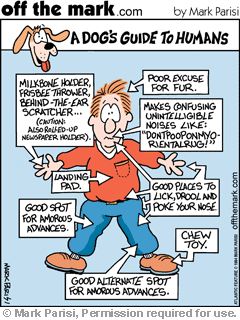
Unit 12

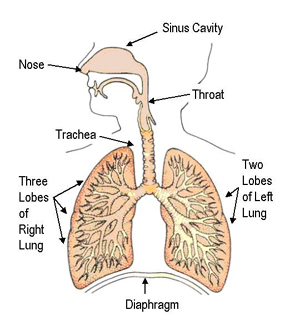
Anatomy and Physiology



Student name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Exam date: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Respiratory System**

***Structure of the respiratory system:***

Nasal cavity – the main route of air entry into the body. It is lined with ciliated epithelial cells which contains mucus-secreting goblet cells. The function of the nasal passage is to warm the air, filter and clean the air and humidification of the air as it enters the respiratory system.

Larynx – is the organ that produces vocal sounds as air passes over the vocal chords and therefore plays a large role in speech. It also protects the lower respiratory tract as during swallowing a flap of cartilage (called the epiglottis) closes over the larynx ensuring food passes into the oesophagus and not into the trachea.

Trachea – is a membranous, muscular tube with cartilaginous rings that carries air from the larynx to the bronchi. The cartilage rings hold the trachea permanently open and the muscular bands in between allow flexibility so that the trachea does not kink when the head/neck are moved. It also contains the ciliated epithelial cells and goblet cells and the cilia waft particles up towards the larynx where they are coughed up or swallowed. Nerve endings in the larynx, trachea and bronchi are sensitive to irritation and this is known as the cough reflex. The trachea continues to warm and humidify the air (as happened in the nasal cavity)

Bronchi and bronchioles – the bronchial walls are composed of the same tissues as the trachea. They subdivide into bronchioles and finally end in alveoli. The cartilage rings are only present in the bronchi – not the bronchioles as this would interfere with the expansion of the lung tissue and therefore gaseous exchange. The function of these structures is to control air entry. This is done by contraction and relaxation of the smooth muscle walls – this regulates the speed and volume of airflow into the lungs.

Pleural membranes – the pleura is made up of a closed sac which contains a small amount of pleural fluid. The lung is inside this sac so that one layer adheres to the surface of the lung and the other layer adheres to the internal surface of the rib cage.

The pleural fluid allows the surface of the lungs to glide and prevents friction during breathing.

Lungs – main organs of the respiratory system that transport oxygen from the air into your blood and remove carbon dioxide from your blood. Each is divided into lobes.

Alveoli – tiny air chambers found at the end of each bronchiole. The walls of the alveoli are one cell thick. The surface of each alveolus is covered in a network of capillaries this thin membrane allows gaseous exchange to take place.

Diaphragm – a large, dome-shaped sheet of muscle which encloses the lower surface of the chest cavity and plays a major role in the inspiration and expiration process.

Intercostal muscles – these occupy the spaces between the 12 pairs of ribs and it is their contraction which allow chest expansion for breathing

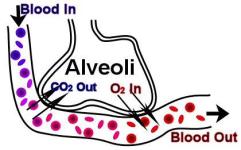
**Functions of the respiratory system:**

The average breathing rate is 12 – 15 breaths per minute. Breathing is dependent on pressure changes within the thoracic (chest) cavity.

***Inspiration*** – the intercostal muscles contract (pulling the rib cage up and out) whilst the diaphragm also contracts (pulling it downwards). This allows the lungs to expand and the pressure within the thoracic cavity falls. As a consequence, air is drawn into the lungs in an attempt to equalise the alveolar air pressure with that of the atmosphere outside.

***Expiration*** – relaxation of the intercostal muscles and the diaphragm results in an inward and downward movement of the ribcage. As this occurs, pressure within the lungs rises and expels air from the respiratory tract.

***Oxygen and carbon dioxide exchange***;

During each inspiration, only some of the alveolar gases are exchanged. Exchange of gases occurs when a difference in partial pressure exists across a semi-permeable membrane. Gases move by diffusion from the higher concentration to the lower until equilibrium is established.

Venous blood arriving in the lungs has travelled from all tissues of the body and contains high levels of CO2 and low levels of O2. Carbon dioxide diffuses from the venous blood into the alveoli until equilibrium with the alveolar air is reached. By the same process, oxygen diffuses from the alveoli and into the bloodstream.

***DYSFUNCTION: ASTHMA***

When a person with asthma comes into contact with something that irritates their airways (an asthma trigger), the muscles around the walls of the airways tighten so that the airways become narrower and the lining of the airways becomes inflamed and starts to swell. Sometimes, sticky mucus or phlegm builds up, which can further narrow the airways. These reactions cause the airways to become narrower and irritated - making it difficult to breath and leading to symptoms of asthma (coughing, wheezing, shortness of breath and tightness in the chest).

***CAUSES***

* **Genetic:**

Research by Imperial College London in 2010, found new genetic variations in over a third of children with asthma. The scientists suggest that by concentrating on these genes it may be possible to develop new asthma treatments.

An implication of their findings is that allergies are probably a consequence of asthma, rather than a cause. The study also suggests that childhood-onset asthma differs biologically from adult-onset asthma, as the gene that affected children the most did not affect adults.

As a result of genetic studies allergies may develop as a result of defects in the lining of the airways in asthma therefore concentrating therapies only on allergy will not effectively treat the whole disease.

Scientists believe that because so many gene variations and environmental factors determine each individual’s asthma risk, genetic testing will be of no value in predicting early in life which children might eventually develop the condition.

* **Lifestyle:**

***Exercise*:** this can be an asthma trigger for some people (especially exercising outside in cold weather) the current advice is to increase fitness gradually and to keep doing some form of exercise. Good asthma control helps.

***Diet:***  Most people with asthma do not have to follow a special diet. In some cases, certain foods, including cow’s milk, eggs, fish, shellfish, yeast products, nuts, and some food colourings and preservatives, can make symptoms worse.

***Smoking*:**  can irritate the lungs and bring on asthma symptoms leading to an increased the risk of an asthma attack and may permanently damage the airways

* **Pollutants** (smoking/industrial);

The air we breathe contains lots of different particles that can trigger asthma symptoms. Air pollutants, like cigarette smoke and car exhaust fumes, release gases and particles into the atmosphere, which can irritate the airways. For those people who know that an air pollutant is their asthma trigger they are advised to keep well informed about air quality. Ozone can be a problem for some people and levels are likely to be higher on hot summer days. For those for whom this is a trigger they are advised to avoid exercising outdoors, especially in the afternoon.

**DIAGNOSTIC TECHNIQUES:**

* ***A chest x-ray*** is a test commonly performed for patients who wheeze. One is usually done to make sure there is not some other condition that may be causing symptoms e.g. a lung infection.
* ***Peak-flow monitoring*** Peak Flow is probably the simplest test that is used to see how well the person’s asthma is doing. Peak flow measure *how quickly* air can be blown out of the lungs. If the airways become narrow or blocked due to asthma, peak flow values will drop because you cannot blow air out of the lungs well.
* ***Spirometry*** measures both *how much* and *how quickly* air moves out of your lungs. The spirometer takes two measurements: the volume of air you can breathe out in one second (called the forced expiratory volume in one second or FEV1) and the total amount of air you breathe out (called the forced vital capacity or FVC). The person may be asked to breathe out a few times to get a consistent reading. The readings are compared with normal measurements for the person’s age, which can show if the airways are obstructed.

**Effects of asthma on lifestyle and daily routine:**

|  |  |
| --- | --- |
| **Problems caused by illness** | **Effect on lifestyle/routine** |
| SOB, coughing, tight chest | Difficulty carrying out all ADLs, mobility, employment.  Changes to social life (avoiding smoky environments) |
| low self-esteem/concept/confidence,  fear | Changes to relationships (work and home) |
| Changes to social life | Social isolation/limited socialising  Time off work (money issues)  Changes to relationships (work and home) |

***TREATMENT:***

There's no cure for asthma but there are effective medicines that allow most people to control their asthma so that is doesn't interfere with daily life.

* ***Reliever inhalers:***

Relievers are medicines that are taken immediately to relieve asthma symptoms. They quickly relax the muscles surrounding the narrowed airways. This allows the airways to open wider, making it easier to breathe again.

* ***Preventer inhalers***:

Preventers control the swelling and inflammation in the airways, stopping them from being so sensitive and reducing the risk of severe attacks.  The protective effect builds up over a period of time so they need to be taken every day (usually morning and evening) even when you are feeling well. Preventers do not give immediate or quick relief when you are breathless but instead they reduce long-term inflammation.

* ***Steroids****:*

Steroids" are a family of chemicals normally made within the body. They serve as hormones —chemical signals that help to regulate the body's growth and function. Corticosteroid hormones, if purified and taken in large amounts as a medicine, have powerful anti-inflammatory effects. Steroids taken in tablet or liquid form ("oral steroids") are usually prescribed for asthma that has become difficult to control by any other means; they are the most effective treatment available for a severe "attack" of asthma. Most often, they are prescribed for a short period of time: a short course may be as brief as 3-4 days or as long as 2-3 weeks. They are stopped when the asthma has gotten better and other treatments (preventer and reliever inhalers) are enough to keep it under control. Longer periods of treatment and continuous treatment with oral steroids are generally avoided except for the most difficult-to-control asthma because of the undesirable side effects that often develop with prolonged oral steroid treatment.

|  |  |
| --- | --- |
| ***Benefits of steroid treatment*** | ***Side effects of steroid treatment*** |
| Quick response (usually within a few hours) | Stomach irritation (indigestion) |
| Easier to breathe, less wheezing | Bloating (fluid retention) |
| Less ‘tightness’ of chest | Hunger |
| Less coughing and mucus production | Sleeplessness |
|  | Women may have their menstrual cycle become irregular for a brief while and may develop a vaginal yeast infection. |

**Lifestyle changes:**

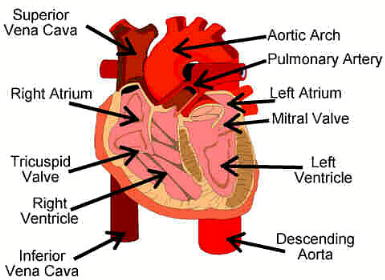
People with asthma are able to carry on with a ‘normal’ lifestyle if their asthma symptoms are well controlled with medication. They may need to make adjustments to their diet and exercise when they are experiencing asthma symptoms.

**CARDIOVASCULAR SYSTEM**

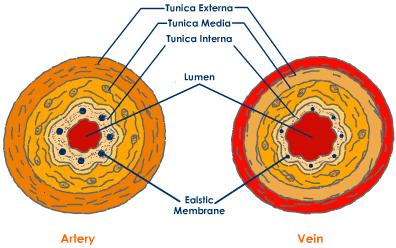
**The structure of the cardio-vascular system**:

The circulatory system involves the heart, blood vessels, blood and the pulmonary and systematic circuits. Its function is to transport oxygen and nutrients to the body and remove waste. It also controls the body temperature and protects the body with its antibodies in the bloodstream.

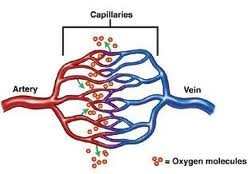
**Diagram of the circulatory system**



Heart – the right side of the heart pumps blood to the lungs (AKA the pulmonary circulation) where gas exchange occurs. The left side of the heart pumps blood to the body (AKA the systemic circulation). The circulatory system ensures a continuous flow of blood to all cells – without this, cell death can occur which is why diseases of the CV system have consequences for all body systems.

Arteries and arterioles – these are blood vessels that transport blood AWAY from the heart. Their walls have 3 layers (outer = fibrous tissue, middle = muscle/elastic tissue and inner = endothelium). The amount of muscle/elastic tissue in the artery depends on their size and function e.g. large arteries have more muscle/elastic tissue which lets them stretch (absorbing the pressure from the heart as it beats). In the arterioles the muscle layer is very thin which lets the arterioles’ diameter be precisely controlled and allows the pressure to be maintained in them.

Veins and venules – these RETURN blood to the heart at low pressure. The walls are thinner than arteries but have the same 3 layers of tissue. Veins have valves along their length which prevent backflow of blood – ensuring it flows towards the heart.

Capillaries – the smallest arterioles and venules meet at the capillaries. The walls of these are one cell thick through which water and other small molecules can pass. The capillaries form a vast network within the body’s tissues allowing each cell to receive the nutrients it needs and take away any waste products.

General functions of blood

***Transportation*** – this is the job of the red blood cells (erythrocytes) and they mainly transport oxygen but also transport nutrients and waste products such as carbon dioxide.

***Protection*** – this is the job of the white blood cells (leukocytes) and their main job is to fight infection at the source, repair damaged tissue and destroy bacteria.

***Temperature regulation*** – heat is produced by oxidative reactions and the blood is essential for distributing and disposing of this heat[[1]](#footnote-1).

Blood cell types and functions

***Red blood cells*** – these are small but there are loads of them. They are the transporters of the blood system, carrying oxygen, nutrients and waste products. They are produced in the bone marrow of long bones.

***White blood cells*** – there are five types of white blood cells and their main function is to fight infection at the source, repair damaged tissue and destroy bacteria. There are fewer white blood cells than there are red blood cells.

***Plasma*** - this is made up of mainly water and makes up 55% of the volume of blood. It helps the blood flow easier and the 10% of the plasma that is not made up of water is made from the following: salts, chlorine, amino acids, glucose, antibodies, fibrinogens, hormones and waste products.

***Platelets*** - these are small parts of large cells and their function is to clot the blood to stop external and internal blood leaks. For example when you get a cut or graze they clot at the skin to form a scab to stop blood leaving through your cut.

**Cardiac cycle and its control**

The vena cava (largest vein in the body) empties its contents into the right atrium. This blood passes via the right atrioventricular valve into the right ventricle and there it is pumped into the pulmonary artery (the only artery which carries *deoxygenated* blood). The opening to the pulmonary artery is protected by the pulmonary valve which prevents backflow of blood into the right ventricle when its’ muscle relaxes. This blood is delivered to the lungs where gaseous exchange takes place. The pulmonary veins carry *oxygenated* blood back to the left atrium. Blood then passes through the left atrioventricular valve into the left ventricle and from there is pumped into the aorta. The opening of the aorta is guarded by the aortic valve preventing backflow into the left ventricle.

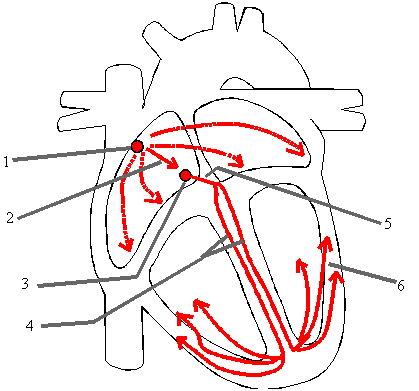
Both atria contract simultaneously – followed by both ventricles. The muscular walls of the atria are thinner than that of the ventricles and this is consistent with the amount of work they do (they are only propelling blood into the ventricles with the help of gravity – whilst the ventricles actively pump blood to the lungs/round the whole body.

The heart generates its own electrical impulses and doesn’t need external stimulation to initiate each heartbeat. The *sinoatrial (SA) node* is a mass of specialised cells in the wall of the right atrium near the opening of the vena cava. The sinoatrial cells generate regular impulses by depolarising regularly (60 – 80 times per minute in an adult) followed by a recovery (repolarisation). The SA node is also known as the pacemaker of the heart as it sets the heart rate and triggers atrial contractions.

The *atrioventricular (AV) node* is in the wall of the septum near the atrioventricular valves and transmits the electrical signals from the atria into the ventricles. There is a slight delay (0.1 of a second) for this signal to pass into the ventricles which gives the atria time to finish contracting before the ventricles start. The impulse from the AV node passes down the septum via the *bundle of His* and then across the walls of the ventricle via the *Purkinje fibres*.

During each heartbeat (AKA cardiac cycle) the heart contracts and then relaxes. Contractions are known as systole and relaxation = diastole. Therefore, a heartbeat consists of:

* Atrial systole – contraction of the atria
* Ventricular systole – contraction of the ventricles
* Complete cardiac diastole – relaxation of the atria and ventricles



**DYSFUNCTION: CORONARY HEART DISEASE (CHD)**

Like any muscle, the heart needs a constant supply of oxygen and nutrients that are carried to it by the blood in the coronary arteries. When the coronary arteries become narrowed or clogged and cannot supply enough blood to the heart, the result is CHD. If not enough oxygen-carrying blood reaches the heart, the heart may respond with pain called angina. The pain is usually felt in the chest or sometimes in the left arm and shoulder. When the blood supply is cut off completely, the result is a heart attack. The part of the heart that does not receive oxygen begins to die, and some of the heart muscle may be permanently damaged. Chest pain (angina) or shortness of breath may be the earliest signs of CHD. A person may feel heaviness, tightness, pain, burning, pressure, or squeezing, usually behind the breastbone but sometimes also in the arms, neck, or jaws. These signs usually bring the patient to a doctor for the first time. Nevertheless, some people have heart attacks without ever having any of these symptoms.

***CAUSES:***

Coronary heart disease is caused by any problem with the coronary arteries that keeps the heart from getting enough oxygen- and nutrient-rich blood. The most common cause by far is atherosclerosis. Lack of sufficient blood is called ischemia, so coronary heart disease is sometimes called ischemic heart disease.

The cause of coronary heart disease is related to multiple risk factors. The following are the most common:

*Heredity*: if either parent has had premature cardiovascular disease, there is an increased the risk of coronary heart disease for offspring of either gender. There have been genes identified which are thought to cause CHD but the other theory is that it is the family environment (such as diet/exercise/smoking etc.) that may lead to the increased risk of CHD.

*High cholesterol*: Levels of cholesterol in the blood are above healthy levels. This usually involves high levels of low-density lipoprotein (LDL), the bad cholesterol, and low levels of high-density lipoprotein (HDL), the good cholesterol. Cholesterol and fat, circulating in the blood, build up on the walls of the arteries. The build-up narrows the arteries and can slow or block the flow of blood. When the level of cholesterol in the blood is high, there is a greater chance that it will be deposited onto the artery walls.

*Tobacco abuse*: Smoking any form of tobacco (cigarettes, cigars, pipes), will reduce the oxygen supply to the blood vessels of the heart.

*Obesity* increases the likelihood of developing high blood cholesterol and high blood pressure, and physical inactivity increases the risk of heart attack.

*High blood pressure* (hypertension) causes the heart muscle to have to work harder to produce the same effect. This puts strain on the vessel walls which can lead to clots/ruptures.

Diabetes - People suffering from type 1 and type 2 diabetes are more likely to be at risk from heart attacks, strokes and high blood pressure as a result of vascular problems (poor circulation)

*Emotional stress + Type A personality (impatient, aggressive, competitive)* - Stress activates the autonomic nervous system which leads to a constriction of the blood vessels and a rise in blood pressure and heart rate. As a result, more and more blood is pushed through shrinking arteries. Long-term stress may lead to wear and tear on, and damage to, the arteries. Type A individuals tended to have higher levels of adrenaline and noradrenaline and higher levels of blood cholesterol. These hormones increase the level of fatty acids in the blood that may lead to the fatty material being deposited on the walls of the arteries which supply the heart with blood. This narrows the arteries and reduces the flow of oxygen carried in the blood to the heart.

***DIAGNOSTIC TECHNIQUES:***

*Angiogram* - An angiogram allows the doctor to look inside the coronary arteries and find out where and how severe any narrowed areas are.The procedure helps decide what treatment might be needed. It can also give information about how effectively the heart is pumping and about the blood pressure inside the heart.The test lasts half an hour, although it can sometimes take longer.The patient is given a local anaesthetic in the arm or groin, where a catheter (a thin, flexible tube) will be passed into the artery. Using an x-ray, the catheter will be directed through the blood vessels and into the heart. A special dye will then be passed through the catheter and a series of x-rays will be taken. The patient might feel a hot, flushing sensation from the dye. The dye will show up any narrowed areas or blockages in the artery on the x-ray. During the procedure, the patient’s heart rate and rhythm is monitored.

*Cardiac ultrasound* - **Echocardiogram \*** *Also called an ‘echo’.* This test uses ultrasound waves to look at the structure of the heart. It is useful for people whose ECG shows changes for example a previous heart attack that they may not have even been aware of. An echocardiogram can also detect inheritable conditions such as cardiomyopathy and mitral valve prolapse. The operator puts some clear gel on the chest and then places an ultrasound probe on it. The probe sends ultrasound beams into the body and their reflections are detected and used to generate images of the heart. Different parts of the heart can be seen on a screen as the probe is moved around on the chest. The test is similar to the ultrasound scan that is used to examine a pregnant woman’s unborn baby. It is completely painless

*Blood pressure monitoring*

Blood pressure is the force (or pressure) that the blood exerts on the walls of the blood vessels. Keeping blood pressure within normal limits is very important – if it becomes too high blood vessels can be damaged causing clots of bleeding from the ruptured site. If it falls too low then blood flow through tissues will be inadequate and this is dangerous for the vital organs (heart, brain + kidneys). When the left ventricle contracts and pushes blood into the aorta it is known as the systolic pressure. When complete cardiac diastole occurs and the heart is resting the pressure within the arteries is much lower and is called the diastolic pressure. Blood pressure is controlled by centres in the brain stem. They respond to changes in pressure and sends impulses to the heart and blood vessels. This controls BP by changing the rate of the heartbeat and by constricting/dilating blood vessels as required.

Blood pressure is measured with a sphygmomanometer and measured in millimetres of mercury (mmHg). Systolic pressure is the figure on the top and diastolic pressure is the figure on the bottom (e.g. 120)

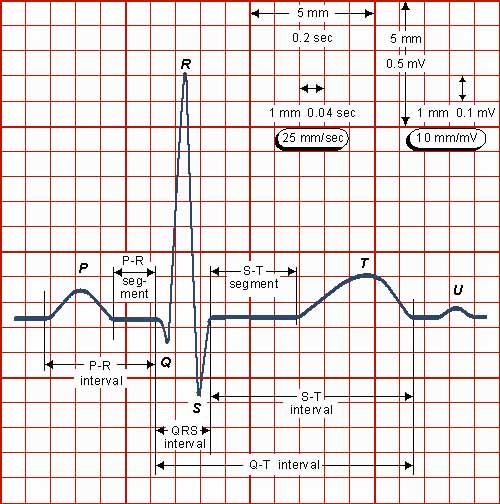
80

*Electrocardiogram (ECG) traces*

As body fluids and tissues are good conductors of electrical activity, the electrical activity within the heart can be detected by attaching electrodes to the limbs and chest. The machine is called an electro cardiograph and the tracing is called an electrocardiogram (ECG). A normal ECG tracing shows 5 waves called P, Q, R, S and T and each corresponds to an electrical activity within the heart muscle.

The P wave corresponds to the atrial systole, the QRS complex represents the rapid spread of the impulse from the AV node, through the bundle of His and Purkinje fibres and the ventricular systole.

The T wave represents the cardiac diastole.



By examining the pattern of waves and the time intervals between cycles and parts of cycles, information about the state of the myocardium (heart muscle) and cardiac conduction system is obtained.

the normal rhythm of the heart is known as sinus rhythm, a fast heart rate is known as tachycardia and a slower than normal rate is known as bradycardia.

**Effects of Coronary heart disease on lifestyle and daily routine:**

|  |  |
| --- | --- |
| **Problems caused by illness** | **Effect on lifestyle/routine** |
| Chest pain (angina)  SOB | Difficulty carrying out all ADLs, mobility, employment.  Changes to social life  Dependent on people for personal care (change in status) |
| Low self-esteem/concept/confidence, | Changes to relationships (work and home) |
| Fear (of recurrence) | Stop exercising, stop having sex with partner, give up smoking/alcohol/fatty food. |
| Changes to social life | Social isolation/limited socialising  Time off work (money issues)  Changes to relationships (work and home) |

**Treatment:**

CHD cannot be cured but it can be managed effectively with a combination of lifestyle changes, medicine and in some cases surgery. With the right treatment, the symptoms of CHD can be reduced and the functioning of the heart improved.

**MEDICATION**

* **ACE (angiotensin-converting enzyme) inhibitors**

ACE inhibitors are commonly used to treat high blood pressure. They block the activity of a hormone called angiotensin II, which causes the blood vessels to narrow. As well as stopping the heart working so hard, ACE inhibitors improve the flow of blood around the body.  Blood pressure will be monitored while taking ACE inhibitors, and regular blood tests will be needed to check that the kidneys are working properly. Around one in 10 people have kidney problems as a result of taking ACE inhibitors.Side effects of ACE inhibitors can include a dry cough, dizziness and fainting.

* **Angiotensin II receptor antagonists -** work in a similar way to ACE inhibitors. They are used to lower your blood pressure by limiting angiotensin II. Mild dizziness is usually the only side effect. Angiotensin II receptor antagonists are often prescribed as an alternative to ACE inhibitors, as they do not cause a dry cough.
* **Calcium channel blockers -** work to decrease blood pressure by relaxing the muscles that make up the walls of your arteries. This causes the arteries to become wider, reducing your blood pressure. Side effects include headache and facial flushing but these are mild and usually decrease over time.
* **Diuretics -** work by reducing the amount of water in the blood and widening your arteries, thereby reducing blood pressure. They are not recommended for pregnant women or people who have gout (a type of arthritis where crystals develop inside the joints). Diuretics have been known to reduce the level of potassium in the blood, which can interfere with heart and kidney functions. They can also raise the level of sugar in the blood, which could lead to diabetes. Therefore, patients have blood and urine tests every six months so potassium and blood sugar levels can be monitored.
* **Beta blockers -** often used to prevent angina and treat high blood pressure. They work by blocking the effects of a particular hormone in the body and this slows down your heartbeat and improves blood flow.
* **Statins -** If you have a high blood cholesterol level, cholesterol-lowering medicine called statins may be prescribed. They work by blocking the formation of cholesterol and increasing the number of LDL receptors in the liver, which help to remove the LDL cholesterol from the blood. This helps to slow the progression of CHD, and will make having a heart attack less likely.
* **Low-dose aspirin -** may be prescribed unless there are reasons not to, e.g. a bleeding disorder. This type of medicine will help prevent the blood clotting and can help to reduce the risk of heart attack and angina.
* **Nitrates -** (vasodilators) are used to widen the blood vessels. They are available in a variety of forms, including tablets, sprays, skin patches and ointments. Nitrates work by relaxing the blood vessels, letting more blood pass through them. This lowers the blood pressure and relieves any heart pain. Nitrates can have some mild side effects, including headaches, dizziness and flushed skin.

**SURGERY – 3 types**

* **Angioplasty -** may be a planned procedure for some people with angina or as an urgent treatment if the symptoms have become unstable. Having a coronary angiogram first determines if the patient is suitable for treatment. Coronary angioplasty is also performed as an emergency treatment during a heart attack. During angioplasty, a small balloon is inserted to push the fatty tissue in the narrowed artery outwards; this allows the blood to flow more easily. A metal stent (a short, wire mesh tube) is usually placed in the artery to hold it open. Drug releasing stents can also be used. These release drugs to stop the artery from narrowing again.
* **Coronary artery bypass graft (*this is the one to focus on for the exam*)**

Also known as bypass surgery, heart bypass, coronary artery bypass surgery.

It is performed in patients where the arteries become narrowed or blocked. A coronary angiogram will determine if they are suitable for treatment. Off-pump coronary artery bypass (OPCAB) is a type of coronary artery bypass surgery performed without a heart-lung machine that keeps blood and oxygen circulating around the body.

A blood vessel is inserted (grafted) between the aorta (the main artery leaving the heart) and a part of the coronary artery beyond the narrowed or blocked area. This allows the blood to bypass (get around) the narrowed sections of coronary arteries.

* **Heart transplant -** In a small number of cases, when the heart is severely damaged and medicine is not effective, or when the heart becomes less efficient at pumping blood around the body (heart failure), a heart transplant may be needed. A heart transplant involves replacing a heart that is damaged or is not working properly with a healthy donor heart.  A heart transplant is complicated surgery that usually takes three to five hours.  Immunosuppressant drugs (which weaken the immune system) are given during and after the transplant and must be taken for life, so the body will not reject the new heart. The patient will have a blood test every six weeks and will be seen at the transplant centre every three months for the rest of their life.

**Life After Bypass Surgery**

* Check-up with the surgeon about 7 to 10 days after going home to discuss recovery, make recommendations for improving the person’s lifestyle, and fine-tune medications if necessary.
* By the sixth week after surgery, most people resume almost all of their regular activities. They can drive, travel, return to your normal sex life and even return to work.
* As the sternum was opened during surgery and the bone does not completely heal for at least 12 weeks no extra stress should be put on it. The patient should remember to avoid heavy lifting (no more than 15 pounds), vigorous activity.

However, healing will progress most smoothly if the person doesn’t let themselves get exhausted, and if they remember to rest when they are tired. They will notice that as their activity increases, their strength will increase too.

**Cardiac Rehabilitation**

The heart surgeon/their team will discuss beginning an exercise program. This will be one of the most important things that will keep the cardiovascular system healthy. These programs teach the importance of exercise, how to get started, and how to know their limits. Some programs may also help the patient make changes in diet, quit smoking, or control stress. Through these programs, the patient will meet other people who have gone through the same procedure, and will have the chance to exchange stories and tips for recovery. Cardiac rehabilitation classes are held three times a week. On at least two other days, exercising for approximately one hour will aid recovery. Walking is the best exercise for improving the overall health of the heart. It may reduce the chances of future heart problems and will probably prolong the person’s life.

**LIFESTYLE CHANGES.**

* ***Diet:*** A low-fat, high-fibre diet is recommended, including plenty of fresh fruit and vegetables (five portions a day) and whole grains. The amount of salt that eaten should be limited to no more than 6g (1 teaspoon) a day because too much salt will increase the blood pressure. There are two types of fat: saturated and unsaturated. Food containing saturated fats should be avoided because these will increase cholesterol levels. However, a balanced diet should include a small amount of unsaturated fat, which will help reduce cholesterol levels. Poor control of cholesterol after surgery increases the risk that the new bypass grafts will be blocked. If changes in diet and lifestyle are not successful in reducing the level of cholesterol, then medications may be necessary. A registered dietician can help make the transition to healthy eating.
* ***Exercise:*** Combining a healthy diet with regular exercise is the best way to maintain a healthy weight. Having a healthy weight reduces the chances of developing high blood pressure. Regular exercise will make the heart and blood circulatory system more efficient; it will lower the cholesterol level, and also keep the blood pressure at a healthy level. If you smoke, giving up will reduce your risk of developing CHD.
* ***Smoking*** is a major risk factor for developing atherosclerosis (hardening of the arteries). It also causes the majority of cases of coronary thrombosis in people under the age of 50.
* ***Alcohol:*** Stick to recommended guidelines. The recommended daily amount of alcohol for men is three to four units a day and two to three units for women. Always avoid binge drinking.
* **High Blood Pressure**

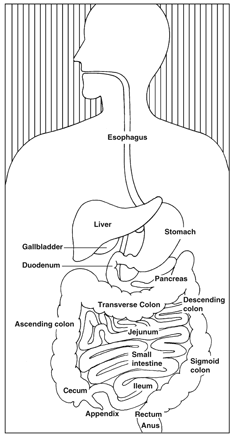
Many patients have hypertension (**high blood pressure**) before surgery. It is essential to monitor their blood pressure carefully after surgery. Poor control of blood pressure after surgery can worsen blockages in the arteries and speed up changes in the bypass grafts. Members of the cardiac team will help the patient work out a plan for controlling blood pressure with diet, and perhaps medication.

* **Stress**

Learning about and controlling stress can help recovery and make it easier to tackle other lifestyle changes. There are many ways that people reduce daily stress: Some have quiet hobbies, some meditate, and some are physically active.

**DIGESTIVE SYSTEM**

**Structure of the digestive system**

The digestive system is made up of the digestive tract—a series of hollow organs joined in a long, twisting tube from the mouth to the anus—and other organs that help the body break down and absorb food.

Organs that make up the digestive tract are the mouth, oesophagus, stomach, small intestine, large intestine (also called the colon) rectum, and anus. Two “solid” digestive organs, the liver and the pancreas, produce digestive juices that reach the intestine through small tubes called ducts. The gallbladder stores the liver's digestive juices until they are needed in the intestine. Parts of the nervous and circulatory systems also play major roles in the digestive system.

**The mouth** is the beginning of the digestive tract - digestion starts here when taking the first bite of food. Chewing breaks the food into pieces that are more easily digested, while saliva mixes with food to begin the process of breaking it down into a form the body can absorb and use. Food placed in the mouth is:

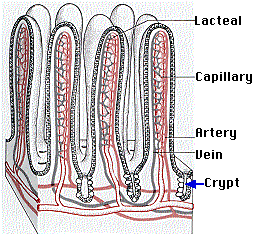
* ground into finer particles by the teeth,
* moistened and lubricated by saliva (secreted by three pairs of salivary glands)
* small amounts of starch are digested by the amylase present in saliva
* the resulting bolus of food is swallowed into the oesophagus and carried by peristalsis to the stomach.

**The Oesophagus** is about 25 cms long and allows the food you swallow to get to your stomach. When you swallow, the muscles along the length of the oesophagus tighten and relax in a ‘wave’ downwards and the food is moved into the stomach. This all happens in a few seconds. The oesophagus has 2 sphincters. A sphincter is a narrowing caused by contracted (tightened) muscles. These muscles remain contracted until the body sends a message for the muscles to relax. When the muscles of the sphincter relax, this then allows things to pass.   
One sphincter is at the top of the oesophagus. The other is where the oesophagus meets the stomach this is known as the gastro-oesophageal junction. The lower sphincter controls the movement of food into the stomach and prevents stomach acid from going up into the oesophagus (gastro-oesophageal reflux). The lining of the oesophagus is very different to that of the stomach and stomach acid will cause it to become inflamed and sore if reflux does occur.

**The Stomach** is used for the temporary storage of the food eaten. Food is usually in the stomach for 2 – 4 hours. However a great deal happens to the food during it’s time in the stomach. The mechanical breakdown of the food continues as the stomach ‘churns’ the food into smaller pieces. Also, cells in the lining of the stomach produce ‘gastric juice’. In a single day you’ll produce about 3 litres of gastric juice. As with saliva, more gastric juice is produced when you smell food (such as passing a bakery), when you’re about to eat and during eating.   
Gastric juice is needed so the body can obtain nutrition from food and drink and to protect against bacteria that may be in the food or drink. It has three main ingredients; a strong acid, a substance called Pepsin and another substance called Intrinsic factor. The stomach acid kills many of the bacteria that may be in the food or drink you have consumed. The acid also creates the right conditions to allow the Pepsin to begin the chemical break down of the protein in your food into peptides. This has to happen so the body can use the protein in your food to replace the protein it has used for various body functions. The Intrinsic factor is needed so the Vitamin B12 in your food can be absorbed by the body. The actual absorption of Vitamin B12 does not occur in the stomach, but in the terminal ileum. Finally a small amount of water, water soluble vitamins and minerals (except Vitamin B12), simple carbohydrates and alcohol are absorbed through the stomach lining. As well as the sphincter that joins the stomach to the oesophagus, there is another one at the bottom of the stomach. This one controls the movement of the food out of the stomach into the start of the small bowel (gastric emptying). At this point the food is semi-liquid and is called ‘chyme’.

**The small intestine**

* **The Duodenum** is the first part of the small bowel and is usually around 20 cm in length. The duodenum is the main site of absorption for minerals, although some Vitamin A and Vitamin D and simple sugars are also absorbed. The gallbladder releases bile (which is made in the liver) into the duodenum. The bile ‘emulsifies’ the fat in the food into tiny (microscopic) droplets so that it can be digested and then absorbed more easily. Additionally the pancreas releases the pancreatic juices into the duodenum. This juice contains a mixture of enzymes to help further breakdown the fat, protein and carbohydrate in the food into smaller pieces. Pancreatic juice is alkaline, this is needed as the enzymes in the pancreatic juice do not work well in acid and the chyme is very acidic as it is partly made from gastric acid.
* **The Jejunum** follows directly onto the duodenum. This is where the final juices to help digestion are secreted by the cells in the jejunal lining. It is also the part of the bowel where the majority of nutrients are absorbed into the body. This includes the absorption of the substances made from the breakdown (digestion) of the carbohydrate, fat and protein from the food. Vitamin A, Vitamin D, water, water soluble vitamins, sodium and a small amount of bile salts are also absorbed in the jejunum.
* **The Ileum** is the final part of the small bowel. It is where any remaining nutrients from the breakdown of protein and some water soluble vitamins are absorbed. It is also where most of the bile salts are absorbed to be re-cycled by the body. The last part of the ileum is called the terminal ileum. It is important because this is where Vitamin B12 is absorbed. As previously mentioned the Intrinsic factor in the gastric juices is needed so that the Vitamin B12 can be absorbed.



Digestion within the small intestine produces a mixture of disaccharides, peptides, fatty acids, and monoglycerides. The final digestion and absorption of these substances occurs in the **villi**, which line the inner surface of the small intestine.

The **crypts** at the base of the villi contain **stem cells** that continuously divide by mitosis producing

* more stem cells
* cells that migrate up the surface of the villus which differentiate into columnar epithelial cells (the majority).

They are responsible for digestion and absorption

* 1. **goblet cells**, which secrete mucus;
  2. **endocrine cells**, which secrete a variety of hormones;
  3. **Paneth cells**, which secrete antimicrobial peptides that sterilize the contents of the small intestine.

The villi increase the surface area of the small intestine to many times what it would be if it were simply a tube with smooth walls. In addition, the exposed surface of the epithelial cells of each villus is covered with **microvilli**.

Incorporated in the plasma membrane of the microvilli are a number of enzymes that complete digestion:

* **aminopeptidases** producing amino acids from protein
* **disaccharidases** These enzymes convert disaccharides into monosaccharide including.
  + **maltase** hydrolyzes maltose into glucose.
  + **sucrase** hydrolyzes sucrose (common table sugar) into glucose and fructose.
  + **lactase** hydrolyzes lactose (milk sugar) into glucose and galactose.

Fructose simply diffuses into the villi, but both glucose and galactose are absorbed by active transport.

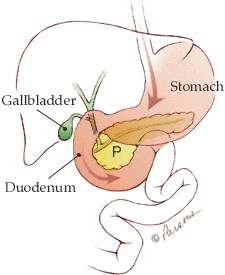
* **Fatty acids and monoglycerides**. These become resynthesized into fats as they enter the cells of the villus. The resulting small droplets of fat are then absorbed into the lymph vessels (called **lacteals**).

**The Large Bowel**,

* This is approximately 4 cm in width and 1 meter in length and is made of 3 sections – the caecum, colon and rectum. Most of the nutrients from your food will have already been absorbed in the small bowel. In the large bowel the stool is made firmer as the water is removed from the stool and absorbed into the body.   
  **The Caecum** is the first part of the large bowel and holds little significance other than the fact it is what your appendix is attached to.
* **The colon** removes water, salt, and some nutrients forming stool. Muscles line the colon's walls, squeezing its contents along. Billions of bacteria coat the colon and its contents, living in a healthy balance with the body.
* **The rectum** is a chamber that begins at the end of the large intestine and ends at the anus. Ordinarily, the rectum is empty because stool (faeces) is stored higher in the descending colon. Eventually, the descending colon becomes full, and stool passes into the rectum, causing an urge to move the bowels (defecate).

**The anus** is the opening at the far end of the digestive tract through which stool leaves the body. A muscular ring (anal sphincter) keeps the anus closed until the person has a bowel movement.

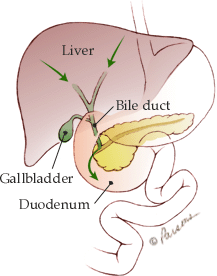
**Solid structures of the digestive system:**

**Pancreas**  
The pancreas secretes digestive enzymes into the duodenum, the first segment of the small intestine. These enzymes break down protein, fats, and carbohydrates. The pancreas also makes insulin, secreting it directly into the bloodstream. Insulin is the chief hormone for metabolizing sugar.

***Islets of Langerhans -*** These are the endocrine (endo= within) cells of the pancreas that produce and secrete hormones into the bloodstream. The pancreatic hormones, insulin and glucagon, work together to maintain the proper level of sugar in the blood. The sugar, glucose, is used by the body for energy.

***Acinar cells -*** These are the exocrine (exo= outward) cells of the pancreas that produce and transport chemicals that will exit the body through the digestive system. The chemicals that the exocrine cells produce are called enzymes. They are secreted in the duodenum where they assist in the digestion of food.

**The pancreatic duct** carries the pancreatic fluid produced by the acinar cells (exocrine) of the pancreas. The pancreatic duct runs the length of the pancreas and joins the common bile duct in the head of the pancreas. These ducts join to form the ampulla of Vater which then empties into the duodenum.



**Liver**The liver has multiple functions, but its main function within the digestive system is to process the nutrients absorbed from the small intestine. In addition, the liver is the body’s chemical "factory." It takes the raw materials absorbed by the intestine and makes all the various chemicals the body needs to function. The liver also detoxifies potentially harmful chemicals. It breaks down and secretes many drugs.

Bile is a greenish-yellow fluid that aids in the digestion of fats. After being produced by cells in the liver, the bile travels down through the bile ducts which merge with the cystic duct to form the common bile duct. The cystic duct runs to the **gallbladder,** a small pouch nestled underneath the liver. The gallbladder stores extra bile until needed. The common bile duct actually enters the head of the pancreas and joins the pancreatic duct to form the ampulla of Vater which then empties into the duodenum.

**DYSFUNCTION: STOMACH ULCERS**

* **A peptic ulcer** is an ulcer caused by stomach acid. An ulcer is where the lining of the gut is damaged and the underlying tissue is exposed. If you could see inside your gut, an ulcer looks like a small, red crater on the inside lining of the gut.
* **A stomach ulcer** is one type of peptic ulcer. A stomach ulcer is sometimes called a gastric ulcer. (The most common type of peptic ulcer is a duodenal ulcer.)

**CAUSES**

Your stomach normally produces acid to help with the digestion of food and to kill bacteria. This acid is corrosive and there is normally a balance between the amount of acid that you make and the mucus defence barrier. An ulcer may develop if there is an alteration in this balance allowing the acid to damage the lining of the stomach or duodenum. Causes of this include the following:

**- Infection with *Helicobacter pylori***

Infection by *Helicobacter pylori* (commonly just called *H. pylori*) is the cause in about 8 in 10 cases of stomach ulcer. Once you are infected, unless treated, the infection usually stays for the rest of your life. In many people it causes no problems and a number of these bacteria just live harmlessly in the lining of the stomach and duodenum. However, in some people this bacterium causes an inflammation in the lining of the stomach or duodenum. This causes the defence mucus barrier to be disrupted (and in some cases the amount of acid to be increased) which allows the acid to cause inflammation and ulcers.

**- Anti-inflammatory drugs - including aspirin**

Anti-inflammatory drugs are sometimes called non-steroidal anti-inflammatory drugs (NSAIDs). These drugs sometimes affect the mucus barrier of the stomach and allow acid to cause an ulcer. About 2 in 10 stomach ulcers are caused by anti-inflammatory drugs.

**- Other causes and factors**

Other causes are rare. For example, some virus infections can cause a stomach ulcer. Crohn's disease may cause a stomach ulcer in addition to other problems of the gut.

**Symptoms**

* **Pain** in the upper abdomen just below the sternum (breastbone) is the common symptom. It usually comes and goes. It may be eased if you take antacid tablets. Sometimes food makes the pain worse. The pain may wake you from sleep.
* **Other symptoms** which may occur include: bloating, retching, and feeling sick. You may feel particularly 'full' after a meal.
* **Complications** develop in some cases, and can be serious. These include:
  + Bleeding ulcer. This can range from a 'trickle' to a life-threatening bleed.
  + Perforation. This is where the ulcer goes right through ('perforates') the wall of the stomach. Food and acid in the stomach then leak into the abdominal cavity. This usually causes severe pain and is a medical emergency.

**DIAGNOSIS**

* **Endoscopy** is the test that can confirm a stomach ulcer. In this test a doctor looks inside your stomach by passing a thin, flexible telescope down your oesophagus. They can see any inflammation or ulcers.
* **A test to detect the *H. pylori* bacterium** is usually done if you have a stomach ulcer. If *H. pylori* is found then it is likely to be the cause of the ulcer. It can be detected in a sample of faeces, or in a 'breath test', or from a blood test, or from a biopsy sample taken during an endoscopy.
* **Biopsies (small samples)** are usually taken of the tissue in and around the ulcer during endoscopy.

**Effects of gastric ulcers on lifestyle and daily routine:**

|  |  |
| --- | --- |
| **Problems caused by illness** | **Effect on lifestyle/routine** |
| Pain in upper abdomen | Changes to sleep pattern.  Time off work (money issues).  Changes to social life + relationships  Increased stress about condition |
| Nausea/vomiting | Loss of appetite, weight changes, changes to diet |
| Risk of perforation/severe bleeding | Time off work (hospitalisation).  Anaemia (if bleeding)  Constantly worried (doesn’t help coz of acid build-up) |
| Changes to diet (spicy food/caffeine etc.) | Social isolation/limited socialising  Changes to relationships (work and home) |

**TREATMENTS**

**Self-help**

Lifestyle changes include:

* not having food and drink that seems to cause more severe symptoms - these foods can include spicy foods, coffee and alcohol
* stopping smoking
* not taking painkillers that are likely to cause ulcers in the future

**Acid suppressing medication**

A 4-8 week course of a drug that greatly reduces the amount of acid that your stomach makes is usually advised.

**If the ulcer was caused by *H. pylori***

Two antibiotics are needed to clear *H. pylori*. In addition, you need to take an acid-suppressing drug to reduce the acid in the stomach. This is needed to allow the antibiotics to work well.

**If the ulcer was caused by an anti-inflammatory drug**

If possible, you should stop the anti-inflammatory drug. This allows the ulcer to heal. You will also normally be prescribed an acid-suppressing drug for several weeks. This stops the stomach from making acid and allows the ulcer to heal.

**Treatment for other uncommon causes**

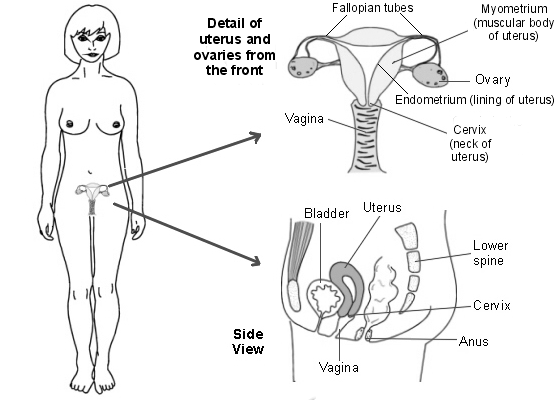
Treatment depends on the underlying cause.

**Surgery**

Surgery is now usually only needed if a complication of a stomach ulcer develops such as severe bleeding or a perforation.

**REPRODUCTIVE SYSTEM**

**The structure of the female reproductive system:**

The female reproductive system is designed to carry out several functions. These are: -  
1. Production of ova (eggs).  
2. Receiving the sperms.  
3. Providing suitable environment for fusion (fertilization) of the egg and the sperm.  
4. Child birth.

If fertilization does not take place, the system is designed to menstruate (the monthly shedding of the uterine lining). In addition, the female reproductive system produces female sex hormones that maintain the reproductive cycle.

During menopause the female reproductive system gradually stops making the female hormones necessary for the reproductive cycle to work. When the body no longer produces these hormones a woman is considered to be menopausal.

The female reproductive anatomy includes internal and external structures.

The function of the external female reproductive structures is:

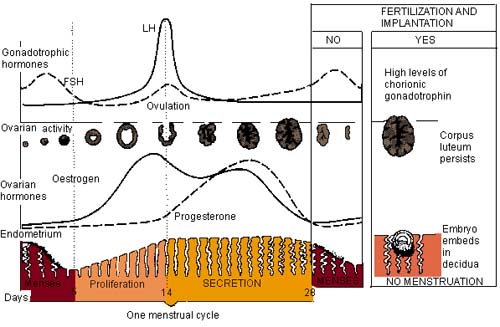
* To enable sperm to enter the body
* and to protect the internal genital organs from infectious organisms.

The main *external* structures of the female reproductive system include:

* **Labia majora:** The labia majora enclose and protect the other external reproductive organs. The labia majora contain sweat and oil-secreting glands.
* **Labia minora:** They lie just inside the labia majora, and surround the openings to the vagina and urethra.
* **Bartholin’s glands:** These glands are located next to the vaginal opening and produce a fluid (mucus) secretion.
* **Clitoris:** The two labia minora meet at the clitoris, a small, sensitive protrusion that is comparable to the penis in males.

The *internal* reproductive organs include:

* **Vagina:** The vagina is a canal that joins the cervix (the lower part of uterus) to the outside of the body. It also is known as the birth canal.
* **Uterus (womb):** The uterus is a hollow, pear-shaped organ that is the home to a developing foetus. The uterus is divided into two parts: the cervix, which is the lower part that opens into the vagina, and the main body of the uterus, called the corpus. The corpus can easily expand to hold a developing baby. A channel through the cervix allows sperm to enter and menstrual blood to exit.
* **Ovaries:** The ovaries are small, oval-shaped glands that are located on either side of the uterus. The ovaries produce eggs and hormones.
* **Fallopian tubes:** These are narrow tubes that are attached to the upper part of the uterus and serve as tunnels for the ova to travel from the ovaries to the uterus. Conception (the fertilization of an egg by a sperm) normally occurs in the fallopian tubes. The fertilized egg then moves to the uterus, where it implants to the uterine wall.

**The menstrual cycle**

Females of reproductive age (anywhere from 11-16 years) experience cycles of hormonal activity that repeat at about one-month intervals. With every cycle, a woman’s body prepares for a potential pregnancy, whether or not that is the woman’s intention. The term *menstruation* refers to the periodic shedding of the uterine lining. The average menstrual cycle takes about 28 days and occurs in phases: the follicular phase, the ovulatory phase (ovulation), and the luteal phase. There are four major hormones (involved in the menstrual cycle: follicle-stimulating hormone, luteinizing hormone, oestrogen, and progesterone.

**Follicular phase**This phase starts on the first day of the period. During the follicular phase of the menstrual cycle, the following events occur:

* Two hormones, follicle stimulating hormone (FSH) and luteinizing hormone (LH) are released from the brain and travel in the blood to the ovaries.
* The hormones stimulate the growth of about 15-20 eggs in the ovaries each in its own "shell," called a follicle.
* These hormones (FSH and LH) also trigger an increase in the production of the female hormone oestrogen.
* As oestrogen levels rise, like a switch, it turns off the production of follicle-stimulating hormone. This careful balance of hormones allows the body to limit the number of follicles that complete maturation, or growth.
* As the follicular phase progresses, one follicle in one ovary becomes dominant and continues to mature. This dominant follicle suppresses all of the other follicles in the group. As a result, they stop growing and die. The dominant follicle continues to produce oestrogen.

**Ovulatory phase**The ovulatory phase, or ovulation, starts about 14 days after the follicular phase started. The ovulatory phase is the midpoint of the menstrual cycle, with the next menstrual period starting about 2 weeks later. During this phase, the following events occur:

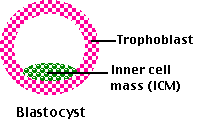
* The rise in oestrogen from the dominant follicle triggers a surge in the amount of luteinizing hormone that is produced by the brain.
* This causes the dominant follicle to release its egg from the ovary.
* As the egg is released (ovulation) it is captured by finger-like projections on the end of the fallopian tubes (fimbriae). The fimbriae sweep the egg into the tube.
* Also during this phase, there is an increase in the amount and thickness of mucus produced by the cervix. If a woman were to have intercourse during this time, the thick mucus captures the man's sperm, nourishes it, and helps it to move towards the egg for fertilization.

**Luteal phase**The luteal phase begins right after ovulation and involves the following processes:

* Once it releases its egg, the empty follicle develops into a new structure called the corpus luteum.
* The corpus luteum secretes the hormones oestrogen and progesterone. Progesterone prepares the uterus for a fertilized egg to implant.
* If intercourse has taken place and a man's sperm has fertilized the egg (a process called conception), the fertilized egg (embryo) will travel through the fallopian tube to implant in the uterus. The woman is now considered pregnant.
* If the egg is not fertilized, it passes through the uterus. Not needed to support a pregnancy, the lining of the uterus breaks down and sheds, and the next menstrual period begins.

**Pregnancy**

Development begins while the fertilized egg is still within the **fallopian tube**. Repeated mitotic divisions produces a solid ball of cells called a **morula**. Further mitosis and some migration of cells converts this into a hollow ball of cells called the **blastocyst**. Approximately one week after fertilization, the blastocyst embeds itself in the thickened wall of the uterus, a process called **implantation**, and pregnancy is established.

The blastocyst produces two major collections of cells:

* Three or four blastocyst cells develop into the **inner cell mass**, which will form
  + 3 extraembryonic membranes: **amnion**, **yolk sac**, and (a vestigial) **allantois** and
  + in about 2 months, become the fetus and, ultimately, the baby.
* The remaining 100 or so cells form the **trophoblast**, which will develop into the **chorion** that will go on to make up most of the **placenta**. All the extraembryonic membranes play vital roles during development but will be discarded at the time of birth.

The placenta grows tightly fused to the wall of the uterus. Its blood vessels, supplied by the foetal heart, are literally bathed in the mother's blood. Although there is normally no mixing of the two blood supplies, the placenta does facilitate the transfer of a variety of materials between the foetus and the mother.

* receiving food
* receiving oxygen and discharging carbon dioxide
* discharging urea and other wastes
* receiving **antibodies** These remain for weeks after birth, protecting the baby from the diseases to which the mother is immune.

But the placenta is not simply a transfer device. Using raw materials from the mother's blood, it synthesizes large quantities of proteins and also some hormones.

The metabolic activity of the placenta is almost as great as that of the foetus itself.

The **umbilical cord** connects the foetus to the placenta. It receives deoxygenated blood from the iliac arteries of the foetus and returns oxygenated blood to the liver and on to the inferior vena cava.

**Birth and Lactation**

Exactly what brings about the onset of labour is still not completely understood. Probably a variety of integrated hormonal controls are at work.

The first result of labour is the opening of the cervix. With continued powerful contractions, the amnion ruptures and the amniotic fluid (the "waters") flows out through the vagina. The baby follows, and its umbilical cord can be cut.

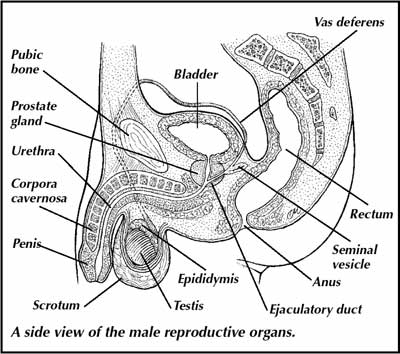
The infant's lungs expand, and it begins breathing. This requires a major switchover in the circulatory system. Blood flow through the umbilical cord, ductus arteriosus, and foramen ovale ceases, and the adult pattern of blood flow through the heart, aorta, and pulmonary arteries begins. In some infants, the switchover is incomplete, and blood flow through the pulmonary arteries is inadequate. Failure to synthesize enough nitric oxide (NO) is one cause.

Shortly after the baby, the placenta and the remains of the umbilical cord (the "afterbirth") are expelled.

At the time of birth, and for a few days after, the mother's breasts contain fluid called **colostrum**. It is rich in calories and proteins, including antibodies that provide passive immunity for the newborn infant.

Three or four days after delivery, the breasts begin to secrete milk.

* Its synthesis is stimulated by the pituitary hormone **prolactin (PRL)**.
* Its release is stimulated by a rise in the level of **oxytocin** when the baby begins nursing.
* Milk also contains an **inhibitory peptide**. If the breasts are not fully emptied, the peptide accumulates and inhibits milk production. This matches supply with demand.

MALE REPRODUCTIVE SYSTEM  
  
The male reproductive system consists of those structures in the male body designed to create life. The reproductive system includes the two testes, a network of ducts, the seminal vesicles, the prostate gland, and the penis.

**The testes** are two oval glands located in the scrotum (the pouch of skin that hangs behind the penis). They produce the male sex hormone testosterone and sperm. Sex hormones control the secondary male sex characteristics (such as growth of the penis and of body hair, voice change, and increased muscle mass), which begin to appear at puberty.

The testes discharge sperm into the epididymis.

**The epididymis** runs along the top and side of each testis. Inside the epididymis are several ducts that conduct sperm from the testis into the vas deferens.

**The vas deferens** loops up into the body before descending into a duct in the seminal vesicle. This duct joins the ejaculatory duct, which extends through the prostate gland, and enters the upper segment of the urethra. At different times, **the urethra** functions as a passageway for urine and for sperm. As sperm travel through the duct system, they combine with fluids from the seminal vesicles, the prostate gland, and the urethra to form semen.

**The two seminal vesicles**, which lie near the underside of the urinary bladder, discharge a thick, sticky fluid.

**The prostate gland** is a small, doughnut-shaped organ that completely surrounds the urethra. The prostate gland secretes an alkaline substance that makes up the major portion of seminal fluid. The sperm are protected from acid (present both in the male urethra and in the vagina) by the alkalinity of the prostatic secretions.

**The penis** is the external organ that propels sperm into the female during sexual intercourse. During sexual excitement, the corpora cavernosa (large internal spaces within the penis) become filled with blood, making the penis rigid enough to enter the vagina. The semen, which is formed in the urethra, then travels out of the penis during ejaculation.

**DYSFUNCTION: INFERTILITY**

**CAUSES**

Infertility can be caused by many different factors. Around a third of infertility is due to problems with the woman, and another third is due to problems with the man. In 23% of cases, a cause cannot be identified.

**Infertility in women**

**Ovulation disorders**

Infertility is most commonly caused by problems with ovulation (the monthly release of an egg). Some of these problems stop women releasing eggs at all, and some cause an egg to be released during some cycles, but not others.

Ovulation problems can occur as a result of a number of conditions, listed below.

* **Premature ovarian failure**, where a woman’s ovaries stop working before she is 40.
* **Polycystic ovary syndrome (PCOS)**, a condition that makes it more difficult for your ovaries to produce an egg.
* **Thyroid problems.** Both an overactive thyroid gland (hyperthyroidism) and an underactive thyroid gland (hypothyroidism) can prevent ovulation.
* **Chronic (long-term) conditions.** Some chronic conditions, such as cancer, or AIDS, can prevent your ovaries from releasing eggs.
* **Cushing’s syndrome**, a rare hormonal disease that can prevent your ovaries from releasing an egg.

**Womb and fallopian tubes**

If the womb or the fallopian tubes are damaged, or stop working, it may be very difficult to conceive naturally. This can occur following a number of factors, outlined below.

* **Pelvic surgery -** can sometimes cause damage and scarring to the fallopian tubes.
* **Cervical surgery** - can sometimes cause scarring, or shorten the cervix.
* **Cervical mucus defect** - When ovulating, the mucus in the cervix becomes thinner so that sperm can swim through it more easily. If there is a problem with the mucus, it can make it harder to conceive.
* **Fibroids** are benign (non-cancerous) tumours that grow in, or around, the womb. Fibroids can reduce fertility, although exactly how they do this is not yet known. It is possible that a fibroid may block one of the fallopian tubes, or prevent an egg from implanting itself into the womb.
* **Endometriosis -** a condition where small pieces of the womb lining, known as the endometrium, start growing in other places, such as in the fallopian tubes or the ovaries. This can cause infertility because the new growths form adhesions (sticky areas of tissue) or cysts (fluid-filled sacs) that can block or distort the pelvis. These make it difficult for an egg to be released and become implanted into the womb. Endometriosis can cause infertility because it can disturb the way that a follicle (fluid-filled space in which an egg develops) matures and releases an egg.
* **Pelvic inflammatory disease -** (PID) is an infection of the upper female genital tract, which includes the womb, fallopian tubes, and ovaries. It is usually a sexually transmitted infection (STI). PID can damage and scar the fallopian tubes, making it virtually impossible for an egg to travel down into the womb.
* **Sterilisation -** involves blocking the fallopian tubes to make it impossible for an egg to travel to the womb. This process is rarely reversible.

**Medicines and drugs**

The side effects of some types of medication and drugs can affect fertility.

* **Non-steroidal anti-inflammatory drugs (NSAIDs).** Long-term use, or a high dosage, of NSAIDs, such as ibuprofen or aspirin, can make it more difficult to conceive.
* **Chemotherapy.** The medicines that are used for chemotherapy can sometimes cause ovarian failure, which means that the ovaries will no longer be able to function properly. Ovarian failure can be permanent.
* **Antipsychotic medicines** that are often used to treat psychosis sometimes cause missed periods or infertility.
* **Spironolactone** is a medicine that is used to treat heart failure, and can cause irregular periods and infertility.
* **Illegal drugs** such as marijuana and cocaine can seriously affect fertility, making ovulation more difficult. Drugs may also adversely affect the functioning of the fallopian tubes.

**Age**

Infertility in women is also linked to age. The biggest decrease in fertility begins during the mid-thirties. For women who are 35, 95% will get pregnant after three years of having regular unprotected sex. For women who are 38, only 75% will get pregnant after three years of having regular unprotected sex.

**Infertility in men**

**Semen -** Abnormal semen is the most common cause of male infertility. Abnormal semen accounts for 75% of male infertility cases. Some possible reasons are:

* Decreased number of sperm. You may have a very low sperm count, or no sperm at all.
* Decreased sperm mobility. If you have decreased sperm mobility, it will be harder for your sperm to swim to the egg.
* Abnormal sperm. Sometimes sperm can be an abnormal shape, making it harder for them to move and fertilise an egg.

**Testicles -** The testicles are responsible for producing and storing sperm. If they are damaged, it can seriously affect the quality of the semen. This may occur if the male has (or had in the past) any of the following:

* an infection of the testicles
* testicular cancer
* testicular surgery
* a congenital defect (a problem with the testicles that they were born with)
* undescended testicles (when one or both of the testicles has not descended into the scrotum)
* a trauma (injury) to the testicles

**Absence of sperm -** The testicles may produce sperm, but it may not reach the semen (known as obstructive azoospermia). This could be due to a blockage in one of the tiny tubes of the male reproductive system, which may have been caused by an infection or surgery.

**Sterilisation -** A vasectomy is the surgical procedure for male sterilisation. It involves cutting and sealing off the vas deferens, so that semen will no longer contain any sperm. A vasectomy can be reversed, but reversals are not usually successful.

**Ejaculation disorders** Some men experience ejaculation problems that can make it difficult for them to ejaculate.

**Hypogonadism –**an abnormally low level of testosterone. This could be due to a tumour, taking illegal drugs or Kallman’s syndrome (a rare disorder that is caused by a faulty gene).

**Medicines and drugs -** Certain types of medicines can sometimes cause infertility problems. These medicines are listed below.

* Sulfasalazine, an anti-inflammatory medicine used to treat conditions such as Crohn's disease (inflammation of the intestine) and rheumatoid arthritis (painful swelling of the joints) can decrease the number of sperm, but its effects are only temporary and the sperm count should return to normal when the male stops taking it.
* Anabolic steroids, which are often used illegally to build muscle and improve athletic performance can reduce sperm count and sperm mobility.
* Chemotherapy. The medicines that are used in chemotherapy can sometimes severely reduce the production of sperm.

**Alcohol -** Drinking too much alcohol can damage the quality of the sperm. Guidelines published by the National Institute of Clinical Excellence (NICE) state that if men follow the Department of Health’s recommendations of drinking no more than three to four units of alcohol a day, it is unlikely that their fertility will be affected. However, drinking more than this could make it difficult to conceive.

**Factors that affect both men and women**

As well as factors that specifically affect a man or a woman’s fertility, there are also a number of factors that can affect fertility in both men and women. These are outlined below.

**Weight -** Being overweight, or obese, reduces both male and female fertility. In women, being overweight can affect ovulation. Being underweight can also have an impact on fertility, particularly for women, who will not ovulate if they are severely underweight.

**Sexually transmitted infections (STIs) -** There are several sexually transmitted infections (STIs) that can cause infertility. For example, chlamydia can damage the fallopian tubes in women, and cause swelling and tenderness of the scrotum (the pouch containing the testes) in men.

**Smoking -** As well as affecting general and long-term health, smoking can also adversely affect fertility.

**Occupational and environmental factors -** Exposure to certain pesticides, metals, and solvents can affect fertility in both men and women.

**Stress -** If either partner is stressed, it may affect their relationship. Stress can reduce libido (sex drive) which in turn can reduce the frequency of sexual intercourse. Severe stress may also affect female ovulation and limit sperm production.

**DIAGNOSTIC TECHNIQUES - FEMALE:**

When the woman visits their GP, they will want to find out about the woman’s full medical, sexual and social history. This will help them to identify any possible factors that may be causing fertility problems

**Blood tests:**

* **Progesterone test**

During a progesterone test, a sample of blood can be tested for progesterone to check whether the woman is ovulating. The test is taken seven days before the woman expects her period to start.

* **Hormone tests**

If the woman’s periods are irregular, the level of follicle-stimulating hormone (FSH) and luteinising hormone in the blood may be tested. If the woman has symptoms of an ovulation disorder (e.g. polycystic ovary syndrome (PCOS)), the level of prolactin, another hormone, may also be tested.

* **Thyroid function test**

If the woman has any symptoms of a thyroid abnormality, such as weight loss or weight gain, the thyroid gland will be tested to check whether it is functioning properly.

**Internal examinations:**

1. The GP will **examine the pelvic area**, to check for vaginal infection, or tenderness, which could be an indication of endometriosis or pelvic inflammatory disease (PID)
2. **Chlamydia test:** Chlamydia is a sexually transmitted infection (STI) that can affect fertility. The GP will use a swab to collect some cells from the cervix to test for chlamydia. If chlamydia is present the woman will be prescribed antibiotics to treat it.

**Imaging techniques:**

* **Hysterosalpingogram**

A Hysterosalpingogram is a type of X-ray that is taken of the womb (uterus) and fallopian tubes after a special dye has been injected. This will detect any abnormalities or defects, such as tumours (growths) or scar tissue.

* **Ultra sound**

Pelvic ultrasound *(see notes at end of male testing for details of what an ultrasound is)*

**Surgical testing:**

**Laparoscopy**

A laparoscopy involves making a small incision (cut) in the lower abdomen. A thin, tubular microscope called a laparoscope will be used to look more closely at the womb, fallopian tubes and ovaries. Dye may be injected into the fallopian tubes through the cervix in order to highlight any blockages in them. A laparoscopy is usually only used if there is a strong chance that the woman has a problem with these structures e.g. an episode of PID in the past.

**Male fertility testing**

When the man visits their GP, they will want to find out about the man’s full medical, sexual and social history. This will help them to identify any possible factors that may be causing fertility problems.

**Physical examination:**

During a physical examination, the GP may check:

* **The testicles**, to look for any lumps or deformities
* **The penis**, to look at its shape and structure, and for any obvious abnormalities

**Semen analysis**.

A semen sample is evaluated for;

* Sperm count = percentage of active sperm (often called motility),
* Sperm shape (usually called morphology)
* And the presence of elements other than sperm, for example blood cells or white cells which can provide evidence of damage and/or evidence of infection.

**Urine test:**

* **Chlamydia test**. A sample of urine will be tested to determine whether the man has chlamydia. If he does have chlamydia, the GP will prescribe antibiotics to treat it.

**Ultrasound** – see below

**Ultrasound examinations (for men and women):**

A pelvic ultrasound uses sound waves to make a picture of the organs and structures in the lower belly (pelvis). You lie on a couch and an operator places a probe (transducer) on your skin over the part of your body to be examined. Lubricating jelly is put on your skin so that the probe makes good contact with your body. The probe is connected by a wire to the ultrasound machine and monitor. Pulses of ultrasound are sent from the probe through the skin into your body. The ultrasound waves then echo ('bounce back') from the various structures in the body.  
The echoes are detected by the probe and are sent down the wire to the ultrasound machine. They are displayed as a picture on the monitor. The picture is constantly updated so the scan can show movement as well as structure. Organs and structures that are solid and uniform (such as the uterus, ovaries, or prostate gland) or that are fluid-filled (such as the bladder) show up clearly on a pelvic ultrasound. Bones or air-filled organs, such as the intestines, do not show up well on an ultrasound. Pelvic ultrasound can be done three ways: trans-abdominal, trans-rectal, and trans-vaginal.

**Trans-abdominal ultrasound.** The transducer is passed back and forth over the lower belly.

**Trans-rectal ultrasound.** The transducer is shaped to fit into the rectum. A trans-rectal ultrasound is the most common test to look at the male pelvic organs, such as the prostate and seminal vesicles. Sometimes, a small sample of tissue (biopsy) may be taken with small tools inserted through the rectum during a trans-rectal ultrasound.

**Trans-vaginal ultrasound.** The transducer is shaped to fit into a woman's vagina. A trans-vaginal ultrasound is done to look for problems with fertility. Sometimes, a biopsy may be taken with small tools inserted through the vagina during a trans-vaginal ultrasound.

**Effects of infertility on lifestyle and daily routine:**

|  |  |
| --- | --- |
| **Problems caused by illness** | **Effect on lifestyle/routine** |
| Physical side effects of fertility drugs include nausea, hot flushes, headaches, abdominal pain. | Changes to eating, sleeping routines.  Changes in relationships. Mood swings. |
| Physical effects of tests/treatment (some procedures can be slightly painful, there are risks associated with anaesthetic/invasive procedures) | Pain can lead to changes in eating/sleeping and relationships. Increased anxiety re: tests |
| Having tests/procedures | Expensive, time off work, added pressure on relationships. Emotional impact if procedures unsuccessful (includes depression, mood swings, embarrassment, exhaustion, anger, confusion etc.) |
| Emotional impact of being infertile/having fertility treatment including: sadness, depression, desperation, hurt, embarrassment, and humiliation. | Changes in eating/sleeping habits. Changes in sex life (being told when is the best time in cycle)  Changes in relationships. Changes in social life (avoiding friends/family with children) |

**TREATMENTS**

Fertility treatments can be grouped into three categories:

**Medicines to improve fertility -** sometimes used alone, but can also be used in addition to assisted conception.

Ovulation is partly controlled by hormones called gonadotrophins. These are made in the pituitary gland (a gland just under the brain). A gonadotrophin is a hormone that stimulates the activity of the gonads (the ovaries in women, and the testes in men). The main gonadotrophins made by the pituitary gland are called follicle-stimulating hormone (FSH) and luteinising hormone (LH). These pass into the bloodstream and travel to the ovaries.

* Clomifene is a medicine that has been used to help with fertility for many years. It is taken as a tablet. It works by blocking a 'feedback' mechanism to the pituitary gland. This results in the pituitary making and releasing more gonadotrophin hormones than normal. The extra amount of gonadotrophin hormones released into the bloodstream stimulates the ovaries which may result in ovulation.
* Medicines that contain gonadotrophins are another type of treatment. These need to be injected and tend to be used when clomifene does not work, or prior to IUI and IVF to cause ovulation. Gonadotrophin medicines may also improve fertility in men with certain types of hormone problems that can affect sperm count.
* Medicines that contain gonadotrophin-releasing hormone are sometimes used. These stimulate the pituitary to release gonadotrophins (which in turn stimulate the ovaries).
* Metformin may be offered to women with polycystic ovary syndrome who have infertility and who have not responded to clomifene. Metformin is a medicine that is commonly used to treat some people with diabetes. Some studies have suggested that metformin may help to improve fertility in some women with polycystic ovary syndrome (PCOS), usually in addition to clomifene.

**Surgical treatments -** The situations where surgery may be an option include:

* **Fallopian tube problems** - Surgery to the fallopian tubes may help some women with infertility caused by fallopian tube problems. For example, if the fallopian tubes have been blocked or scarred from a previous disease, infection, or other problem. Some women who have had a 'tubal tie' (sterilisation) in the past for contraception may be able to have their fertility restored by tubal surgery. These days, most surgery to the fallopian tubes is done by 'keyhole' surgery.
* **Endometriosis** - Surgery may help to improve fertility in women with endometriosis.
* **Polycystic ovary syndrome** - A special operation on the ovaries may be suitable for some women with polycystic ovary syndrome. The procedure is sometimes called 'ovarian drilling' or 'ovarian diathermy'. Using keyhole surgery, a heat source (diathermy) is used to destroy some of the follicles (tiny cysts) that develop in the ovaries. It is usually done if other treatments for polycystic ovary syndrome haven't worked.
* **Fibroids** - For women with fibroids, sometimes surgery to remove the fibroid may be considered if there is no other explanation for the infertility.
* **A cause of male infertility** - One cause of infertility is due to sperm being blocked by an abnormality in the epididymis in the testis. This may be treated with surgery.

**Assisted conception**

**Intrauterine insemination (IUI)**

This is the process by which sperm is placed in the woman's uterus. It is done by using a fine plastic tube which is passed through the cervix into the uterus. Sperm are passed through the tube. It is a relatively straightforward procedure. It can be timed to coincide with ovulation (about half way through a monthly cycle) in women who are still ovulating. Fertility medicines may also be given beforehand, to maximize the chance of ovulation occurring. Women who have this procedure need to have healthy fallopian tubes to allow the egg to travel from the ovary into the uterus. If successful, fertilisation takes place within the uterus.  
The sperm used can be either from the male partner, or from a donor.

* The male partner's sperm can be used when the cause of the infertility is unexplained and the sperm seem fine, or for cases where the female cervical mucus seems to block or kill the sperm. Sperm is obtained by masturbation just prior to the IUI procedure.
* Donor sperm is obtained from a 'sperm bank' of frozen sperm provided by donors. It may be considered as an option when: the male partner has no or very few sperm; has had a vasectomy, and reversal has failed or not been tried; has an infectious disease such as HIV; there is a high risk of transmitting a genetic disorder to a baby.

If IUI does not work, couples tend to move on to try other methods described below.

**In vitro fertilisation (IVF)**

In vitro fertilisation means fertilisation outside of the body. In vitro literally means 'in glass' (that is, in a laboratory dish or test tube). IVF is mainly used in couples whose infertility is caused by blocked fallopian tubes, or unexplained infertility.  
IVF involves taking fertility medicines to stimulate the ovaries to make more eggs than usual. When the eggs have formed, a small operation is needed to get them ('egg retrieval'). Each egg is mixed with sperm which is obtained in the same way as for IUI (described above). The egg/sperm mixture is left for a few days in a laboratory dish (often referred to as a 'test tube'). The aim is for sperm to fertilise the eggs to form embryos.  
One or two embryos which have formed are then placed in the woman's uterus using a fine plastic tube passed through the cervix. Any other embryos which have formed in the dish are either discarded or, if you wish, frozen for further attempts at IVF at a later date (if the initial attempt fails to result in pregnancy). You may also be asked to consider donating any spare embryos to be used for research, or to be donated to other infertile couples.  
  
Your chance of success with IVF may be higher if:

* The female partner is under the age of 39.
* The female partner has been pregnant before.
* The female partner has a Body Mass Index (BMI) between 19 and 30 (that is, they are not underweight or overweight).

Other things that may reduce the chance of success of IVF include:

* For the woman, drinking more than 1 unit of alcohol per day or consuming a lot of caffeine.
* For both partners, smoking.

It is recommended that couples should be given the chance of three complete cycles of IVF in order to have a realistic chance of conceiving. Most Primary Care Trusts in the UK currently offer one cycle of IVF on the NHS.

**Gamete intrafallopian transfer (GIFT)**

A gamete is an egg or sperm. Eggs and sperm are collected in the same way as for IVF. The eggs are mixed with sperm. The mixture of eggs and sperm are then placed into one of the woman's fallopian tubes. Therefore, unlike IVF, the sperm fertilises the egg 'naturally' inside the woman's fallopian tube or uterus, and not outside the body in a laboratory dish. For this to work, the woman's fallopian tube needs to be healthy. GIFT has been used in cases of 'unexplained fertility' or male factor infertility problems. However, it does not seem to be any more effective than IVF and so is not so commonly used.

**Intracytoplasmic sperm injection (ICSI)**

This technique involves an individual sperm being injected directly into an egg. (It is injected into the cytoplasm - the outer part of the egg.) This method bypasses any natural barriers that may have been preventing fertilisation. For example, some cases of infertility are due to the sperm of a male partner not being able to 'penetrate' the outer part of the egg to fertilise the egg. ICSI can also be used when a male partner has a low sperm count as only one sperm is needed.  
If needed, a sperm can also be obtained by a small operation to the testis. This may be done when sperm cannot be produced in the usual way (for example, if the male partner has a blocked vas deferens, or has had a vasectomy).  
The egg containing the sperm is then placed in the uterus in the same way as with IVF. ICSI is used for couples who have failed to achieve fertilisation through IVF, or where the quality or number of sperm is too low for normal IVF to be likely to succeed.

**Egg donation**

This involves stimulating the ovaries of a female donor with fertility medicines, and collecting the eggs which form. The eggs are mixed with and fertilised by sperm of the recipient's partner (similar to IVF). After 2-3 days, embryos are placed in the uterus of the recipient via the cervix. This method is an option for: women who have ovarian failure and cannot produce eggs; who have had their ovaries removed; who have conditions where the ovaries do not work (for example, Turner's syndrome); where there is a high risk of transmitting a genetic disorder to the baby. It is also used in certain cases of IVF failure.

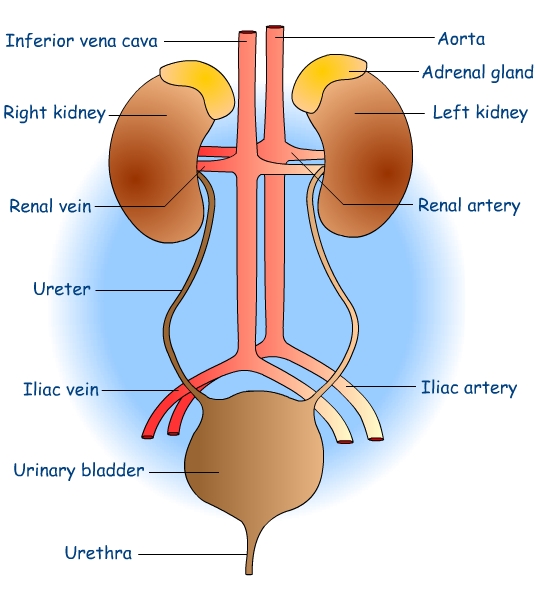
**Embryo donation**

Couples who have had successful IVF treatment may decide to donate any spare embryos to help other infertile couples.

|  |  |
| --- | --- |
| **Advantages of IVF treatments** | **Disadvantages of IVF treatments** |
| * It has allowed previously-infertile couples to have children. * It permits screening for the presence of genetic disorders — so avoiding starting a pregnancy if a disorder is found. * Frozen sperm can be used - allowing fatherhood for a man who is no longer able to provide fresh sperm. * Because a number of embryos are created, the extras can be frozen, stored, and used later.   If the initial attempt fails (the prospective mother must still receive hormones to prepare her uterus for implantation and the success rate is lower with thawed embryos). Where regulations permit, the extras can be used as a source of embryonic stem (ES) cells. | • Although improving, the success rate is still sufficiently low (~35%) that the process often has to be repeated.  • Because several morulas are usually transferred, multiple births are common, and as is the case with most multiple births, the babies are born early and weigh less. |

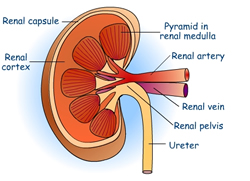
**Lifestyle choices:** those factors which are known to cause infertility need to be addressed in order to improve chances of a successful pregnancy.

**RENAL SYSTEM**



The chemical composition of body fluids is important for the well-being of the cells of the body. The circulatory system is mainly responsible for the physical transport of fluids but not for the composition of those fluids. This function is largely the responsibility of the kidneys. Although they help with various physiological functions, the kidneys' main roles are the removal of wastes and the maintenance of the body's water balance. The functions of the kidneys can be summarised as follows:  
1. Control of the body's water balance. The amount of water in the body must be balanced against the amount of water which we drink and the amount we lose in urine and sweat etc.  
2. Regulation of blood pressure.  
3. Regulation of blood electrolyte balance.  
4. Excretion of metabolic wastes such as urea, creatinine and foreign substances such as drugs and the chemicals we ingest with our food  
5. Help in the regulation of the body’s acid base balance  
6. Regulation of red blood cell production via the hormone erythropoietin.  
7. Help in the production of vitamin D

As this list shows, the renal system is very important to the normal functioning of the body.

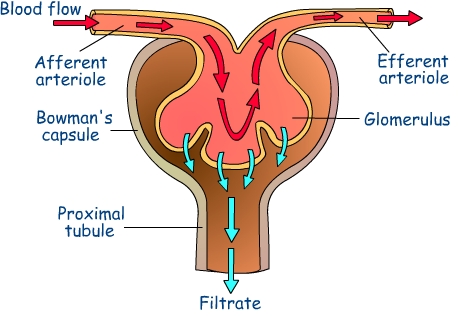
Urine is produced in the kidneys from water and wastes extracted from the blood. The rest of the urinary system is concerned with the storage and removal of the urine to the outside of the body

The kidneys are protected by a tough fibrous coat called the renal capsule. Under the capsule, the arrangement of nephrons and capillaries in the kidney produce the appearance of distinct regions when viewed in longitudinal section. The outer cortex region surrounds darker triangular structures called pyramids which collectively form the medulla. The inner part of the kidney, the renal pelvis, collects the urine draining from the nephron tubules and channels it into the ureter.

The basic functional unit of the kidney is the nephron. There are over one million nephrons in each human kidney and together they are responsible for the complex water regulation and waste elimination functions of the kidneys. The heads of the nephrons are in the cortical region and the tubular component then descends through the medulla and eventually drains into the renal pelvis.

Renal function

(1) Glomerular Filtration  
Blood enters the kidney via the **renal artery**. This separates many times eventually forming many **afferent arterioles**, each of which delivers blood to an individual kidney nephron.

The diameter of the afferent (incoming) arteriole is greater than the diameter of the efferent arteriole (by which blood leaves the glomerulus). The pressure of the blood inside the glomerulus is increased due to the difference in diameter of the incoming and out-going arterioles. This increased blood pressure helps to force the following components of the blood out of the glomerular capillaries:

* Most of the water;
* Most/all of the salts;
* Most/all of the glucose;
* Most/all of the urea.

Blood cells and plasma proteins are not filtered through the glomerular capillaries because they are relatively larger in physical size.

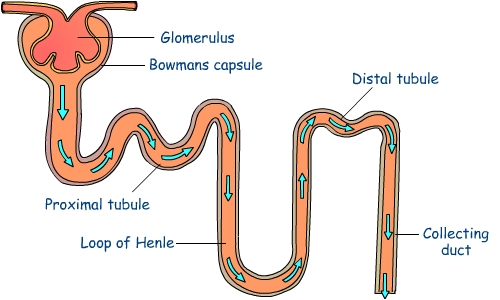
The water and salts that have been forced out of the glomerular capillaries pass into the Bowman's Capsule and are called the **glomerular filtrate**. The glomerular filtrate passes from the renal corpuscle to the renal tubule:

(2) Tubular Reabsorption

Only about 1% of the glomerular filtrate actually leaves the body because the rest (the other 99%) is reabsorbed into the blood while it passes through the renal tubules and ducts. This is called **tubular reabsorption** and occurs via three mechanisms. They are:

* **Osmosis**
* **Diffusion**, and
* **Active Transport**.

Reabsorption varies according to the body's needs, enabling the body to retain most of its nutrients. The processes of tubular reabsorption occur in the following order:

**In the PCT**  
Most of the volume of the filtrate solution is reabsorbed in the **proximal convoluted tubule (PCT)**. This includes some water and most/all of the glucose (except in the case of diabetics).  
As the concentration of Na+ in the filtrate solution is high (about the same as the concentration of Na+ in blood plasma), Na+ moves from the tubular fluid into the cells of the PCT. Other such substances that are reabsorbed with Na+ include: glucose, amino acids, lactic acid, and bicarbonate ions. These then move on through cells via diffusion.  
A short way to summarize the above is to say that solutes are selectively moved from the glomerular filtrate to the plasma by active transport. Following the movement of solutes (including Na+), **water** is then also reabsorbed by osmosis. About 80% of the filtrate volume is reabsorbed in this way.

**In the loop of Henle**

Descending Limb of Loop of Henle

The lining of the descending limb of Henle is *relatively permeable to water - but much much less permeable to the salts Na+ and Cl, and to urea*. Therefore water gradually moves from the descending limb as fluid flows through this part of the system of renal tubules.

Ascending Limb of Loop of Henle  
The ascending limb of Henle differs from the descending limb in that it is *impermeable to water (so the water that is inside the tubule at this stage generally remains inside it), but is highly permeable to Na+ and Cl-, and somewhat permeable to urea*. Therefore while the tubular fluid flows back towards the renal cortex, Na+ and Cl diffuse from the tubules. Some urea also enters the tubules at this stage

**In the DCT**  
The water, urea, and salts contained within the ascending limb of Henle eventually pass into the **distal convoluted tubule (DCT)**.

The DCT reacts to the amount of anti-diuretic hormone (ADH) in the blood:

* The more ADH is present in the blood, the more water is re-absorbed into it. This happens because the presence of ADH in the blood causes the cells in the last section of the DCT (and associated tubules and collecting ducts) to become more permeable to water, therefore they allow more water to pass from the tubular fluid back into the blood. This results in more concentrated urine.
* The opposite is also true, i.e. if the level of ADH in the blood is reduced then the cells in the latter sections of the DCT (and associated tubules and collecting ducts) becomes less permeable to water therefore less water is able to pass from the tubular fluid back into the blood - which results in less concentrated urine.

The amount of ADH in the blood may be affected by **conditions** such as diabetes insipidus, or by consumption of **diuretics**\* in the diet (\**substances that occur in some foods and drinks and can also be given as drugs for certain conditions*).

(3) Tubular Secretion

The third process by which the kidneys clean blood (regulating its composition and volume) is called **tubular secretion** and involves substances being added to the tubular fluid. This removes excessive quantities of certain dissolved substances from the body, and also maintains the blood at a normal healthy pH (approx. 7.5).

The substances that are secreted into the tubular fluid (for removal from the body) include:

* Potassium ions (K+),
* Hydrogen ions (H+),
* Ammonium ions (NH4+),
* creatinine,
* urea,
* some hormones, and
* some drugs (e.g. penicillin).

Tubular secretion occurs from the cells that line the renal tubules and collecting ducts.

It is the tubular secretion of H+ (hydrogen) and NH4+ (ammonia) from the blood into the tubular fluid (i.e. urine - which is then excreted from the body via the ureter, bladder, and urethra) that helps to keep blood pH at its normal level.   
The typical pH of urine is about 6.

**DYSFUNCTION – RENAL FAILURE**

**Causes:**

**Diabetes**: Kidney damage develops in about 20% of patients with both type 1, young onset, insulin-dependent diabetes and type 2, older onset, non-insulin dependent diabetes. Problems start after 10 to 15 years of diabetes. The glucose can damage the tiny filters in the kidneys, which affects the ability of the kidneys to filter out waste products and fluids.

**Infection:** Kidney infection (pyelonephritis) doesn't usually pose a serious threat to health if treated promptly, but if a kidney infection isn't treated it can get worse and cause permanent kidney damage. Often the symptoms come on quickly, within a few hours, and they can make the person feel feverish, shivery, sick and with a pain in their back or side. A kidney infection usually happens when bacteria, often a type called E. coli, accidentally gets into the urethra from the anus and then travels up through the bladder into one of the kidneys.

In most cases of kidney infection, only one kidney is affected.

**Raised blood pressure:** Hypertension causes damage by putting strain on the small blood vessels in the kidneys. This prevents the filtering process from working properly.

**Lifestyle:** long-term, regular use of medicines, such as non-steroidal anti-inflammatory drugs (NSAIDs), including aspirin and ibuprofen

**Auto-immune disease:** Lupus is an autoimmune condition, which means that it is caused by problems with the immune system (the body’s natural defence against illness and infection). In people with lupus, for reasons that are not clearly understood, the immune system starts to attack healthy cells, tissue and organs.

**Diagnostic techniques:**

**Urine dipsticks/urine analysis:** When functioning normally, glomerular filters are able to filter out wastes, but keep protein and red blood cells in the bloodstream. In many types of kidney disease, the tiny glomerular filters are damaged and this allows proteins and red blood cells (that are normally kept in the bloodstream) to spill into the urine, where they can then be detected. A urine dipstick is a small flat plastic stick containing a row of several chemically-treated paper squares which is dipped into a urine sample. The squares then turn different colours. By comparing the stick with a colour chart, staff can tell whether or not the urine contains various substances, such as protein, blood, glucose (suggesting diabetes), and white blood cells (suggesting infection).

**Blood tests:** blood tests for urea and creatinine are used to diagnose kidney disease. These two substances are normal waste products that are excreted by the kidneys. Urea is a by-product of protein breakdown, and creatinine is a by-product of normal muscle functioning. In kidney disease, these substances are not excreted normally, so they accumulate in the body. This causes an increase in blood levels of urea and creatinine, which can be easily detected on blood tests.

**Diagnostic imaging techniques:**

**Ultrasound** - This procedure is good for determining the size of the kidneys and for detecting cysts (round fluid-filled pockets that are common in older people and usually of no significance), solid masses that may be benign or malignant tumours, and kidney stones. Ultrasound can also help to estimate the amount of scarring in a kidney, and can detect whether there is a blockage to urine flow anywhere in the kidney, the ureters, or the bladder.

**IVP (intravenous pyelogram**) - this uses traditional x-rays to produce pictures of the kidneys, ureters, and bladder. A "contrast dye" is injected into a vein, circulates through the bloodstream, and is processed and excreted by the kidneys. This technique produces two-dimensional black-and-white images and can provide fairly-detailed information about the size and shape of the kidneys, as well as the presence of kidney stones and sometimes cysts or tumours. However, if kidney function is reduced, IVPs are not done, for two reasons: 1) the kidneys will not process the dye as well and will not show up well in the pictures; and 2) there is some risk of the dye's causing renal failure (temporary) in people who already have reduced kidney function to begin with. The contrast dye may also produce an allergic reaction in some people.

**CAT (Computed Axial Tomography) scan** - this uses x-rays to produce pictures in crosswise slices (as though the body was sliced like a loaf of bread). Like an ultrasound, a CAT scan can detect kidney stones, blockage, cysts, and solid masses. CAT scans are sometimes done using contrast dye, which (as with IVPs) carries the risk of inducing an allergic reaction and/or causing renal failure, especially in people who already have reduced kidney function.

**MRI (Magnetic Resonance Imaging) scan** – this scan exposes the body to a strong magnetic field and creates images based on the molecular composition of different organs and tissues. The amount of fine detail in the pictures is greater than with either the ultrasound or CAT scan. However, the procedure, since it involves exposing the patient to a strong magnetic field, cannot be used in those who have metal devices in their bodies (such as pacemakers or defibrillators). The procedure may also be somewhat difficult for patients to undergo, since the patient must lie still in a dark, enclosed tunnel and must not be upset by banging noises made by the machinery. MRI scans are sometimes done with a special type of dye (administered by IV) called gadolinium: this dye is not used in patients with moderately- to severely-reduced renal function because of a risk of adverse effects.

**Effects of Renal Failure on lifestyle and daily routine:**

|  |  |
| --- | --- |
| **Problems caused by illness** | **Effect on lifestyle/routine** |
| Reduced appetite, nausea/vomiting | Changes in eating habits, weight loss, mood swings |
| Generalised itching (pruritus) | Avoiding social situations (due to itching/state of skin)  Expense of prescription creams/tablets |
| Lethargy/weakness | Changes in sleeping patterns,  possible time off work,  changes in relationships  feelings of being useless/depression |
| Changes in diet (limit the following: water, salt, potassium and phosphorus. Foods with high phosphorus include milk, cheese, nuts, and cola drinks. Foods high in potassium include bananas, apricots, and salt substitutes. | Possible different diet to rest of family (added expense/time consuming). Impact on social life. |
| Taking medication to control symptoms | Expensive, have to deal with side effects |
| **Dialysis**   1. Access to the blood vessels needs to be surgically created so that large amounts of blood can flow into the machine and back to the body. (fistula) 2. time consuming treatment (2 – 3 times per week at least | Risks of infection, risks associated with anaesthetic/invasive procedures  Time off work/school/away from family (changes to relationships). Changes to social life. |

**TREATMENTS:**

*Kidney transplant and medication can be used but for the exam we are focussing on dialysis.*

**Dialysis -** Carried out if 85 – 90% of kidney function is lost.

Functions of dialysis:

* Removes waste
* Removes excess salts
* Prevents build-up of excess water in the body
* Maintains safe levels of potassium, sodium and bicarbonate in the blood
* Helps control blood pressure

There are 2 types of dialysis:

1. Haemodialysis (AKA artificial kidney)

Two tubes are inserted into blood vessels in the arm/leg. A pump passes the patient’s blood into the machine. Blood is kept at body temperature and has an anti-coagulant added to prevent it clotting in the machine. Inside the machine the blood flows between 2 membranes. On the other side of the membrane is DIALYSATE (fluid with the same composition as ‘clean’ blood so the urea and wastes pass from the patient’s bloodstream across the membrane into the dialysate.

1. Peritoneal dialysis

The blood is “cleaned” inside the body using the body’s natural filtering membrane (the peritoneum lining the abdominal cavity.) a catheter is inserted into the abdominal cavity and the cavity is slowly filled with dialysate. The waste products are drawn out of the patient’s bloodstream and into the dialysate by diffusion.

**Dialysis – problems + impact on lifestyle**

Both haemodialysis and peritoneal dialysis cause side effects. This is due to two main reasons:

* the way dialysis is carried out, and
* the fact that dialysis can only compensate for the loss of kidney function to a certain extent.

**Bleeding from the Access Point**

As dialysis is an invasive technique, the area surrounding the access point can be damaged and bleeding can occur.

**Hypotension**

Dialysis patients are at risk of a sudden drop in blood pressure (hypotension), due to the stress the cardiovascular system is under from regular hemodialysis. However this can be controlled by medication.

**Infections**

Dialysis patients are generally more susceptible to infection. The access point should be kept clean, and any sign of infection (redness, itching, or other problems) watched for. Peritonitis with its associated flu-like symptoms is also a possibility. Hence the importance of cleanliness and good general hygiene.

**Fatigue**

Fatigue is a common side effect in people who have used both haemodialysis and peritoneal dialysis on a long-term basis. It is thought that fatigue arises from a combination of factors such as:

* the loss of normal kidney function,
* the effects that dialysis can have of on the body,
* the dietary restrictions associated with dialysis, and
* the overall stress and anxiety that many people with kidney failure experience.

**Side effects of haemodialysis**

**Low blood pressure**

One of the most common side effects of haemodialysis is low blood pressure (hypotension). Low blood pressure can be caused by the drop in fluid levels that occurs during dialysis.

Low blood pressure can cause symptoms of:

* nausea, and
* dizziness.

The best way to help minimise the symptoms of low blood pressure is to ensure that you stick to your daily fluid intake recommendations. If symptoms of low blood pressure persist, you should  consult with your dialysis care team because the amount of fluid used during dialysis may need to be adjusted.

**Muscle cramps**

Some people experience muscle cramps, usually in the lower legs, during a haemodialysis session. It is thought that this is due to the muscles reacting to the fluid loss that occurs during haemodialysis.

If these muscle cramps become particularly troublesome, you should consult with your dialysis care team because medication may be available that can help you cope better with the symptoms.

**Itchy skin**

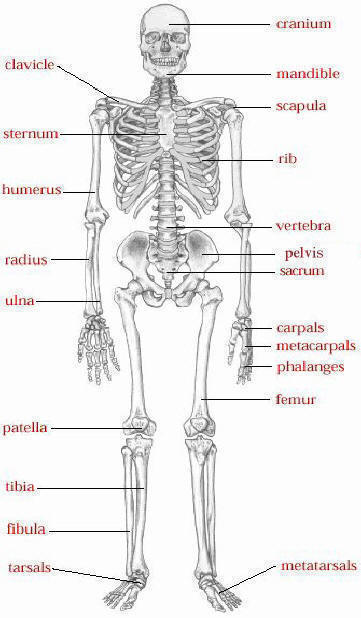
Many people receiving haemodialysis experience symptoms of itchy skin. It is though that this is due to a build-up of potassium in the body. Making sure that you avoid potassium-rich food can be an effective way of helping to reduce the frequency and severity of this symptom.

Some people have also found that using moisturising cream can help to minimise the discomfort caused by itching.

**MUSCULO-SKELETAL SYSTEM**

**Skeletal System -** functions of the skeletal system

The skeletal system has 5 functions which are; to provide a large surface area for our muscles to attach to, to protect delicate organs, to give shape to the body, to give support to the body and to manufacture red blood cells and to store fat, calcium and phosphate.



There are 206 bones in the adult human body which are divided into 2 groups; the axial skeleton which consists of the skull, thoracic girdle and the vertebral column, and then the appendicular skeleton which consists of the shoulder girdle and upper limbs and the pelvic girdle and lower limbs

Bone is the tissue that forms the skeleton in the human body; it is chiefly made up of calcium phosphate and calcium carbonate.

Cartilage is a firm, smooth, resilient non-vascular connective tissue.

A tendon connects muscle to bone. These tough, yet flexible, bands of fibrous tissue attach to the skeletal muscles that move your bones.

Ligaments are similar to tendons, but they connect bone to bone and help to stabilize joints. They are composed mostly of long, stringy collagen fibers creating short bands of tough fibrous connective tissue. Ligaments are slightly elastic, so they can be stretched to gradually lengthen increasing flexibility.

There are 4 different types of bone found in the human body which are long, short, flat and irregular.

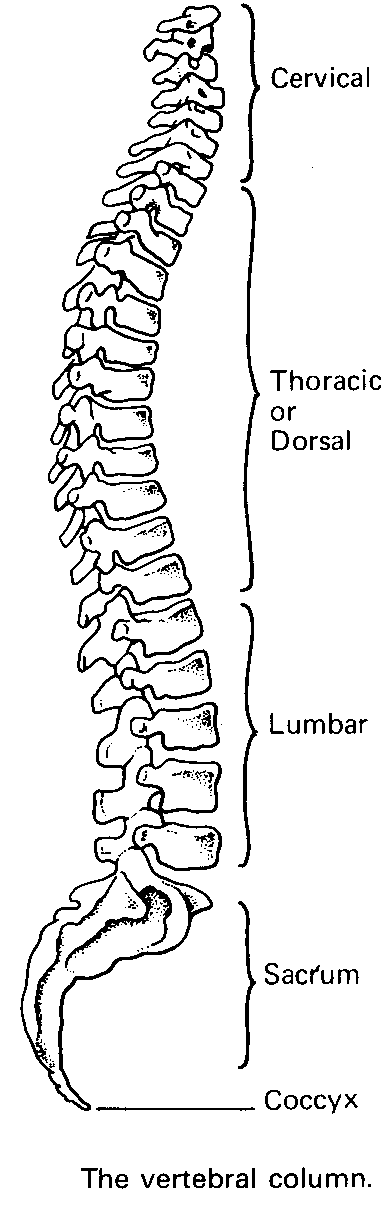
Long bones are a hollow cylindrical shaft formed of compact bone such as the tibia,

Short bones are small roughly cube-shaped bones consisting of entirely cancellous bone surrounded by a thin layer of compact bone such as the carpals,

Flat bones are smooth flattened and usually slightly curved bones such as the cranium, and

Irregular bones have no definite shape such as the vertebral column.

Vertebral column

The vertebral column consists of 24 articulating vertebrae and 9 fused vertebrae in the sacrum and coccyx. Its main function is to home and protect the spinal cord of which the body’s limbs move from.

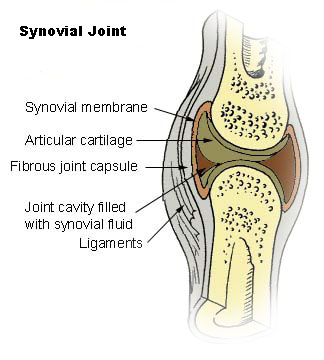
**JOINTS**

Joints are an area in the body where 2 or more bones come together Joints allow movement but they also stabilise areas of the body. There are 3 classifications of joints which are grouped dependent on their area of movement.

These joints are; fibrous which is a fixed joint that has no movement at all such as the sutures in the skull, cartilaginous which is a joint that allows slight movement, and then synovial which is a freely moving joint such as the knee.

Synovial Joints - have 4 main features; ligaments which connect bones to bones, synovial fluid which reduces friction in the joint, articular cartilage which absorbs shock and a joint capsule which strengthen the joint.

Types of synovial joints:

Ball and socket joints – e.g. hip and shoulder joints, are the most mobile type of joint in the human body. They allow movement in many different directions.

Ellipsoidal joints – e.g. the joint at the base of the index finger, allow bending and extending, rocking from side to side, but rotation is limited.

Gliding joints occur between the surfaces of two flat bones that are held together by ligaments. Some of the bones in the wrists and ankles move by gliding against each other.

Hinge joints - e.g. knee and elbow, enable movement similar to the opening and closing of a hinged door.

Pivot joint (in the neck) allows the head to be moved from side to side.

Saddle joints – the only one is in the thumbs. The bones in a saddle joint can rock back and forth and from side to side, but they have limited rotation.

**Muscular System**

The muscular system is made up of over 600 muscles; most of these muscles extend from one bone to another and are attached in at least two places across at least one joint. They are attached to the bone by tendons. Muscles only perform a pulling action, never a pushing movement.

**Functions of the muscular system**

**Movement -** is created through contractions in the muscles and is used for anything such as moving our legs to walk to moving our heart to make it beat.

**Shape -** the muscular system gives us shape, for example in our arms and legs and they are more obvious in people with bigger muscles.

**Protection -** muscles protect our abdominal organs and keep them in place as there is no bone to do this.

**Stability -** muscles stabilise our joints during movement to ensure that our bones do not come out of place.

**Posture -** when muscles have a good tone about them it enables us to maintain a good posture and without them we would not be able to keep our body upright.

**Circulation -** muscles also help with the circulation of our blood.

**Heat -** muscles also generate body heat when they contract which can help keep us warm.

**Types of muscle**

Muscles can be divided into three main types which is dependent on the way that they work these are voluntary muscles, involuntary muscles and cardiac muscles.

**Voluntary muscles** these are muscles that are under the control of the will and are generally attached to the skeleton, for example your biceps in your arms.

**Involuntary muscles** these are muscles that work without will and perform action on their own, such as the muscles in your eyelids that make you blink and the muscles that help you breathe.

**Cardiac muscles** these are involuntary muscles that contract and relax automatically and are only found in the heart.

**Muscle fibres**

*Fast twitch* fibres are a type of muscle fibre that produces a large force over a short period of time and have a low resistance to fatigue, *slow twitch* fibres however are a muscle fibre which produce a small force over a long period of time and have a high resistance to fatigue.

**How muscles work**

Muscles contract to cause movement by one bone being pulled towards another across a moveable joint. They work in pairs so when one pulls the other one has to lengthen to allow the movement to happen.

**Dysfunction: osteoporosis.**

**Causes of osteoporosis**

Bones are at their thickest and strongest in early adult life. From around the age of 35, more bone cells are lost than are replaced. This causes the bone to become thinner and weaker. People who exercise when they are young and who remain active into old age are less likely to get osteoporosis. This is because bones stay strong if they are used.

**Women**

Women are at greater risk of developing osteoporosis than men. This is due to the decrease in the hormone oestrogen after the menopause, which is essential for healthy bones. Women are at greater risk of developing osteoporosis when they have:

* an early menopause (before the age of 45),
* a hysterectomy before the age of 45, particularly when the ovaries are also removed, or
* when their periods are absent for a long time (more than six months) as a result of over-exercising or over-dieting.

The male hormone testosterone also helps to keep the bones healthy. Men continue to produce this hormone into old age, but the risk of osteoporosis is increased in individuals with low levels of testosterone.

**Diseases of the hormone-producing glands**

Diseases of the hormone-producing glands may cause osteoporosis. The female hormone oestrogen and male hormone testosterone play an important role in keeping bones strong, by processing minerals such as calcium. Osteoporosis can be triggered by hormone-related diseases, including:

* hyperthyroidism (overactive thyroid gland),
* disorders of the adrenal glands, such as Cushing's syndrome,
* reduced output of sex hormones (oestrogen and testosterone),
* disorders of the pituitary gland, and
* diabetes.

**Other factors**

Other factors that can increase the risk of osteoporosis include:

* a close family history of osteoporosis,
* long periods of inactivity, such as long-term bed rest,
* heavy drinking and smoking,
* malabsorbtion problems, as experienced in coeliac disease and Crohn's disease,
* long-term use of high-dose corticosteroid treatment (widely used for conditions such as arthritis and asthma), which can affect bone strength,
* long-term use of a medicine known as enoxaparin, which is used to prevent blood clots,
* inadequate amounts of calcium,
* low vitamin D levels, and
* very low body mass (for example being very underweight - having a BMI of 19 or less - or having thin bones as a result of an eating disorder).

**Diagnosing osteoporosis**

**DEXA scan**

A bone density scan, called a dual energy X-ray absorptiometry (DEXA) scan, measures the density of bones and compares this to a normal range. The difference between your bone density and this average is calculated and you are given what is called a ‘T score’. If your T score is between 0 and 1, you're considered to be within the normal range. If it is between -1 and -2.5, you will be diagnosed with osteopenia, which is the name for the category of bone density between normal and osteoporosis.

You will be classed as having osteoporosis if your T score is below -2.5.

This test helps to measure the strength of bones and the risk of fracture.

**Treating osteoporosis**

There are a number of different treatments available for osteoporosis.

**Hormone replacement therapy (HRT)**

HRT is used for women going through the menopause as it helps to maintain bone density and reduce fracture rates during the treatment. However, HRT is not always recommended as the first treatment for osteoporosis specifically, because it can slightly increase the risk of stroke, heart disease and breast cancer. You should discuss the benefits and risks of HRT with your GP.

**Testosterone treatment**

Testosterone treatment for men is useful in the relatively rare cases when osteoporosis is due to an insufficient production of male sex hormones.

**Bisphosphonates**

Bisphosphonates are non-hormonal drugs that maintain bone density and reduce fracture rates. The rate at which cells called osteoclasts break down bone is slowed, and the production of new bone increases. Strontium ranelate can be used as an alternative, if bisphosphonates are found not to be suitable. Your GP will advise you of the best course of treatment.

**Calcitonin**

Calcitonin is a hormone made by the thyroid gland. It inhibits the cells that break down bone.

**Calcium and vitamin D supplements**

Calcium and vitamin D supplements can be of benefit for older people, male and female, to reduce the risk of hip fracture. Having enough calcium in your diet when you are young is important in minimising the risk, especially for women. You should aim to eat or drink 700mg of calcium each day, which is roughly equivalent to one pint of milk (preferably semi-skimmed). If you are not getting enough calcium in your diet, ask your GP for advice about taking a calcium supplement. All people over the age of 65 should take a vitamin D supplement.

**Selective estrogen receptor modulators (SERMs)**

SERMs are drugs that have a similar effect on bone as the hormone oestrogen. They help to maintain bone density and reduce the risk of fracture, particularly at the spine.

**Impact on lifestyle**

|  |  |
| --- | --- |
| Pain if # bone | Changes to sleep pattern.  Time off work (money issues).  Changes to social life + relationships  Increased stress about condition  Difficulty carrying out ADLs – may need additional support |
| Have to exercise | Organise time so you can fit in exercise, possible increased pain/risk of injury |
| Increased risk of fractures | Stress/worry. Having to minimise risks of falls/fractures can lead to the risk of the disease “taking over your life” |
| Having to lose weight to be correct BMI | Stressful, expensive (joining club), etc. |
| Changes to diet   1. increase intake of calcium + Vit D (or take supplements) 2. low fat 3. not too high/too low protein | Expensive (buying supplements/paying for prescriptions)  Can have issues if intolerant to lactose  Too much calcium (+2500mg/day) can lead to risk of kidney stones  Possible different diet to rest of family (added expense/time consuming) |

**THE NERVOUS SYSTEM**

The nervous system is the body's information gatherer, storage center and control system. Its overall functions are to [collect information about the body's external/internal states](http://webschoolsolutions.com/patts/systems/nervous.htm#somatosensory#somatosensory) and transfer this information to the brain (*afferent system*), to analyze this information, and to send impulses out (*efferent system*) to initiate appropriate motor responses to meet the body's needs.

The system is composed of specialized cells, termed nerve cells (**neurons)** that communicate with each other and with other cells in the body.  A neuron has three [parts](http://www.newhorizons.org/blab_terms.html):

1. The *cell body*, containing the **nucleus**
2. *Dendrites,* hair-like structures surrounding the cell body, which conduct **incoming** signals.
3. The *axon* (or *nerve fibre*), varying in length from a millimeter to a meter, which conduct **outgoing** signals emitted by the neuron. Axons are encased in a fat-like sheath, called **myelin**, which acts like an insulator and, along with the **Nodes of Ranvier**, speeds impulse transmission.

Typically a given neuron is connected to many thousands of neurons. The specific point of contact between the axon of one cell and a dendrite of another is called a **synapse**. Messages passed to and from the brain take the form of electrical impulses, or [action potentials](http://faculty.washington.edu/chudler/ap.html), produced by a chemical change that progresses along the axon. At the synapse, the impulse causes the release of **neurotransmitters** and this, in turn, drives the impulse to the next neuron. These impulses travel very fast along these chain of neurons -- up to 250 miles per hour.

|  |  |
| --- | --- |
| Parts of a neuron |  |

Nerve cell bodies are generally located in groups. Within the brain and spinal cord, the collections of neurons are called **nuclei** and constitute the *gray matter*, so-called because of their colour. Outside the brain and spinal cord the groups are called **ganglia**. The remaining areas of the nervous system are tracts of axons, the *white matter*, so-called because of white myelin sheath. Tracts carrying information of a specific type, such as pain or vision, generally have specific names. 

Input (*afferent system*) to the nervous system is in the form of the five senses: touch/pain, vision, taste, smell, and hearing. Pain, temperature, and pressure are known as **somatic senses**.

The nerves of the body are organized into two major systems:

* the [**central nervous system**](http://gened.emc.maricopa.edu/bio/bio181/biobk/BioBookNERV.html#Central Nervous System) (CNS), consisting of the brain and spinal cord,
* the [**peripheral nervous system**](http://gened.emc.maricopa.edu/bio/bio181/biobk/BioBookNERV.html#Peripheral Nervous System) (PNS), the vast network of spinal and [cranial nerves](http://webschoolsolutions.com/patts/systems/nervous.htm#nerves#nerves) linking the body to the brain and spinal cord. The PNS is subdivided into:
  1. the [autonomic nervous system](http://gened.emc.maricopa.edu/bio/bio181/biobk/BioBookNERV.html#Autonomic Nervous System) (**involuntary control** of internal organs, [blood vessels](http://webschoolsolutions.com/patts/systems/heart.htm#vessels), [smooth and cardiac muscles](http://webschoolsolutions.com/patts/systems/muscles.htm)), consisting of the [sympathetic NS](http://gened.emc.maricopa.edu/bio/bio181/biobk/BioBookglossS.html#sympathetic system) and  [parasympathetic NS](http://gened.emc.maricopa.edu/bio/bio181/biobk/BioBookglossPQ.html#parasympathetic system)
  2. the [somatic nervous system](http://gened.emc.maricopa.edu/bio/bio181/biobk/BioBookNERV.html#Somatic Nervous System) (**voluntary control** of skin, [bones, joints](http://webschoolsolutions.com/patts/systems/skeleton.htm), and [skeletal muscle](http://webschoolsolutions.com/patts/systems/muscles.htm#musculoskeletal)).

The two systems function together, with nerves from the periphery entering and becoming part of the central nervous system. (See separate sheet)

**Reflexes**   
A reflex is an automatic (involuntary) response of the body to some stimulus, e.g. pupil dilation, to collect more light at night. Reflexes have afferent (signals **to** the CNS) and efferent (signals **from** the CNS) components and may involve one nerve/synapse or multiple synapses.  The simplest spinal reflex is the tendon reflex. When the tendon is tapped, the sensory receptor in the muscle sends a signal to the spinal cord (*afferent system*), where it enters through the dorsal/posterior root, then synapses with a sensory nerve axon in the ventral/anterior horn. From there, the receiving axon carries the impulse through the ventral/anterior root back to the muscle (e*fferent system*) whose tendon was tapped and the muscle jerks/ contracts.

**THE BRAIN**

**The** [**brain**](http://www.innerbody.com/text/nerv01.html) is typically divided into four parts:

1. The [**cerebrum**](http://webschoolsolutions.com/patts/systems/nervous.htm#Cerebrum#Cerebrum)
2. The [**cerebellum**](http://webschoolsolutions.com/patts/systems/nervous.htm#cerebellum#cerebellum)
3. The [**diencephalon**](http://webschoolsolutions.com/patts/systems/nervous.htm#Diencephalon#Diencephalon) (thalamus, hypothalamus, [sometimes classed as cerebral structures])
4. The [**brain stem**](http://webschoolsolutions.com/patts/systems/nervous.htm#stem#stem) (medulla oblongata, pons, midbrain), which is an extension of the spinal cord.

|  |  |
| --- | --- |
|  | [Major Brain Structures](http://www.abta.org/primer/brain.htm) |

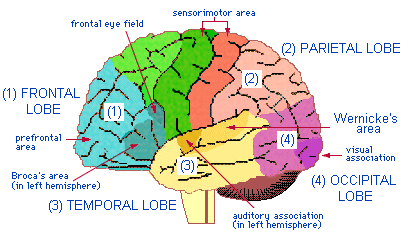
**Cerebrum**   
The largest division of the brain, the cerebrum, consists of two sides, the right and left **cerebral hemispheres**, which are interconnected by the **corpus callosum**. The two hemispheres are "twins," each with centers for receiving sensory (*afferent*) information and for initiating motor (*efferent*) responses. The **left** side sends and receives information to/from the **right** side of the body, and *vice versa*. Various intellectual functions are concentrated in either the [left or right hemispheres](http://www.innerbody.com/image/nerv04.html).

The hemispheres are covered by a thin layer of gray matter known as the **cerebral cortex**. The interior portion consists of white matter, tracts, and nuclei (gray matter) where synapses occur. Each hemisphere of the cerebral cortex is divided into [four "lobes"](http://faculty.washington.edu/chudler/lobe.html) by various *sulci* (grooves) and *gyri (*the "bumps") on the brain's surface.

The four lobes [perform specific functions](http://www.innerbody.com/image/nerv03.html):

1. [Frontal](http://www.waiting.com/brainanatomy.html#anchor2587568) - controls *fine* movements (Betz cells)/ *upper motor neuron*) and smell. Also, centre for abstract thinking, judgment, and **language** (**left hemisphere**)
2. [Parietal](http://www.waiting.com/brainanatomy.html#anchor2703258) - coordinates afferent information dealing with pain, temperature, form, shape, texture, pressure, and position. Some memory functions are also found here.
3. [Temporal](http://www.waiting.com/brainanatomy.html#anchor2729415) - handles dreams, memory, and emotions. Center for auditory function.
4. [Occipital](http://www.waiting.com/brainanatomy.html#anchor2684498) -  governs vision

In addition to the four lobes, there are **basal ganglia** (also called the *extrapyramidal system)* control postural adjustment and **gross** voluntary movements.  The basal ganglia receive afferent input from the cerebral cortex and [thalamus](http://webschoolsolutions.com/patts/systems/nervous.htm#Diencephalon#Diencephalon). Their axons synapse in the [brain stem](http://webschoolsolutions.com/patts/systems/nervous.htm#stem#stem) and the [spinal cord](http://webschoolsolutions.com/patts/systems/nervous.htm#cord#cord).



The [**cerebellum**](http://www.waiting.com/brainanatomy.html#anchor2672516), has an outer cortex of gray matter and two hemispheres. It receives/relays information via the [brain stem](http://webschoolsolutions.com/patts/systems/nervous.htm#stem#stem). The cerebellum performs 3 major functions, all of which have to do with skeletal-muscle control:

**Functions:**

* Balance/ Equilibrium of the trunk
* Muscle tension, [spinal nerve reflexes](http://gened.emc.maricopa.edu/bio/bio181/biobk/BioBookglossR.html#reflex), posture and balance of the limbs
* Fine motor control, eye movement. (Incoming information is transferred from the cerebral cortex via the [pons](http://webschoolsolutions.com/patts/systems/nervous.htm#stem#stem). Outgoing information goes back to the cortex via the [thalamus](http://webschoolsolutions.com/patts/systems/nervous.htm#Diencephalon#Diencephalon).)

**The Diencephalon** is located between the cerebrum and the [midbrain](http://www.waiting.com/brainstem.html#anchor558967) and contains 2 important structures:

* **Thalamus:** Receives/relays sensory information to/from the cerebral cortex, including pain/pleasure centers.
* **Hypothalamus:** a collection of ganglia located below the thalamus and intimately associated with the pituitary gland. It has a variety of functions: senses changes in body temperature; controls [autonomic activities](http://gened.emc.maricopa.edu/bio/bio181/biobk/BioBookNERV.html#Autonomic Nervous System) (so is the regulator of the sympathetic and parasympathetic nervous systems); links to the [endocrine system](http://gened.emc.maricopa.edu/bio/bio181/biobk/BioBookENDOCR.html)/controls the [pituitary gland](http://www.innerbody.com/image/endo01.html); regulates appetite; functions as part of the arousal or alerting mechanism; and links the mind (emotions) to the body -- sometimes, unfortunately, to the degree of producing "psychosomatic disease."

**Brain Stem**   
The [**medulla oblongata**](http://www.waiting.com/brainstem.html#anchor543500), [**pons**](http://www.waiting.com/brainstem.html#anchor561399), and [**midbrain**](http://www.waiting.com/brainstem.html#anchor558967) often referred to collectively as the *brain stem* -- control the most basic life functions.

**Functions:**

* Breathing/respiration (pons, medulla)
* Heart rate/ action (medulla)
* Blood pressure (vasoconstriction)/ blood vessel diameter (medulla)
* Reflex centers for pupillary reflexes and eye movements (midbrain, pons); and for vomiting, coughing, sneezing, swallowing, and hiccuping (medulla).

**DISORDER - Multiple Sclerosis**

Multiple Sclerosis (MS) is an inflammatory disease of the Central Nervous System (CNS). Predominantly, it is a disease of the "white matter" tissue. The white matter is made up of nerve fibres which are responsible for transmitting communication signals both internally within the CNS and between the CNS and the nerves supplying rest of the body.

In people affected by MS, patches of damage called plaques or lesions appear in seemingly random areas of the CNS white matter. At the site of a lesion, a nerve insulating material, called myelin, is lost. MS is very unpredictable and variable - depending on which areas of the CNS are affected and how badly they are damaged, the type and severity of symptoms can vary greatly. The different courses of the disease differ in their timing, location and severity, but are usually a slowly progressing disease. Underneath similar processes (including demyelination and sometimes other forms of nerve degeneration) are going on.

In general, people with MS can experience partial or complete loss of any function that is controlled by, or passes through, the brain or spinal cord.

**Effects of MS on lifestyle and daily routine:**

|  |  |
| --- | --- |
| **Problems caused by illness** | **Effect on lifestyle/routine** |
| extreme fatigue, lack of coordination, weakness, tingling, impaired sensation, vision problems | Changes to daily routine, changes to sleep pattern, may need additional help with ADL’s. Mood swings – changes to relationships. Time off work/school. May need help caring for other family members e.g. children |
| bladder problems | Embarrassment if incontinent.  Kidney problems if person restricts fluid intake.  Expense of buying new clothing (easy to remove so quicker to get to toilet). Expense of buying incontinence aids |
| cognitive impairment | Embarrassment (of losing memory). May need help to cope with ADL’s. time off work/school |
| Relapses and remissions | Time off work/school. Changes to pay can cause money problems at home. |
| Shock, anger, anxiety, sadness, | Changes to relationships, avoid social situations, time off work/school |
| Drug treatments | Cope with side effects, expensive to pay for prescriptions |

**DIAGNOSIS**

Diagnosing MS is complicated because no single laboratory test can positively diagnose it as several conditions have symptoms that are similar to those of MS.

**Neurological examination**

The neurologist will look for changes or weakness in eye movements, leg or hand co-ordination, balance, speech and reflexes. This will show whether any of the nerve pathways are damaged.

**Blood tests**

Blood tests are usually performed to rule out other causes of your symptoms, such as vitamin deficiencies.

**MRI scan**

A magnetic resonance imaging (MRI) scan creates a detailed image of the brain and spinal cord. The procedure is painless and usually takes between 10 and 30 minutes. MRI scans can show whether there is any damage or scarring of the myelin in the central nervous system. Over 90% of people with MS are diagnosed using an MRI scan.

**Evoked potentials test**

An evoked potentials test involves placing small electrodes on the head. These monitor how the brain waves respond to what the person sees and hears. It is painless and can show whether it takes the brain longer than normal to receive messages.

**Lumbar puncture**

A sample of cerebrospinal fluid (the fluid that surrounds the brain and spinal cord) is taken using a needle inserted into the area around the spinal cord. This is done under local anaesthetic, so area that the needle goes into will be numbed. The sample is tested for antibodies, the presence of which means that the immune system has been fighting a disease in the central nervous system. A lumbar puncture is usually only needed if other tests for MS are inconclusive, or for a diagnosis of primary progressive MS.

**TREATMENT**

There is no cure for multiple sclerosis (MS).

**Drug treatment** for MS can be split into three main categories:

* treatment for relapses of MS symptoms

**Steroids** are sometimes given for a few days; they can either be administered orally by tablet or as a solution into a vein (intravenously). While there is no evidence that steroids make any difference to the long-term course of the condition, they can be effective at speeding up recovery from relapse.

* treatment for specific MS symptoms, and

Drugs are available to treat some specific symptoms of MS. Symptoms where drug therapies are often used include: bladder problems, spasms, spasticity and pain.

e.g. pain: The management of pain in multiple sclerosis is not always easy and may not be completely successful. The body can adapt to tolerate a certain level of day-to-day pain and the person with MS may not recognise the pain as a symptom after a while. Treatment depends largely on the cause of the pain and so a proper assessment in necessary to determine whether the pain is nerve pain, muscle pain or might be due to causes other than MS. The aim of treatment if the pain cannot be eradicated is to manage the level of pain so that the individual can carry out normal day-to-day living; therefore it is important to be open to a range of possible treatment options, which may include drugs or non-drug treatments such as physiotherapy.

* treatment to slow the progression of MS (disease-modifying medicines)

Several different disease modifying drugs are available including:

**Beta interferon** - Interferon are proteins produced naturally in the human body, and help fight viral infections in the immune system. It’s thought that beta interferon can reduce (and might prevent) inflammation which can damage nerve fibres in MS. Clinical trials have shown the drugs reduce the number of relapses by around a third over two years (compared to what would be expected if no treatment was taken). They also noted that relapses could be less severe for those taking the drugs.

**Physiotherapy** can also be valuable for other MS symptoms such as: stiffness, balance, spasticity and spasms as well as pain.

**Stem cells** will probably never be used to grow whole organs, but they may be able to repair patches of damage, and this is the reason for researching their use in MS. Three possible ways have been suggested. Stem cells might be persuaded to:

* Develop into nerve cells to repair damage to the brain
* Develop into cells to repair damage to [myelin](http://www.mstrust.org.uk/atoz/myelin.jsp)
* Boost the immune system to prevent damage

This could be achieved by encouraging stem cells already resident in the body to develop into, for example, dendrocytes. Alternatively, cells could be transplanted that would go on to differentiate into a therapeutic cell type. Stem cells are found in large numbers in embryos and also in umbilical cord blood. Stem cells are found in smaller numbers in adults and may be more limited in their potential to develop into different cell types.

**Lifestyle changes.**

No specific diet has been proven to be beneficial for people with MS. Poor diet and nutrition can also worsen existing symptoms such as fatigue and weakness.

Exercise improves both general physical and emotional health as well as improving fitness. It releases good chemicals and makes us feel more in tune with our bodies and elevates mood. Research has shown specific benefits of exercise for people with MS including reduced fatigue levels and improved strength, mobility and bowel and bladder function.

People with MS remain at risk from the same health concerns as the general population. For this reason it is important to recognise changes in your health and not just assume that all changes are MS related

You need to recognize that a number of lifestyle choices and environmental conditions will affect the body systems either positively and/or negatively. For testing purposes these will be limited to:

 diet;

 smoking;

 alcohol;

 exercise;

 air pollution.

**GENERAL TESTING PROCEDURES**

**X-RAY**

X-rays are able to penetrate through non-metallic materials. This property makes it possible to use X-ray equipment to create an image of the human body that allows a physician to get a look at what is happening inside without the need for an invasive procedure. The process involves creating a concentrated beam of electrons and smashing them into a metal film. The result of that crash between the metallic film and the highly charged electrons is a concentration of high-energy electromagnetic radiation. This radiation is what is normally termed X-rays.

Along with the sheet of metallic film, a second sheet serves as a filter that prevents the beam from scattering or making the image produced by the action foggy or otherwise difficult to view. As the image appears, the portions of the body that contain certain elements, such as calcium-enriched bones, will appear outlined. Other mineral deposits help to identify the presence of growths such as tumours, and other irregularities can be seen, such as breaks in the bones or foreign objects in the body, like knife blades or bullets. In some instances, the patient may ingest what is known as a contrast agent, such as barium or iodine. This helps to make the presence of blood vessels and organs appear more prominently on the X-ray.

X-ray technology is not without some degree of risks. High levels of exposure to radiation in a short period of time can produce a variety of health problems, but occasional exposure to X-rays during an annual check-up or at the dentist are not likely to result in any type of permanent damage. However, X-rays are not recommended for pregnant women in most cases.

X-rays will tend to pass through materials made from lighter atoms with relatively few electrons (such as skin, built from carbon-based molecules), but they're stopped in their tracks by heavier atoms with lots of electrons. Lead is particularly good at stopping X rays. (That's why X-ray technicians in hospitals wear lead aprons and stand behind lead screens.)

**Watch: http://video.about.com/orthopedics/How-Does-an-X-Ray-Work--.htm**

**MAGNETIC RESONANCE IMAGING (MRI)**

Magnetic resonance imaging is a type of scan used to diagnose health conditions that affect organs, tissue and bone. MRI scanners use strong magnetic fields and radio waves to produce detailed images of the inside of the body. An MRI scanner is a large tube that contains a series of powerful magnets. You lie inside the tube during the scan. An MRI scan is a painless and harmless procedure, but some people experience a slight sense of claustrophobia (fear of enclosed spaces) when they are inside the scanner.

An MRI scan can be used to investigate almost any part of the body including the:

* brain and spinal cord
* bones and joints
* breasts
* heart and blood vessels
* internal organs, such as the lungs and liver

The MRI scanner is controlled by a computer which is in a different room from the scanner. This is to keep it away from the magnetic field generated by the scanner. A radiographer will operate the computer. At certain times during the MRI scan, the scanner will make a loud clicking sound. This is the magnets being turned on and off. It is very important that you keep still during your MRI scan. The scan will last between 15 and 90 minutes, depending on the size of the area being scanned and how many images are taken. Unlike X-rays, MRI scans do not involve exposing the body to radiation. This means that people who may be vulnerable to the effects of radiation, such as pregnant women and babies, can safely use them.

**Who can’t have an MRI?**

The strong magnets that are used during MRI can interfere with certain medical devices that are implanted in the body. Therefore, an MRI scan may not be recommended if you have:

* **a pacemaker**: an electrical device that is used to control an irregular heartbeat
* **an implantable cardioverter-defibrillator (ICD)**:a similar device to a pacemaker that uses electrical shocks to regulate heartbeats
* **a nerve stimulator**: an electrical implant that is used to treat long-term nerve pain
* **a cochlea implant**: a device that is similar to a hearing aid but is surgically implanted inside the ear
* **a drug pump**: used to treat long-term pain by delivering painkilling medication directly to an area of the body such as the lower back
* **brain aneurysm clips**: small metal clips that are used to seal blood vessels in the brain that would otherwise be at risk of rupturing (bursting)
* **metallic fragments** in or near your eyes or blood vessels
* **prosthetic (artificial) metal heart valves**
* **eye implants**: such as small metal clips that are used to hold the retina in place

You must tell the radiographer if you have an intrauterine device (IUD) fitted, although it is not likely to prevent you having an MRI scan. (An IUD is a contraceptive device made of plastic or copper that fits inside the womb).

If you're unsure whether or not you have metal fragments in your body, for example, from metalwork or welding, you will need to have an X-ray to confirm whether this is the case.

**Tattoos -** Some tattoo ink contains traces of metal, but most tattoos are safe in an MRI scanner. Tell the radiographer immediately if you feel any discomfort or heat to your tattoo.

**Pregnancy -** There is no evidence to suggest that MRI scans pose a risk during pregnancy. However, as a precaution, scanning is not usually recommended during the first three months of pregnancy

MRI is usually suitable for people with:

* **artificial joints**, such as those who have had a hip replacement or knee replacement
* **dental fillings and bridges**
* **tubal ligation clips**, which are used in female sterilisation (an operation that permanently prevents a woman from being able to get pregnant)
* **surgical clips or staples**

Extensive research has been carried out into whether the magnetic fields and radio waves used during MRI scans could pose a risk to the human body. No evidence to suggest that there is a risk has been found, which means that MRI is one of the safest medical procedures currently available.

**BLOOD TESTS**

Blood tests are a very useful diagnostic tool. Blood is made up of several different kinds of cells and other compounds, including various salts and certain proteins. The liquid portion of the blood is called plasma. When blood clots outside the body, the blood cells and some of the proteins become solid. The remaining liquid is called serum, which can be used in chemical tests and in tests to find out how the immune system fights diseases. Doctors can take blood samples and grow the infectious organisms that cause an illness to see exactly what they are through a microscope.

Blood samples for testing can be taken either from a vein (which carries blood to the heart) or from an artery (which takes blood away from the heart). If only a few drops of blood are needed (for monitoring blood sugar in diabetes, for example) it is enough to make a small prick in the tip of the finger and then squeeze the blood out.

Blood contains two main elements: the fluid that is called plasma and cells. There are three kinds of cells: red blood cells, white blood cells and platelets. To get the information they need from the blood, doctors actually do several tests with the blood sample. These include measurements of the levels of the cells and a blood smear. A blood smear is a film of blood placed on a slide to allow doctors to look at the individual cells under a microscope.

***Red blood cells***

One of the most important red blood cell tests is used to find out how much haemoglobin there is in the blood. Haemoglobin carries oxygen around your body. This is called the haemoglobin concentration or level. Another important test, the mean corpuscular volume or MCV test, measures the size of the red blood cells. If a person suffers from anaemia their haemoglobin level will always be less than normal. But the size of the red blood cells depends on the type of anaemia you have. Doctors also add stains to the blood smear to test the blood for parasites, for example in the case of sleeping sickness or malaria. They may also test for bacteria in the case of blood poisoning.

***White blood cells (WBC)***

The doctor counts the total number of white blood cells and works out how many different types of white blood cells the patient has. This is called the differential WBC count. The number of white blood cells may go up and this may be because of a bacterial infection, bleeding or a burn. More rarely the cause of a raised white count is due to leukaemia, cancer or malaria. A person may lose white blood cells because they have autoimmune problems. Other reasons for loss of white blood cells include viral infections. More rarely, this can be a side effect of certain kinds of medication. Doctors keep an eye on white blood cells to work out how a disease is changing.

***Platelets***

Platelets are very small cells in the blood that clump together at sites of injury to blood vessels. They form the basis of the blood clot that would form if you cut yourself. Low numbers of platelets can make a person vulnerable to bleeding, sometimes even without injury occurring. Causes of low platelet counts include autoimmune diseases where you produce an antibody to your own platelets, chemotherapy, leukaemia, viral infections and some medicines.

High numbers of platelets make a person more vulnerable to blood clots. High platelet counts are found in conditions involving the bone marrow such as leukaemia and cancer.

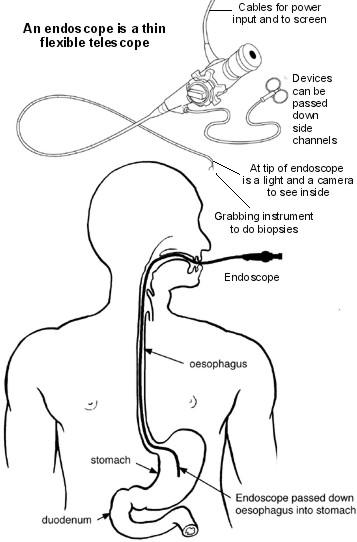
**BIOPSY**

A biopsy is the removal of a sample of tissue from the body for examination. A tissue sample can be taken from almost anywhere on, or in, your body. Biopsies are used to identify abnormal cells and to help diagnose many different health conditions or to find out a specific type or cause of a disease. In cases where a condition has been diagnosed, a biopsy can be used to measure how severe it is or what stage it's at.

The tissue will be examined under a microscope to assist in diagnosis. Therefore, only very small samples are needed. Sometimes, it's enough just to scrape over an area. This is the case with smear examinations of the cervix (neck of the womb). During examination of the large intestine, a biopsy can be taken with forceps through a tube known as an endoscope. In other cases, for instance, a liver or kidney biopsy, the biopsy is taken using a large hypodermic needle.

**ENDOSCOPY**

An endoscopy is a procedure where the inside of your body is examined internally using an endoscope. An endoscope is a thin, long, flexible tube that has a light source and a video camera at one end. The endoscope also has a 'side channel' down which various instruments can pass. These can be manipulated by the operator. For example, the operator may take a small sample (biopsy). Images of the inside of your body are relayed to an external television screen.

Endoscopes can be inserted into the body through a natural opening, such as through your nose, throat or anus. Alternatively, it can be inserted through a small surgical incision (cut) that is made in the skin. Endoscopies are used mainly to help diagnose health conditions, some specially adapted endoscopes known as gastroscopies can be used to treat certain conditions, such as bleeding stomach ulcers. An endoscopy is usually carried out while a person is awake. Before the procedure, a sedative may be given to help the patient relax.

1. [↑](#footnote-ref-1)