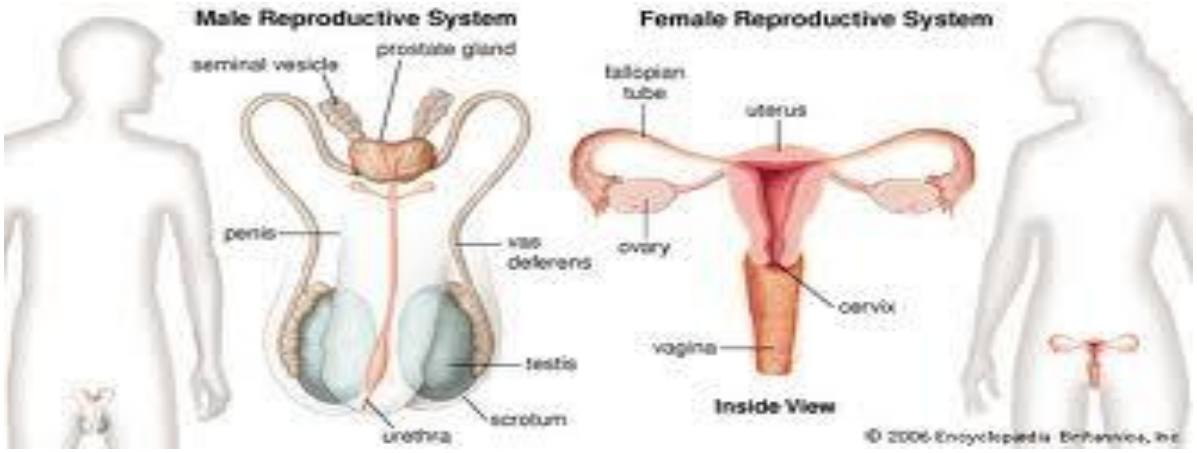
- Male and Female Reproductive Systems



Gametes are produced by germline cells in the ovaries and testes. Testes produce sperm in the seminiferous tubules and testosterone in the interstitial cells. Testosterone also stimulates sperm production and activates the prostate gland and seminal vesicles.

➔ **What are the functions of the fluids secreted by the seminal vesicles and prostate gland?**

The ovaries contain ova - each ovum is surrounded by a follicle that protects the developing ovum and secretes hormones. Mature ova are released into the oviduct where they may be fertilised by sperm to form a zygote.

➔ **Give the functions of FSH, LH and ICSH.**

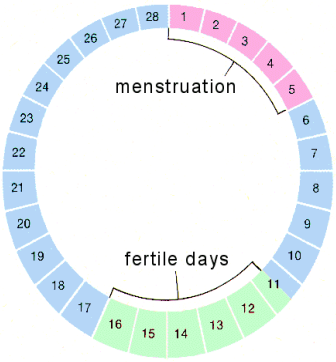
To regulate male hormone production, negative feedback is used. Increasing concentrations of testosterone inhibits the production of FSH and ICSH. The pituitary gland therefore produces less FSH and ICSH.

➔ **What effect will this have on testosterone production?**

- The Menstrual Cycle

The menstrual cycle lasts for approximately 28 days with the first day of menstruation regarded as day one of the cycle. FSH stimulates the development of a follicle and the production of oestrogen by the follicle in the follicular phase.

➔ **What is the function of oestrogen?**



Menstrual cycle of 28 days

Peak levels of oestrogen stimulate a surge in the secretion of LH which triggers ovulation. In the luteal phase the follicle develops into a corpus luteum and secretes progesterone. Progesterone promotes further development and vascularisation of the endometrium preparing it to receive a blastocyst if fertilisation occurs.

Increasing concentrations of female hormones inhibits the production of FSH and LH which prevents further follicles from developing. The lack of LH leads to degeneration of the corpus luteum with a subsequent drop in progesterone levels leading to menstruation.

➔ **Describe in detail the follicular phase and the luteal phase of the menstrual cycle.**

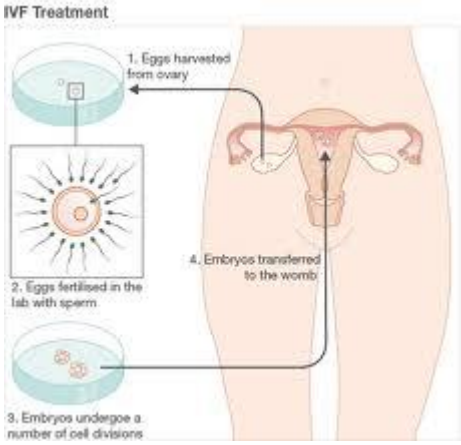
- Fertility and Contraception

Females have cyclical fertility leading to a fertile period. Males have continuous fertility. To achieve fertilisation, it can be useful to calculate fertile periods.

➔ **Describe the changes in the female body that occur during ovulation.**

Ovulation can be stimulated by drugs that prevent the negative feedback effect of oestrogen on FSH secretion. Others mimic the action of FSH and LH. These drugs can cause super ovulation that can result in multiple births or be used to collect ova for *in vitro* fertilisation (IVF).

Artificial insemination is particularly useful where the male has a low sperm count. Several samples of semen are collected over a period of time. If a partner is sterile a donor may be used
If mature sperm are defective or very low in number ICSI can be used. In this technique the head of the sperm is drawn into a needle and injected directly into the egg to achieve fertilisation.



In IVf, eggs are surgically removed from ovaries after hormone stimulation. The eggs are then mixed with sperm in a culture dish. The fertilised eggs are incubated until they have formed at least 8 cells and are then transferred to the uterus for implantation. Pre-implantation genetic screening (PGS) can be used at this stage to identify genetic disorders and chromosome abnormalities or to confirm a hereditary condition (PGD).

Some contraceptives are physical methods, whereas others are chemical contraceptives. Contraceptive pills are based on combinations of synthetic hormones that mimic negative feedback preventing the release of FSH/LH, prevent implantation ('morning after pills') or cause thickening of cervical mucus ('mini pill' or progesterone only pill).

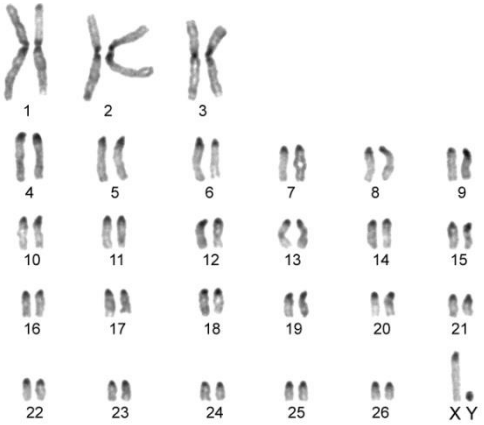
➔ **Summarise all of the physical methods of contraception.**

➔ **What are the key differences between the combined pill and the progesterone only pill (mini pill)?**

- Antenatal screening

Antenatal screening identifies the risk of a disorder so that further tests and a prenatal diagnosis can be offered. These can be picked up through ultrasound, biochemical tests, urine and blood tests, amniocentesis and chorionic villus sampling.

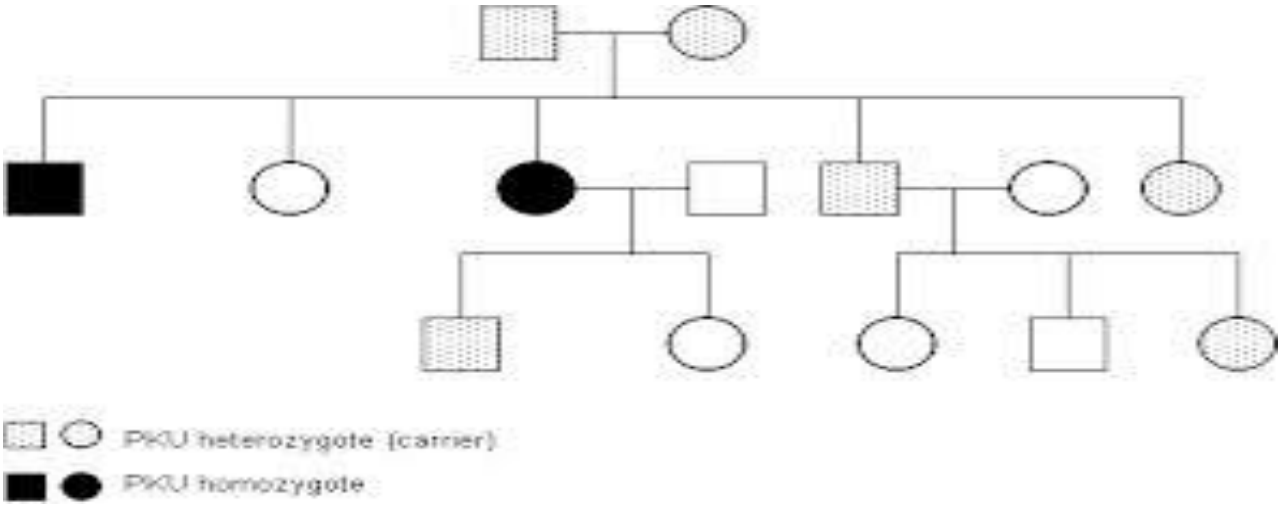
➔ **From the abstracts on antenatal screening, highlight all the key terms of the procedures and what they can test for.**



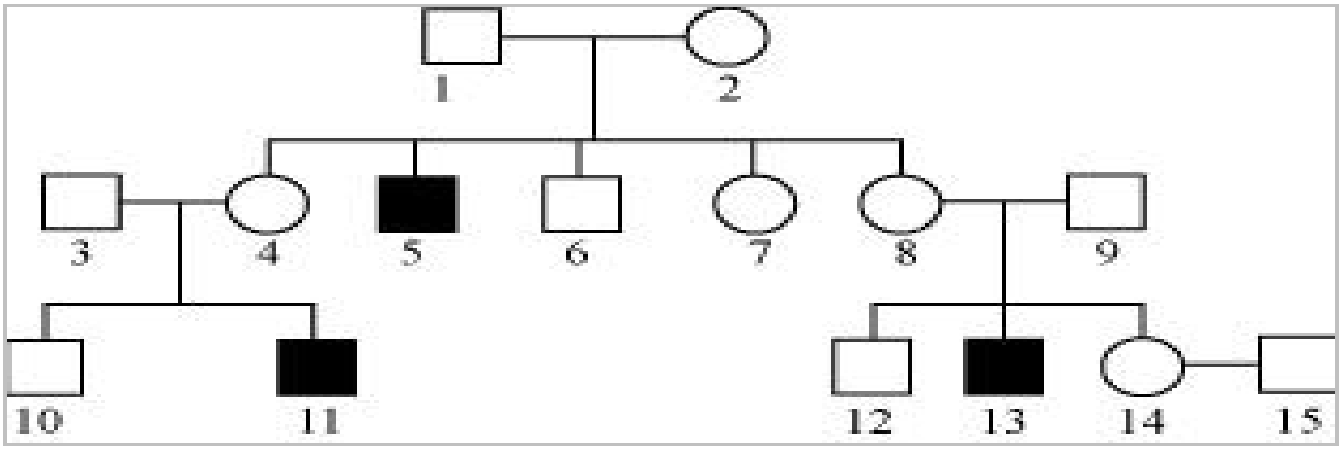
A common post natal screening test is for phenylketonuria (PKU), an inborn error of metabolism. A simple blood test can pick up PKU - individuals with high levels of phenylalanine are placed on a restricted diet. PKU is a metabolic pathway disorder.

➔ **Think back to Unit 1. Describe how such a disorder would arise through a mutation.**

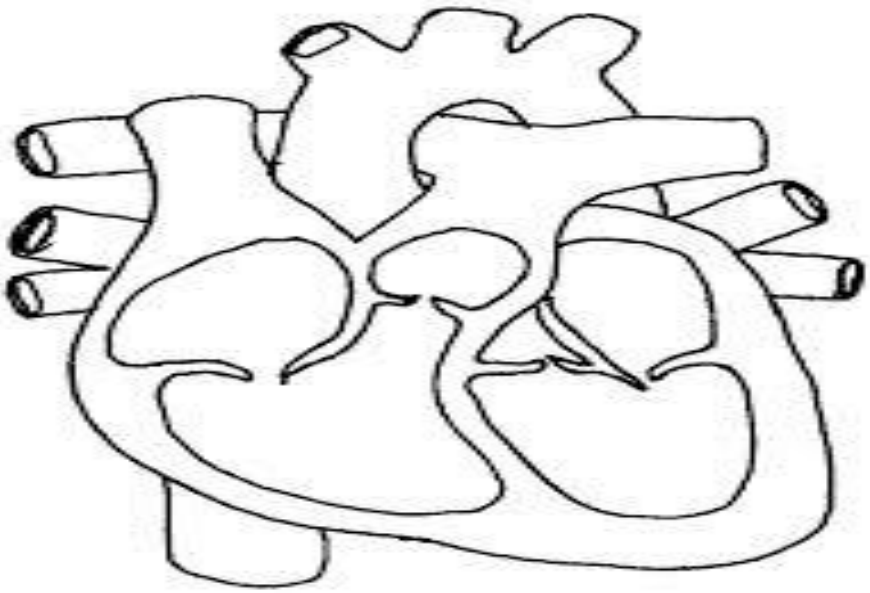
- Autosomal and Sex Linked Inheritance



➔ **From the pedigree chart above, try to write down genotypes of as many offspring as you can. Is this an autosomal or sex linked pattern of inheritance? Try the one below too. Which type of inheritance does it show?**



- The Heart



➔ **Label as much of the diagram as you can.**

The left and right ventricles pump the same volume of blood through the aorta and pulmonary artery. The volume of blood pumped through each ventricle per minute is the cardiac output. Cardiac output is determined by heart rate and stroke volume (CO = HR x SV).

During diastole blood returning to the atria flows into the ventricles. Atrial systole transfers the remainder of the blood through the atrioventricular (AV) valves to the ventricles. Ventricular systole closes the AV valves and pumps the blood out through the semi lunar (SL) valves to the aorta and pulmonary artery. In diastole the higher pressure in the arteries closes the SL valves. The opening and closing of the AV and SL valves are responsible for the heart sounds heard with a stethoscope.

The heart beat originates in the heart itself but is regulated by both nervous and hormonal control. The autorhythmic cells of the sinoatrial node (SAN) or pacemaker set the rate at which cardiac muscle cells contract. The timing of cardiac cells contracting is controlled by the impulse from the SAN spreading through the atria and then travelling to the atrioventricular node (AVN) and then through the ventricles.

- ➔ **Describe the PQRST wave as shown on an ECG.**

The medulla regulates the rate of the SAN through the action of the autonomic nervous system (ANS). Sympathetic accelerator nerves release adrenaline (epinephrine) which increases hart rate; slowing parasympathetic nerves release acetylcholine which decreases heart rate.

Blood pressure can be measured using a sphygmomanometer. An inflatable cuff stops blood flow and deflates gradually. The blood starts to flow (detected by a pulse) at systolic pressure. The blood flows freely through the artery (and a pulse is not detected) at diastolic pressure.

- ➔ **What is the average blood pressure reading?**

- ➔ **What other diseases can be linked to hypertension?**

- Blood Vessels

Arteries have an outer layer of connective tissue containing elastic fibres and a middle layer containing smooth muscle with more elastic fibres. The elastic walls of the arteries stretch and recoil to accommodate the surge of blood after each contraction of the heart. The smooth muscle can contract or relax causing vasoconstriction or vasodilation to control blood flow.

- ➔ **Describe the process of a) vasodilation b) vasoconstriction**

Capillaries allow exchange of substances with tissues. Veins have an outer layer of connective tissue containing elastic fibres but a much thinner muscular wall than arteries. Veins also contain valves which prevent the backflow of blood.

Pressure filtration of fluids occurs through capillary walls. Tissue fluid and blood plasma re very simila except plasma contains plasma proteins.

➔ **What substances are carried in tissue fluid?**

Much of the tissue fluid returns to the blood. Lymphatic vessels absorb excess tissue fluid and return the lymph fluid to the circulatory system.

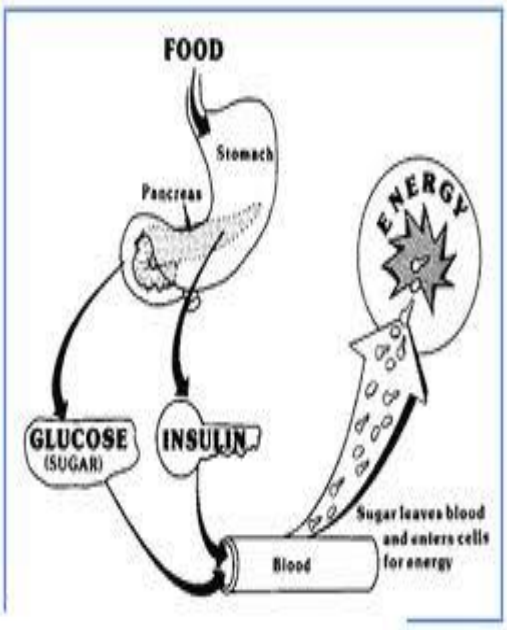
- Blood Glucose Regulation

Chronic elevation of blood glucose levels leads to the endothelium cells taking in more glucose than normal damaging the blood vessels. Atherosclerosis may develop leading to cardio vascular disease, stroke or peripheral vascular disease.

➔ **What other conditions can result due to elevated blood glucose levels?**

Pancreatic receptors respond to high blood glucose levels by causing secretion of insulin.

➔ **Describe how insulin and glucagon are involved in regulating blood glucose levels.**



During exercise and fight or flight responses glucose levels are raised by adrenaline (epinephrine) released from the adrenal glands stimulating glucagon secretion and inhibiting insulin secretion.

- Type 1 and Type 2 Diabetes

Type 1 diabetes usually occurs in childhood. Type 2 diabetes or adult onset diabetes typically develops later in life and occurs mainly in overweight individuals. A person with Type 1 diabetes is unable to produce insulin and can be treated with regular doses of insulin. In type 2 diabetes individuals produce insulin but their cells are less sensitive to it. This insulin resistance is linked to a decrease in the number of insulin receptors in the liver leading to a failure to convert glucose to glycogen.

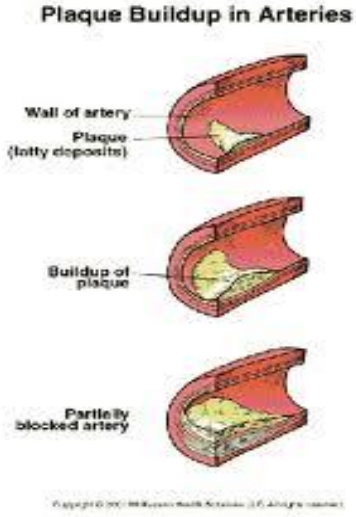
In both types of diabetes individual blood glucose levels will rise rapidly after a meal and the kidneys are unable to cope resulting in glucose being lost in the urine. This is a common test for diabetes. Another method would be to carry out a glucose tolerance test. Here, the blood glucose levels of the individual are measured initially, so that there is a baseline figure for the individual.

➔ **Describe how a glucose tolerance test would be used.**

➔ **Name other conditions usually linked to type 2 diabetes.**

- Cardiovascular Disease

Atherosclerosis is the accumulation of fatty material (consisting mainly of cholesterol), fibrous material and calcium forming an atheroma or plaque beneath the endothelium. As the atheroma grows the artery thickens and loses its elasticity. The diameter of the artery becomes reduced and blood flow becomes restricted resulting in increased blood pressure.



➔ **What other medical conditions can be linked to atherosclerosis?**

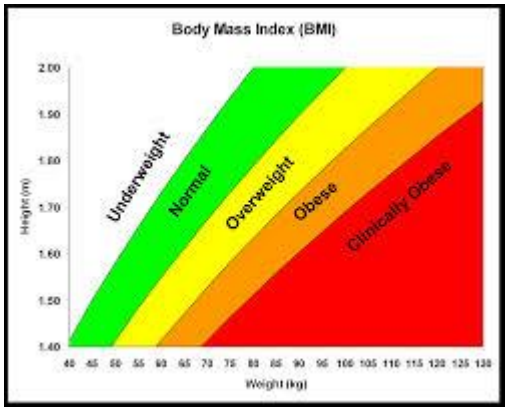
Peripheral vascular disease is narrowing of the arteries due to atherosclerosis of arteries not involving the heart and brain. The arteries to the legs are most commonly affected. Damage to these arteries can cause deep vein thrombosis (DVT).

➔ **What is DVT, and what are the symptoms?**

Atherosclerosis can be linked to a high fat diet, including cholesterol. Most cholesterol is synthesised by the liver from saturated fats in the diet. Cholesterol is a component of cell membranes and is needed to produce steroid hormones. High-density lipoprotein (HDL) transports excess cholesterol from the body cells to the liver for elimination. This prevents accumulation of cholesterol in the blood. Low-density lipoprotein (LDL) transports cholesterol to body cells. Most cells have LDL receptors that take LDL into the cell where it releases cholesterol. Once a cell has sufficient cholesterol a negative feedback system inhibits the synthesis of new LDL receptors and LDL circulates in the blood where it may deposit cholesterol in the arteries forming atheromas. A higher ratio of HDL to LDL will result in lower blood cholesterol and a reduced chance of atherosclerosis.

➔ How can we increase our HDL lipid profiles?

➔ What is familial hypercholesterolaemia?



- BMI and Obesity

Obesity is a major risk factor for cardiovascular disease and type 2 diabetes. Obesity is characterised by excess body fat in relation to lean body tissue (muscle). A body mass index greater than 30 is used to indicate obesity.

➔ How is BMI measured?

➔ Give a more reliable way to measure body fat.

Obesity is linked to high fat diets and a decrease in physical activity. The energy intake in the diet should limit fats and free sugars as fats have a high calorific value per gram and free sugars require no metabolic energy to be expended in their digestion. Exercise increases energy expenditure and preserves lean tissue. Exercise can help to reduce risk factors for CVD by keeping weight under control, minimising stress, reducing hypertension and improving HDL blood lipid profiles.