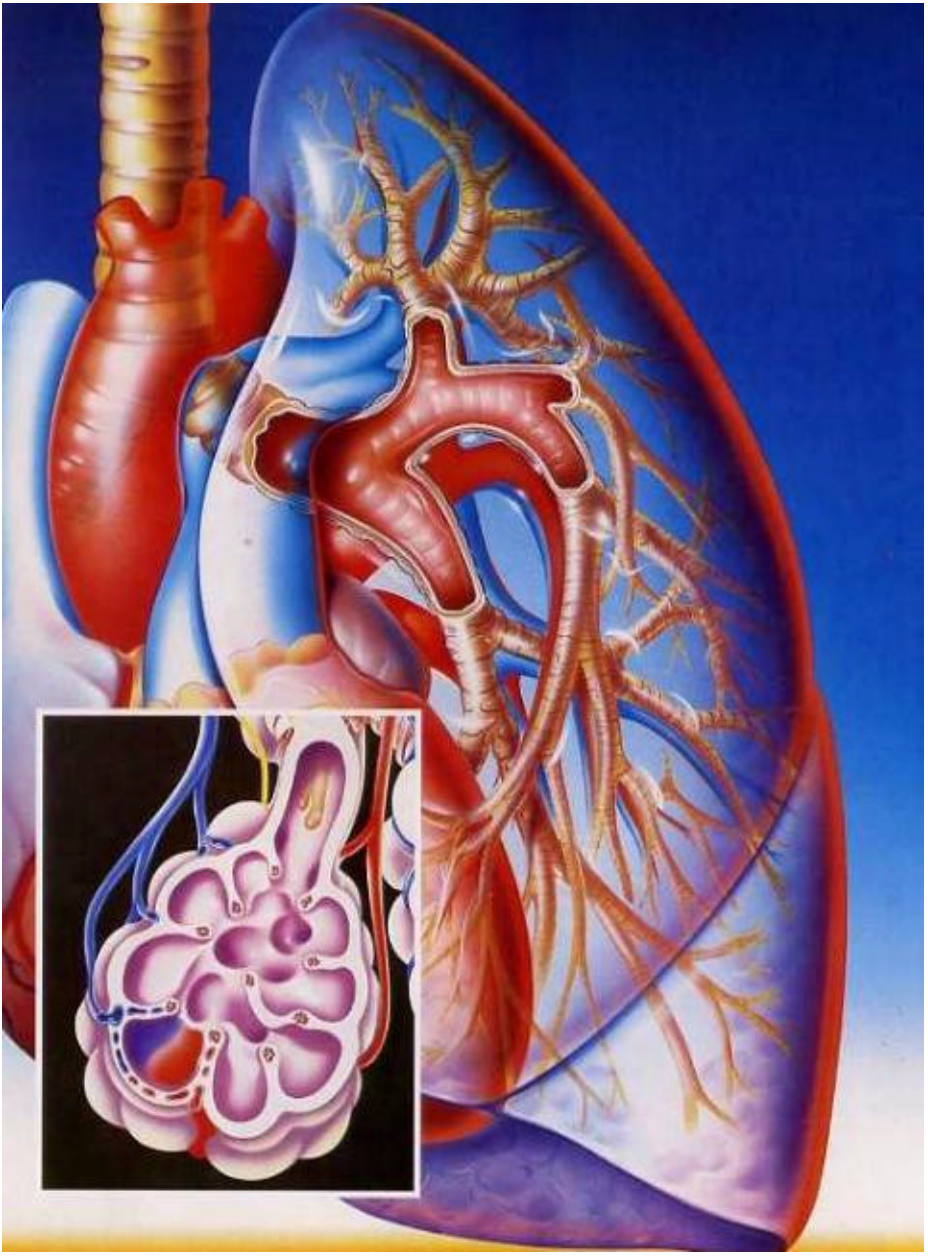
## PULSE RATE

The more oxygen your body cells require, the faster fresh oxygenated blood must reach them. This is achieved when your brain speeds up your heart beat.
The amount of oxygen your cells need depends on a number of factors, the most important being your level of activity - the more active you are, the more work your cells do (particularly your muscle cells), and the more oxygen they need.
You can tell how fast your heart is beating by locating an artery near the surface of your skin and feeling for the pulses of blood which are pushed along it every time your heart beats. The number of pulses you count in one minute is called your PULSE RATE.

Some arteries are easy to find. They are positioned in your wrist and neck. Try filling in this table:

| **ACTIVITY** | **PULSE RATE** |
|---|---|
| Lying in bed | |
| Sitting | |
| Walking | |
| After running | |

**PROGRAM 3: HEART OPERATION**
In this program you are to control the actions of a mechanical heart, in which the muscle contractions are represented by pistons. Four valves are present. You must devise a program in which this model heart pumps blood correctly. Please refer to your program instruction booklet.



# BREATHING

We breathe in (inhale) so that our lungs can be filled with a supply of fresh air. An exchange of gases then takes place between the fresh air in the lungs and the used-up air dissolved in the blood. Oxygen passes into the blood and carbon dioxide leaves it whilst your blood is in your lungs. When you breathe out (exhale), the carbon dioxide leaves your body.

Our rate of breathing is controlled by the activity of our body cells, particularly our muscle cells. The more active the cells, the greater the amount of gas we need to exchange in the lungs.

**There are three ways in which the exchange can be increased:**

**1** Increase the pulse rate
**2** Increase the breathing rate
**3** Inflate the lungs more by taking deeper breaths

❝ The lungs are not empty balloon-like bags. The pipe bringing air into the lungs divides into two smaller airways which then sub-divide into much smaller tubes. These tubes end in millions of tiny little sacs or bags called ALVEOLI (inset). Each tiny little sac is surrounded by hundreds of blood vessels called capillaries. Both the sacs and the blood vessels have very thin walls which will allow gases to pass through them. If you opened out every sac in a pair of lungs they could cover a tennis court. ❞


**Breathing in.** The diaphragm moves **downwards** and pulls the bottom of the lungs down as well to expand them. Muscles between the ribs raise your rib cage which pulls your lungs **outwards** so that they expand

**Breathing out.** The diaphragm moves **upwards** and pushes the bottom of the lungs up as well to squeeze them. Muscles between the ribs lower your rib cage which pushes your lungs **inwards** and squeezes them.

## HOW WE BREATHE

Your lungs must expand to inhale fresh air. They cannot expand by themselves, so they have to be stretched. Once there is space in your lungs, fresh air rushes down from your nose and mouth and through your trachea (windpipe) into your lungs.
In order to exhale (breathe out), the lungs are squeezed by the diaphragm moving upwards and the ribs moving inwards. Because these two actions reduce the space in your lungs, air is pushed up through your trachea, and leaves your body through your nose and mouth.

**Try filling in this table:**

| **ACTIVITY** | **BREATHS PER MINUTE** |
|---|---|
| Lying in bed | |
| Sitting | |
| Walking | |
| After running | |

**PROGRAM 4: SO YOU THINK YOU CAN BREATHE**
In this program you must control the breathing rate. The person will be doing a number of actions and the activity of his muscle cells will require different levels of oxygen/carbon dioxide exchange. By controlling the size of his rib cage and his breathing rate, you can keep his blood correctly oxygenated. The pulse rate will be controlled by his brain (in this case, the computer).
Please refer to your program instruction booklet.

# YOU ARE WHAT YOU EAT

We need to eat food to keep our bodies alive and healthy. Our body cells are made from complex molecules called PROTEINS. We eat protein so that our body can produce new cells and repair damaged ones.

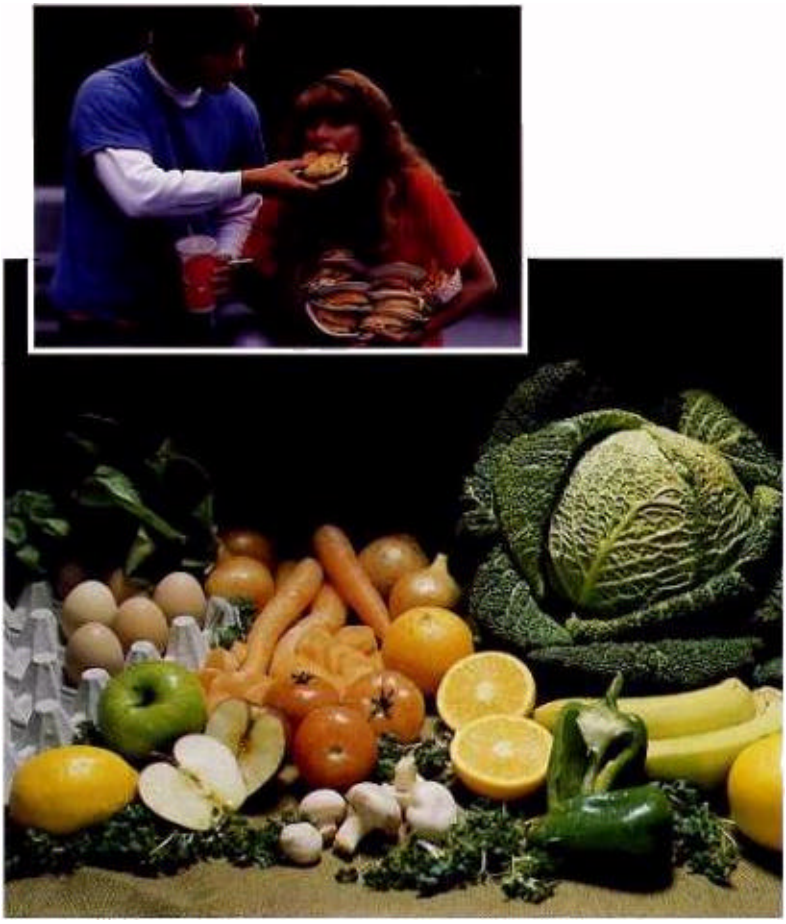
Cells need energy to stay alive. They obtain this energy by breaking down molecules from the food we eat. CARBOHYDRATE and FAT molecules contain a lot of energy, so food containing carbohydrates and fats forms part of a healthy diet.

Cells require other molecules to keep them working properly. Red blood cells, for example, need iron to help them carry oxygen. Bone and teeth cells need calcium and phosphate to make them strong. These molecules come from a group called MINERAL SALTS.

Cells also require another group of molecules called VITAMINS. Vitamins perform a huge variety of important jobs. Vitamin A helps our eyes to see in poor light. The B Vitamins are required by the nervous and digestive systems and the skin. A lack of Vitamin C leads to scurvy, whilst Vitamin D is needed for healthy bones and teeth.

Finally, our diet should contain cellulose molecules from plant tissue. We called this ROUGHAGE. Roughage is not used to nourish our body cells, but it is required to help exercise the muscular gut walls of our digestive system. Without exercise, these muscles become flabby and food gets stuck in the gut - not very pleasant!

> “ Food is used to repair or replace cells and provide energy for them. ”



❝ In every living cell of our body, food molecules are broken down to provide energy in much the same way as coal is burnt in a steam engine. In both processes a great deal of oxygen is needed and waste products such as carbon dioxide and water are formed. Breathe onto a cold surface - what do you see? ❞

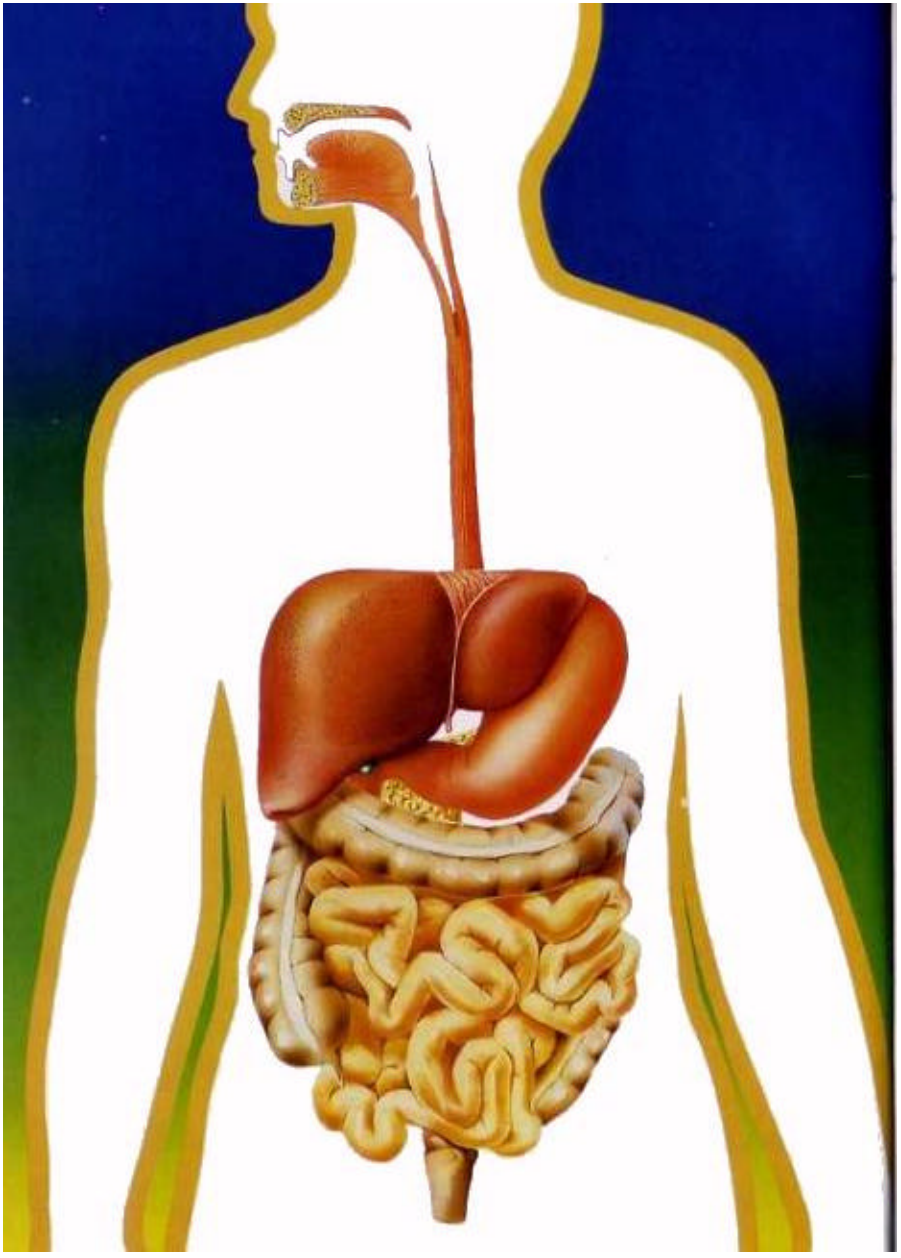
## A BALANCED DIET

Our bodies require a balanced diet to work correctly and grow properly.

We need regular supplies of:

| | |
|---|---|
| **PROTEIN** | found in milk, meat, fish, eggs, etc. |
| **CARBOHYDRATES** | found in bread, potatoes, rice, cakes, etc. |
| **FATS** | found in butter, margarine, meat, nuts, etc. |
| **MINERAL SALTS** | found in meat (for iron), milk (for calcium), etc. |
| **VITAMINS** | found in milk products, carrots (for Vitamin A), citrus fruits (for Vitamin C), etc. |

The actual quantities you require vary according to age, sex and your level of activity. If you are still growing, you require a lot of protein; if you play a lot of sport, you need extra carbohydrates and fats for energy.
A balanced diet contains all the different molecules of food in the correct quantities. Too much or too little of any molecule is harmful to your health.



# DIGESTION

Selecting the right food molecules is your job. The task of supplying these food molecules to living cells in all areas of your body is a long and complicated process. It involves the digestion, absorption and transport of food molecules. These processes are carried out by your body systems without your knowledge or control.

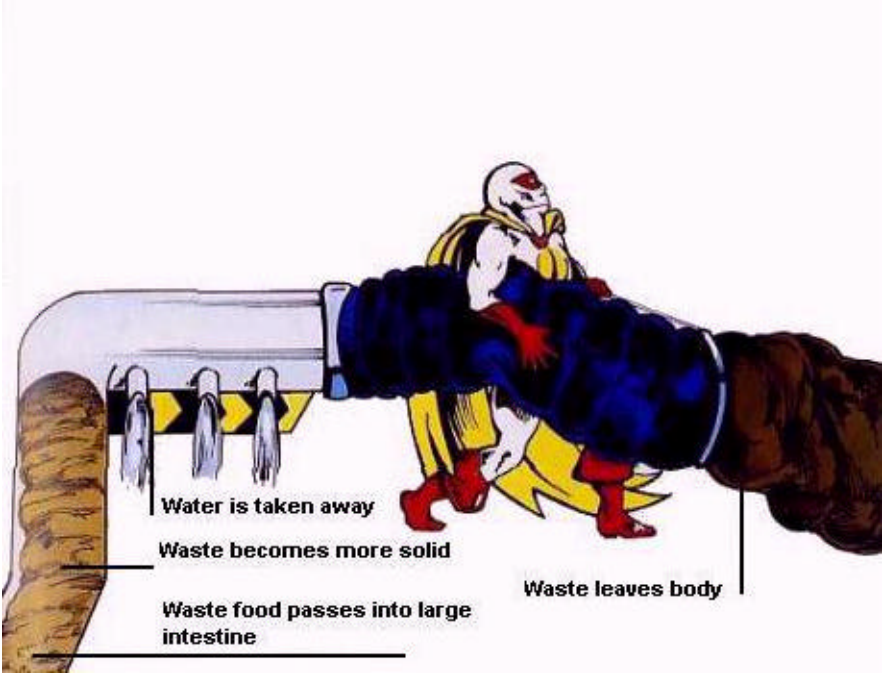
Digestion is the breakdown of large, complex molecules of proteins, carbohydrates and fats, into small soluble molecules which can be absorbed through your gut walls and transported by the blood to your body cells.

Vitamins and mineral salts are already small enough to be absorbed so they do not need to he digested. Roughage is not digested or absorbed; its function is to exercise gut muscles and make it easier for them to push food along.

Digestion occurs in the alimentary canal, or gut, a long tube of muscle which starts in your mouth, stretches down through your thorax, coils in your abdomen and finishes at the anus.

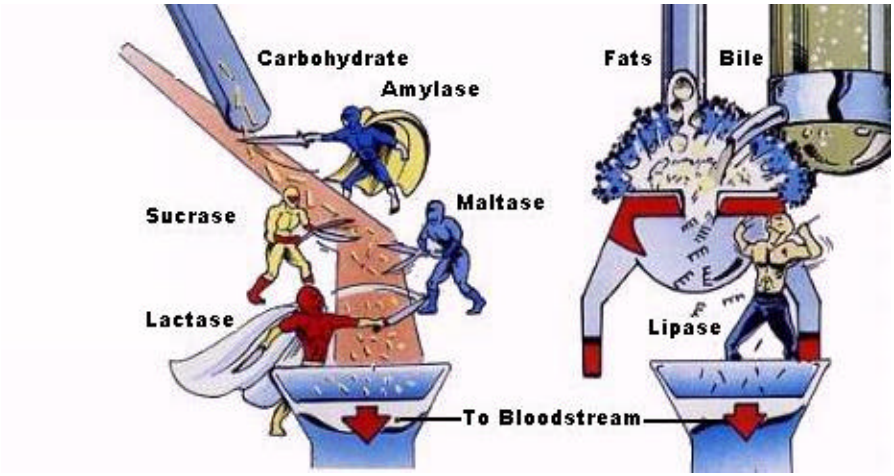
> “ Most of the food we eat consists of particles and molecules which are too large to enter our bloodstream. The ten metre journey from mouth to anus allows the body systems to break down the food into molecules for absorption and use. Anything the body cannot use is removed when we go to the lavatory. ”


Teeth cut and chop food
Digestive juices
Food churned and
mixed in stomach
Leaves as liquid
More juices added
Digested food passes into
bloodstream




The digestive system turns the food we eat into molecules which our bodies can absorb and then use. The fact that you have eaten a superb dinner prepared by the finest chef in the land, or a hamburger and chips, makes little difference to the end result. The digestive system reduces all food to the same few molecules. A simple balanced diet is all that we need to stay healthy.

> “ The alimentary canal is like a long production line working automatically without our conscious control. The food is moved through this process by a slow rippling of muscles in the gut walls called PERISTALSIS. ”




# ENZYMES

The food we eat is broken down into small particles by the mechanical action of the jaws. But these particles are still too bulky. We need ENZYMES to break large food molecules down into molecules small enough to be absorbed and used by our bodies.

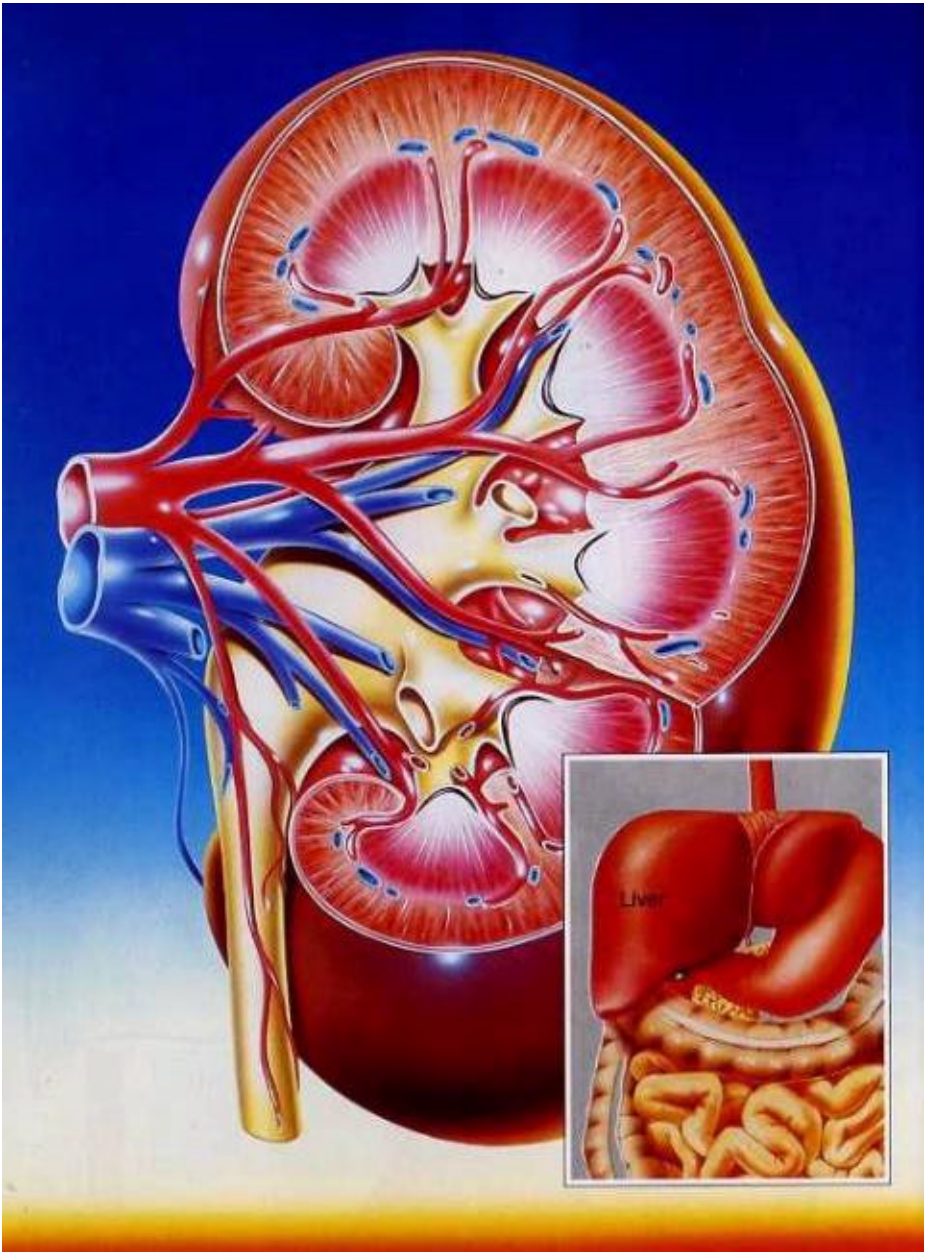
Our bodies contain many ENZYMES, each one capable of performing a specific task. We do not fully understand how they work, but they are vital and without them most of our bodily functions would cease to work.

Our digestive system makes use of nine enzymes. AMYLASE is the first enzyme food meets. It is found in saliva which is added to food in the mouth. Amylase can break starch molecules down into sugar molecules. Try chewing a piece of white bread for several minutes. What do you taste?

**PROGRAM 5: ADVENTURE IN DIGESTION**

In this program you will travel with food through the digestive system, and be in control of what happens on the way. Please refer to your program instruction booklet.


Solid Protein
Liquid Protein
Renin
Pepsin
Trypsin
To Bloodstream
Peptidase


Liver

# LIVER AND KIDNEYS

The liver is one of the most important organs in the body and has well over a hundred different jobs to do. We shall concentrate on its two major functions.

*The Liver as a Storehouse* We eat food only three or four times a day, if we are lucky, but our body cells need a constant supply of digested food molecules if they are to stay alive. The liver is able to store carbohydrates, fats, mineral salts and vitamins. It then releases them into the bloodstream when they are required by the body cells.

*The Liver as a Dustbin* As your body cells die, they are replaced by new ones. The amino acid remnants of these dead cells, with the exception of surface cells such as skin or hair, end up in the bloodstream. An excess of amino acid from the digested protein in your diet may also be present in the blood. The liver removes this excess amino acid and converts it into a waste molecule called UREA.

The kidneys remove urea, as well as excess water and mineral salts. The resulting liquid, called URINE, is collected in a muscular sac called the BLADDER. Urine is expelled at intervals when we go to the lavatory.

**PROGRAM 6: KEEPING GOING**

We are not going to give you any more clues to help you survive in the last program. You must keep your body alive for as long as possible by controlling your blood flow Please refer to your program instruction booklet.

“ Each kidney contains about 1,000.000 tiny tubes called nephrons which filter out waste.

The liver is the largest organ in the body weighing between 1.4 and 1.8kg. ”

# ACKNOWLEDGEMENTS


**ILLUSTRATIONS**

John Bavosi **8** (bottom), **12**, **16**, **30**
Peter Davies **8** (top), **18**, **23**, **26-27**, **28-29**
Tom McArthur **4**, **11**, **24**, **30** (inset)
Mike Saunders **7**, **14**, **15**

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THE LIVING BODY

Just as a flight simulator allows you to try your hand at flying a plane, so your computer programs will give you the chance to take control of some of your body systems. How successful you are will depend on your skill, and on your understanding of how your body works. Use this booklet as a pilot would use his pre-flight brief. Once you have studied it, you will be ready for take-off!

Why not get in touch with us for details of all our computer programs. Write or telephone to:

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# THE LIVING BODY
## (SPECTRUM 48K)

**INTRODUCTION**

The six computer programs in this package have been designed to help you find out in an entertaining and interesting way how the human body keeps itself going.

The booklet will provide you with additional information to help you master the programs (if you are good enough that is!) and the relevant sections should be read before each program is attempted.

It must be stressed that these programs only illustrate processes and functions which in practice are far more complicated. We've also tried to make it fun to use, so **please** do not take everything that happens too seriously. However, if eventually you understand the booklet and can master each of the six programs to a reasonable level, you will have gained a very valuable insight into the workings of your own living body.

**THE PROGRAMS**

**1. Getting to know your insides**

This program has been designed to make sure that you know, or to help you discover, the names and principle functions of the main parts of a living body. Ev ery time you correctly identify a part, it will be connected to the body's blood supply.

**KEYS**

SPACE — Pressing this key will either change the part of the body you can try to label or will change the label currently being displayed for the part of the body chosen. Several options will be available for each part.

ENTER — Pressing this key will select either the part to be labelled or the label currently being displayed. Parts which are labelled correctly will appear in RED. Incorrectly labelled parts will appear in GREEN.

H (help!) — Will give a clue. On Skill Level 1 the clues will be easier. On Skill Level 7 they will be more difficult.

**SCORE**

Your score will depend on:-
1. Number of correct answers 2. Time taken to finish 3. Skill Level

**2. Building a blood system**

Blood flows around a living body in a double circulatory system.

Two arteries take blood away from the heart. One takes blue deoxygenated blood to the lungs and the other takes red oxygenated blood to the body.

Two veins carry blood back to the heart. One carries blue deoxygenated blood away from the body and the other carries red oxygenated blood away from the lungs.

To build a system which works, therefore, you have to connect four major blood vessels.

Only four? - sounds easy!

Just you try.

**KEYS**

2 = Freeze the game
3 = Allows game to continue
Q = Chases little man away on the left of screen
P = Chases little man away from the right of screen
W = Freezes and releases just the vena cava
E = Freezes and releases just the pulmonary artery
O = Freezes and releases just the pulmonary vein
I = Freezes and releases just the aorta

The object of the game is to connect all four blood vessels into their correct positions (see I for information).

To do this you must try and organise the movements of the blood vessels so that all four are in the correct position at the same instant. This is achieved by holding up one blood vessel at a time and releasing it at the right moment.

For example, you could start by lining up the pulmonary artery with the pulmonary vein (use the 2 key to check if it is correct).

Then try to line up a third vessel with these two and so on.

When all four are correct, they will automatically "lock on" and your score will be displayed.

Good luck. You are going to need it!

**SCORE**

Your score will depend on:-

1. Speed of completion
2. Skill level

### 3. Heart operation

Compare the mechanical heart on your screen to the diagram on page 14.

Before the mechanical heart will work you must devise a program for its correct operation. To do this you must place six actions which control the heart into the right order.

The six actions are shown to you on the screen, but they have been jumbled up. Use keys 1 to 6 to choose the correct sequence. Press 'ENTER' after each choice.

(HINTS:- atrium pistons push is number 1,
semi-lunar valves are (G) and (H))

Once the heart is beating correctly it will be your job to repair it should it become diseased. A message will tell you which part or parts are in urgent need of surgery. Use the keyboard or a joystick to move the scalpel (here shlows as a ⊗) to the correct letter and the disease will be removed.

If the heart becomes too diseased, it will suffer a heart attack!

| **JOYSTICK** | **KEYBOARD** |
|---|---|
| Left | ← |
| Right | → |
| Up | ↕ |
| Down | |

**SCORE**

Your score will depend on:-

1. The number of diseases you were able to deal with
2. Skill level

### 4. So you think you can breathe

Imagine what life would be like if we had to take conscious control of our breathing. Fortunately, although we can change how quickly we breathe, or how deep our breaths are, our brain is quite capable of looking after this process on its own.

In this program you must take control of the breathing of a person as they go through a series of activities. As the activities become more strenuous, their muscles will require more oxygen.

As you have seen in the booklet, there are three ways in which more oxygen can be made available to muscles (see page 17).

In this game, the computer controls (1) i.e. the person's pulse rate.

It will be your job to take control of (2) and (3).

A bar gauge in the left-hand corner will show you whether the blood leaving the lungs is correctly oxygenated.

If it becomes all BLUE, the person is UNDERVENTILATED and will faint. If it becomes all RED the person is OVERVENTILATED (called "HYPERVENTILATION") and will also faint.

**KEYS**

1. Decreases breathing rate
2. Increases breathing rate
9. Decreases tidal volume (i.e. the volume of air taken into the lungs in one breath)
0. Increases tidal volume

Every time you tap one of the keys shown above, it will slightly alter the way in which the person breathes. You will find you sometimes need to tap the keys rapidly to keep the level of oxygenation correct.

How long can you last?

**5. Adventure in digestion**

Imagine you have been shrunk to so small a size that you could easily wander throughout a living body. That is what this program is all about.

Starting in the mouth it will be your job to travel around the body trying to visit each of the locations in the alimentary canal and add the correct substance to the food that you find there. The more correct actions you do, the higher the score you will achieve.

Unlike a real body, however, the substances you need have been scattered and lost. Before you can use them, therefore, you will firstly have to find them.

Making your job even more difficult are bacteria which are constantly invading the body. If the bacteria are not killed by the antibodies which you carry, they will multiply and spread to neighbouring parts of the body, eventually killing it.

The body's temperature should be 37°C, any higher than this and you know there are bacteria in the body.

Bacteria always spread to neighbouring locations if not killed. As they spread, the body temperature will rise. If the body temperature becomes too high, the body will die.

To help you find the bacteria you can use a special X-ray which will show you their approximate location. However, you can only use this X-ray once for each new outbreak.

**SUBSTANCES SCATTERED IN THE BODY**

| NUMBER | NAME |
|---|---|
| 1 | amylase |
| 2 | maltase, sucrase, lactase |
| 3 | acid |
| 4 | bile |
| 5 | alkali |
| 6 | renin and pepsin |
| 7 | trypsin |
| 8 | peptidase |
| 9 | lipase |

**PLAYING INSTRUCTIONS** (Press 'ENTER' after **each** key)
**KEYS**

| | | |
|---|---|---|
| F | - | moves you forward |
| B | - | moves you backwards |
| R | - | moves you right |
| L | - | moves you left |
| U | - | moves you up |
| D | - | moves you down |
| G | - | to pick up an object |

e.g., G = Get
3 = Acid
Pressing G then 3, therefore, will pick up one unit of acid, if it is present.

| | | |
|---|---|---|
| A | - | to add an object |

e.g., A = Add
9 = lipase
Pressing A then 9, therefore, will add one unit of lipase to the location. A message will tell you what effect on the food, if any, this action has had.

| | | |
|---|---|---|
| I | - | Inventory<br>Tells you how many units of each object you are carrying. |
| X | - | X-ray |
| H | - | Help (sometimes!) |
| S | - | Score so far<br>Every correct action scores 100 points. |

**6. Keeping going**
In this program it will be your job to control the flow of blood in a living body.
In practice blood is flowing through every part of a living body all of the time, but in this game you must direct the red oxygenated blood leaving the heart through one of four routes,
Parts which are becoming de-oxygenated will give a warning that they need oxygen quickly.
They will also give you a warning if they need food. To take food to a body part you must first make the blood pass through the gut. Here it will pick up the food that you need.

The body part can survive for a longer period without food than without oxygen. You will need quick reactions and quick thinking in this game. How long will you survive?

**SYMBOLS AND KEYS**

| | | |
|---|---|---|
| OXYGEN |  | - if flashing blue, oxygen is needed urgently |
| FOOD |  | - if flashing yellow, food is needed urgently |
| | U | - directs blood through the upper body |
| | D | - directs blood through the lower body |
| | G | - directs blood through the gut |
| | L | - directs blood through the liver |
| | K | - directs blood through the kidneys |

**SCORE**
Your score depends upon how long you manage to survive.