

Study Notes: Module 8

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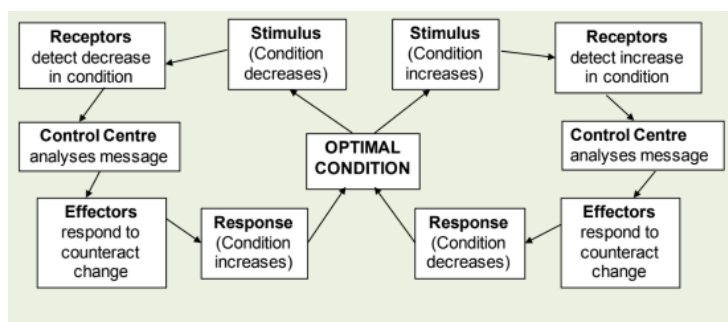
Inquiry Question 1:

How is an organism's internal environment maintained in response to a changing external environment?

DOT POINTS:

- *construct and interpret negative feedback loops that show homeostasis by using a range of sources, including but not limited to:*
 - *temperature*
 - *glucose*

Negative Feedback Loops

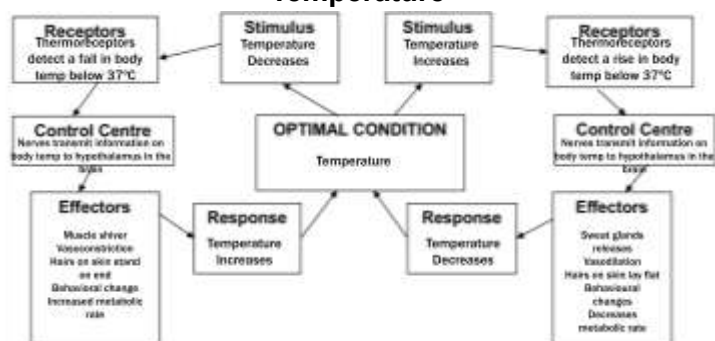


- The process when the body detects an imbalance of something within the body and how it does the opposite effect
- It has a stimulus-response relationship

Process:

- Stimulus
 - Change in the environment that body can detect
- Receptor
 - Cells which detect stimuli pass it on to the control centre
- Control Centre
 - Analyses message and initiates actions
- Effector
 - A muscle or gland that produces a response
- Response
 - Action carried out by the organism

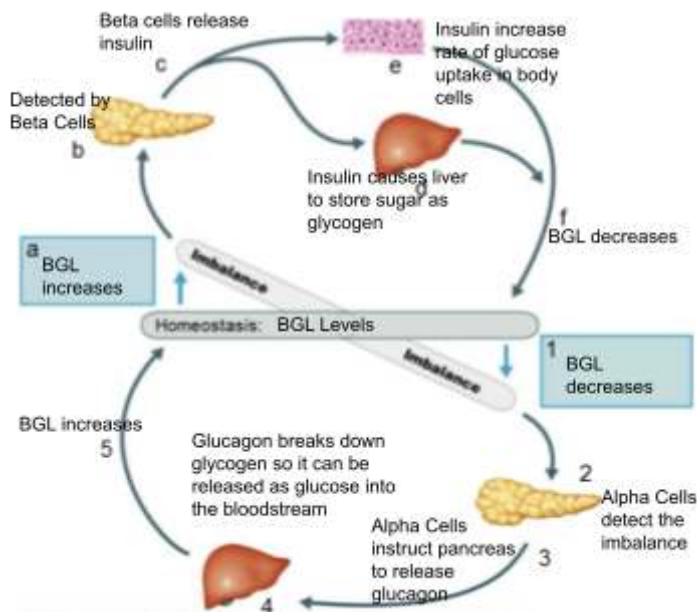
Temperature



- In order to keep the body's temperature at a constant level, there is a negative feedback loop
- If the temperature were to **increase** (Stimulus)
 - The change in temperature is recognised by the thermoreceptor (Receptor)
 - The nerves transmit the information to the hypothalamus (control centre)
 - Effectors then trigger to decrease the temperature
 - Sweat glands release
 - Hairs on skin lay flat
 - Behavioural changes (going into shade)
 - The temperature will then decrease (response)
- If the temperature were to **decrease** (Stimulus)
 - The change in temperature is recognised by the thermoreceptor (Receptor)
 - The nerves transmit the information to the hypothalamus (control centre)

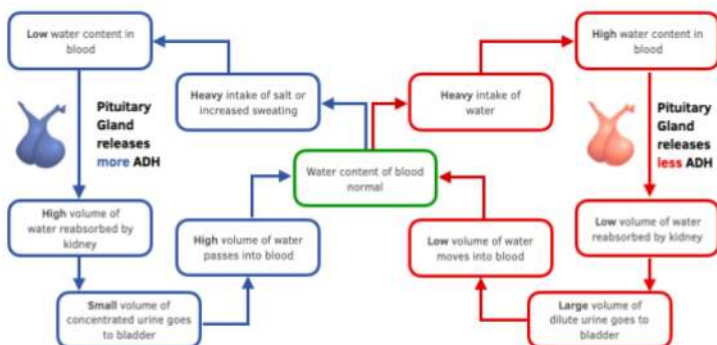
- Effectors then trigger to increase the temperature
 - Muscles shiver
 - Hairs stand on end (goosebumps)
 - Vasodilation
- The temperature will then increase (response)

Glucose



- In order to keep the body's blood glucose level maintained, there is a negative feedback loop
- The optimum level for glucose is 90-100mL
- If the BGL were to **rise** (stimulus)
 - Beta cells in the pancreas detect the change in BGL (receptor)
 - Beta cells release insulin (hormone)
 - Increases rate of glucose uptake in body cells
 - Insulin causes the liver to store sugar as glycogen
 - BGL then decreases (response)
- If the BGL were to **fall** (stimulus)
 - Alpha cells in the pancreas detect the change in BGL (receptor)
 - Alpha cells instruct pancreas to release glucagon (hormone)
 - Glucagon breaks down glycogen, so it can be released as glucose into the bloodstream
 - BGL then increases (response)

Water Concentration

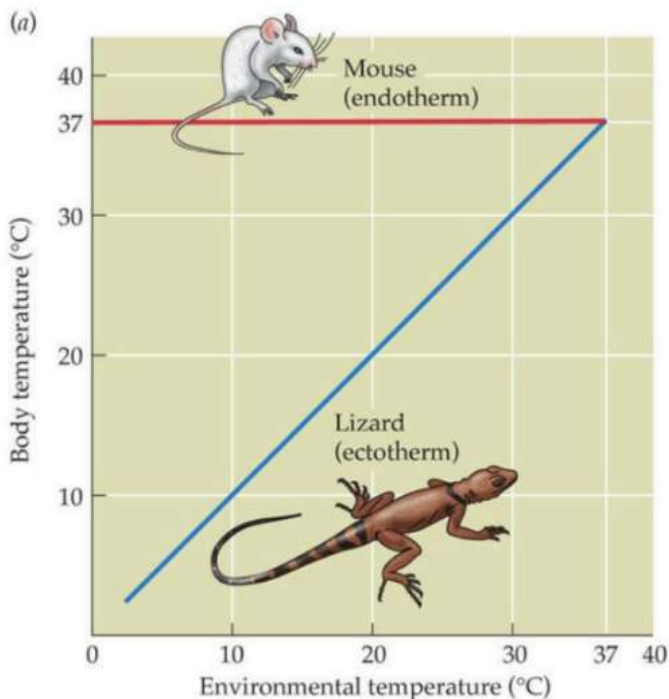


- In order to keep water levels maintained there is a negative feedback loop
- Osmoreceptors detect the amount of water concentration relative to salts in the blood
- ADH or Anti-Diuretic Hormone acts as an effector to alter the water concentration in the blood
- When ADH levels are high the hormone acts in the kidneys and causes them to absorb more water
 - ADH reduces the amount of water lost through urination
- When ADH levels are low there is too much water concentration in the blood, meaning less ADH is released, which increases the amount of water lost through urination

DOT POINTS:

- investigate the various mechanisms used by organisms to maintain their internal environment within tolerance limits, including:
 - trends and patterns in behavioural, structural and physiological adaptations in endotherms that assist in maintaining homeostasis
 - internal coordination systems that allow homeostasis to be maintained, including hormones and neural pathways
 - mechanisms in plants that allow water balance to be maintained

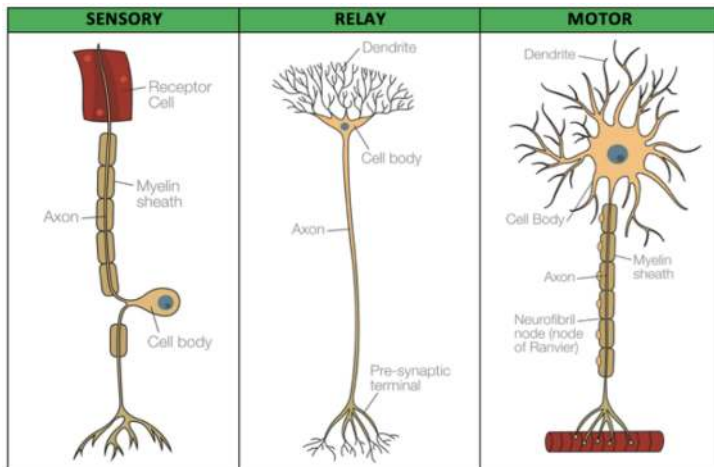
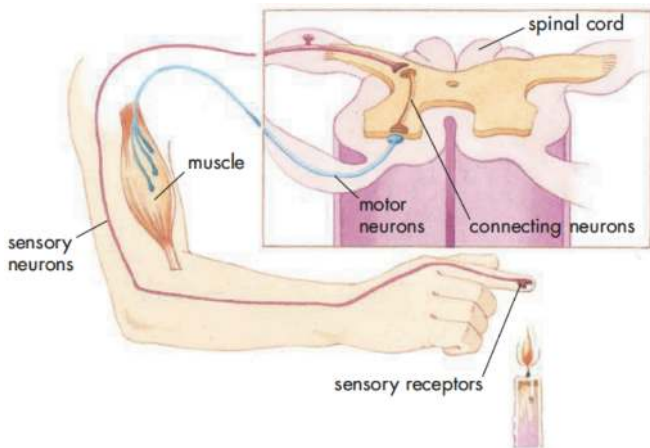
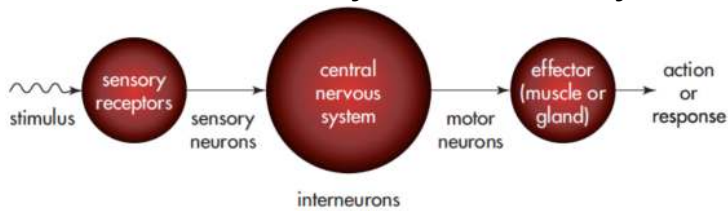
Trends and Patterns in Adaptions in Endotherms



- An endotherm is what we know as a 'warm-blooded' animal. In other words, they generate most of their heat internally
- The opposite is an ectotherm (cold-blooded) and generate heat from their environment
 - Reptiles, fish, and amphibians are examples
- Endotherms rely on metabolic activity to retain heat
 - Allows them to maintain a generally constant body temperature
 - Mammals and birds are examples
- There are 3 main types of adaptations for endotherms:
 - Structural
 - Relates to the size and shape of an organism and its body parts
 - Behavioural
 - Refers to the organism's behaviour
 - Psychological
 - Relates to how an organism's body functions

Adaptation Type	Cooling Down	Warming Up
Structural	Large ears increase the surface area for evaporative heat loss. A larger surface to volume ratio helps to maximise heat loss.	Insulation such as fat layers, blubber, hair, fur and feathers. A small surface area to volume ratio helps to minimise heat loss
Behavioural	Burrowing Nocturnal Activity Seeking shade Cooling down in water Stretching out to increase the surface area for heat loss	Hibernation Migration Curling up in a ball or huddling together to decrease surface area
Physiological	Sweating to increase evaporative heat loss Increased blood flow to the extremities: more blood enters skin capillaries and heat is lost – vasodilation (widening blood vessels)	Reduced blood flow to extremities which keeps the core of the body warm – vasoconstriction (narrowing blood vessels) Shivering causes rapid contraction and relaxation of skeletal muscles resulting in more heat being generated increases in metabolic activity.

Internal Coordination Systems: Nervous System



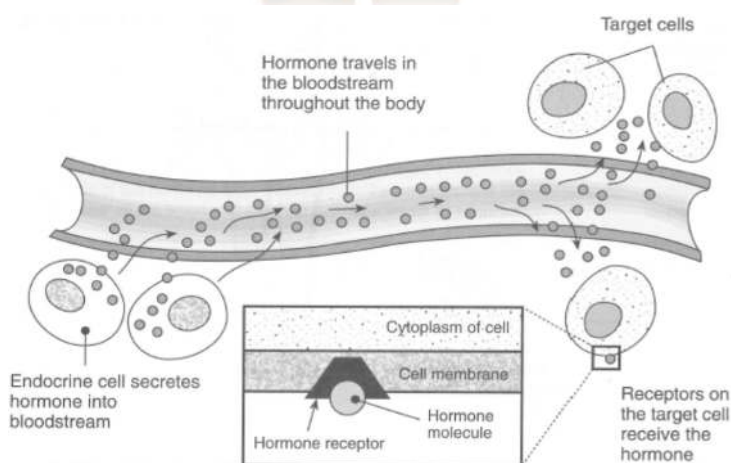
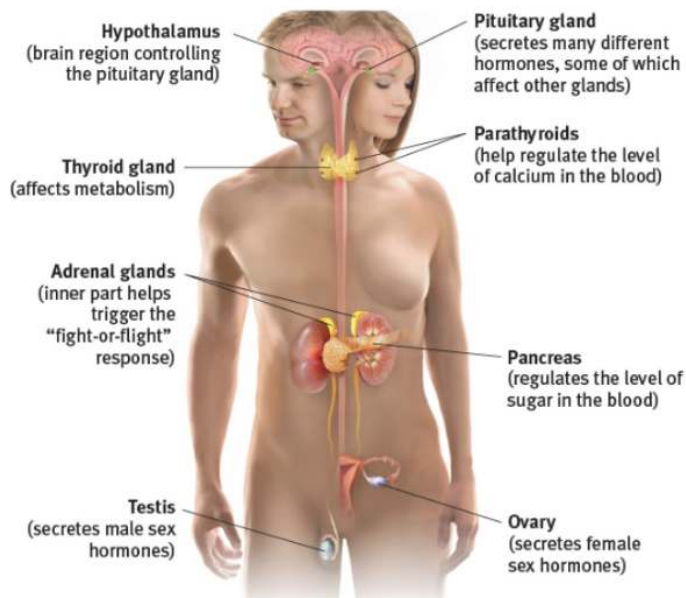
- Consists of nerves that are extended all over the body and pass messages through electrical impulses
- It consists of a control centre which is the brain and spinal cord
- The nerves allow the brain to respond to stimuli from internal and external environments

Process:

- Information about the stimuli is passed through electrical impulses (nerve signals or neurons)
 - Nerve impulses only travel along a neuron in one direction only
 - Dendrite to axon branch
- It passes rapidly from the receptors along sensory neurons (nerve cells)
- Interneurons then carry the impulse through the central nervous system where the information is processed
 - If the stimulus requires more of a rapid reaction, then this part can be skipped, this is known as a reflex arc
- The central nervous system then reacts by activating motor neurons in the nerves to transmit information to an effector organ
- The effector then produces a response to the stimulus
- This process happen very rapidly compared to the endocrine system
- A stimulus could be your finger touching an open flame
 - The nerves then react to the flame, transporting the message to the central nervous system (spinal cord or brain)
 - Motor cells then trigger to make the effector organ complete an action
 - In this case, the action would be to move your finger away from the hot flame

Internal Coordination Systems: Endocrine System

- The endocrine system is a complex network of glands and organs
- Both the endocrine and nervous system work together to achieve homeostasis, regulating the body's activities
- The endocrine system focus more on long-term adjustments and slower responses such as growth or reproduction



Process

- The endocrine system regulates the body processes by releasing chemical messengers (hormones) into the bloodstream
- The endocrine system comprises endocrine glands and their hormones
- Endocrine glands secrete hormones that are carried in the blood to target cells that have a specific metabolic effect
 - Target cells have a receptor on the cell membrane which recognises and binds the hormone
 - Binding of the hormone and the receptor triggers the response in the target cell
 - Other cells are unresponsive to a hormone if they do not have the receptor for it
- After exerting their effect, hormones are broken down and excreted from the body
- The effect of one hormone is generally counteracted by another opposing hormone
- Negative feedback mechanisms adjust the balance of the hormones to maintain a psychological function
- **Insulin decreases blood glucose and glucagon raises it. (Regulate blood glucose)**
- **Aldosterone brings about retention of salts within the body. ADH brings about reabsorption of water within the body. (Regulate water balance)**

Water Balance in Plants

- Xerophytes are plants which are adapted to live in dry conditions – have features that minimise water loss from transpiration. **Eg. cactus**
- Tough cuticles **e.g. pigface**
 - Thick, waxy surface reduces transpiration
- Fine hairs **e.g. paper flower**
 - Create humid environment around stomata, reducing water loss
- Water storage **e.g. pigface**
 - Leaves and stems have large vacuoles to store water
- Extensive root systems **e.g. pigface**
 - Absorb and store large amounts of water from the soil

Inquiry Question 2:

Do non-infectious diseases cause more deaths than infectious diseases?

DOT POINTS:

- *investigate the causes and effects of non-infectious diseases in humans, including but not limited to:*
 - *genetic diseases*
 - *diseases caused by environmental exposure*
 - *nutritional diseases*
 - *Cancer*
- *collect and represent data to show the incidence, prevalence and mortality rates of non-infectious diseases, for example:*
 - *nutritional diseases*
 - *diseases caused by environmental exposure*

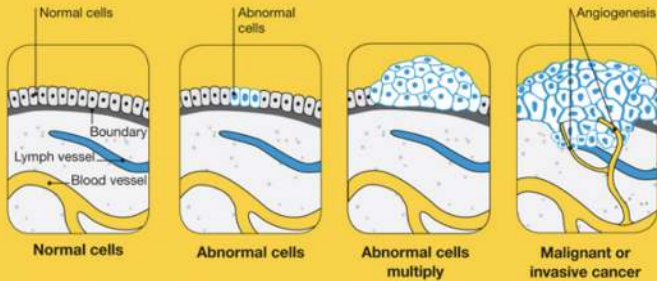
Genetic Diseases

- Diseases that are able to be passed down through procreation and genes
- Sickle-cell Anaemia
 - Caused by a mutation in a gene that tells the body to make haemoglobin
 - There are not enough healthy red blood cells to carry adequate oxygen and this leads to fatigue, painful swelling in hands and feet, and frequent infections
- Down Syndrome (trisomy)
 - Caused by an additional chromosome 21
 - Mild to moderate retardation and poor muscle tone; higher risk of disorders such as congenital heart defects.
- Haemophilia
 - The gene that controls blood clotting proteins occurs on the sex chromosomes
 - Males do not have the genetic information for blood clotting
- Huntington's Disease
 - A faulty gene makes an abnormal, toxic version of the Huntington protein
 - Progressive brain disorder causes uncontrolled movements, emotional problems and loss of cognitive function

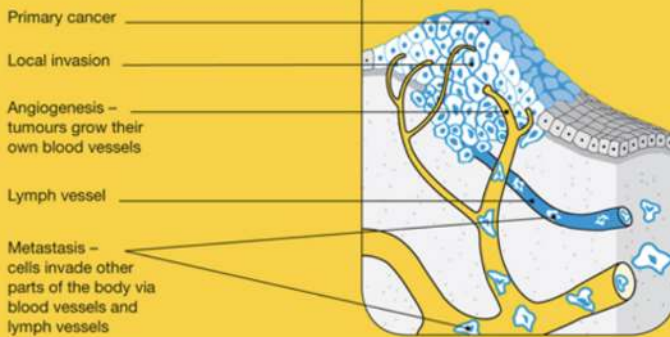
<p>Diseases Caused by Environmental Exposure</p>	<ul style="list-style-type: none">• Diseases caused by exposure to toxic substances, radiation, drug abuse, stress and noise• Mesothelioma• A rare type of cancer affecting the membrane that covers and protects the lungs (pleura) caused by exposure to asbestos• Asbestos fibres cause inflammation in the protective membranes called mesothelium and form a tumour• Skin Cancer (e.g. malignant melanoma)• Excessive exposure to UV radiation, melanoma generally develops when a mole becomes cancerous• Most lethal form of skin cancer and tumours start in the pigment-producing melanocytes in the skin.• Malignant cells can spread to other parts of the body.• Minamata Disease• Caused by heavy metal poisoning by mercury of the fish and shellfish in Minamata Bay, Japan in the 1950s• Sufferers had severe convulsions, partial paralysis, intermittent loss of consciousness with crazed mental states and then permanent coma, high fever and death.
<p>Nutritional Diseases</p>	<ul style="list-style-type: none">• Nutritional diseases are caused by nutritional deficiencies that can be caused by diets lacking the proper balance and amount of nutrients.• Scurvy• Lack of Vitamin C in the diet which is found in citrus fruits eg. oranges• Collagen cannot be made properly by the body resulting in:<ul style="list-style-type: none">○ Hair falling out○ Skin erupting, flaking and discolouring○ teeth loosening and falling out○ blood capillaries leak blood, so bruising spots appear all over the body• Kwashiorkor• severe form of malnutrition caused by a protein deficient diet, more common in poverty area where starchy foods and rice are the main diet• change in skin and hair color (to a rust color) and texture, loss of muscle mass, failure to grow or gain weight, edema (swelling) of the ankles, feet, and belly, damaged immune system, which can lead to more frequent and severe infections

Cancer

How cancer starts



How cancer spreads



- A disease caused by an uncontrolled division of abnormal cells in a part of the body
- **Bowel Cancer**
- Involves a growth (tumour) on the inner lining of the large intestine and/or rectum
- Symptoms include diarrhoea, constipation, blood in the faeces, weight loss, a lump in the anus or rectum and abdominal pain
- **Prostate Cancer**
- Occurs when the cells in the prostate gland grow in an abnormal way, creating a lump of tissue - 'tumour'
- Symptoms relate to urination e.g. there is a need to urinate frequently, especially at night and difficulty beginning to urinate, incontinence, a slow, interrupted flow of urine, blood in urine or semen, lower back or pelvic pain and painful ejaculation

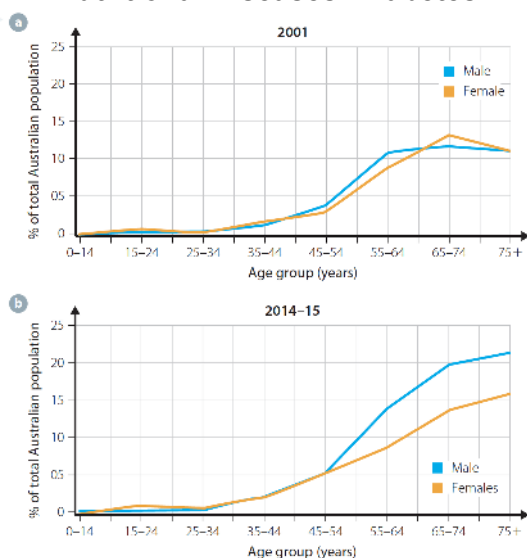
Inquiry Question 3:

Why are epidemiological studies used?

DOT POINTS:

- *analyse patterns of non-infectious diseases in populations, including their incidence and prevalence, including but not limited to:*
 - *nutritional diseases*
 - *diseases caused by environmental exposure*

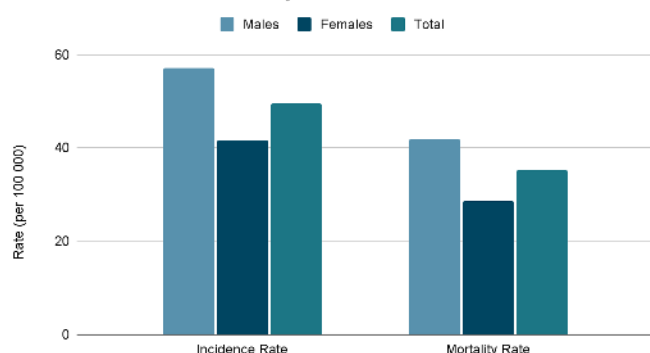
Nutritional Diseases: Diabetes



- The 2001 graph shows that males and females aged between 55 - 74 had the highest percentage of individuals with diabetes.
- The 2014 - 2015 graph shows that males and females aged between 55 - 75+ have the highest percentage of individuals with type 1 and 2 diabetes.
- For the 2001 graph the prevalence of the graph shows how individuals of a young age are less likely to be diagnosed with type 1 or 2 diabetes due to their age which benefits their health seen in the graph showing people aged from 0 - 44yrs old are less likely to have diabetes. Yet those who are more elderly are at a high risk of being diagnosed with diabetes such as people aged from 45-75+
- For the 2014 - 2015 graph the Prevalence shows how only around 5% of both males and females aged from 0- 44 are less likely to be diagnosed with diabetes in contrast to people aged from 45 - 75 + especially in males 20% of males and 15% of females aged 65 - 74 are diagnosed with diabetes.

Diseases Caused by Environmental Exposure: Lung Cancer

Prevalence Rate vs Mortality Rate



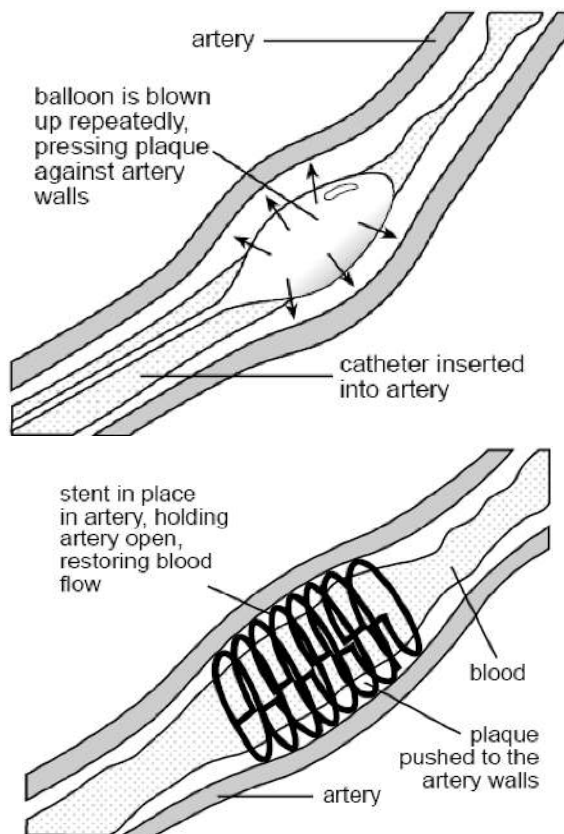
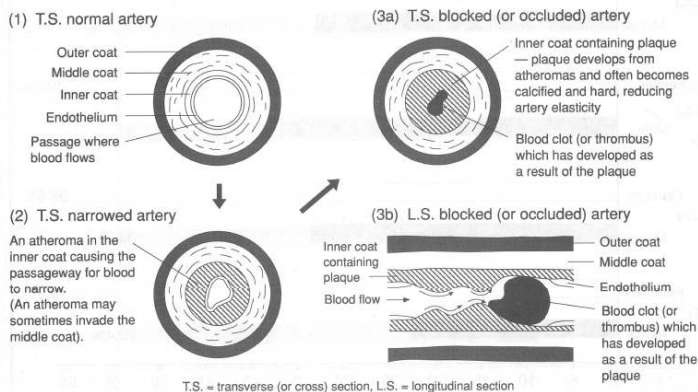
- The incidence rate increased from 1982 when it was 16.6 per 100 000 to 41.7 per 100 000 in 2015 in females
- The incidence rate decreased from 1982 where it was 61.1 per 100 000 to 57.2 per 100 000 in 2015 in males
- Female mortality rate increased from 14 per 100 000 in 1982 to 28.7 per 100 000 in 2015
- Male mortality rate has decreased from 55.8 per 100 000 in 1982 to 41.9 per 100 000 in 2015

DOT POINTS:

- *investigate the treatment/management, and possible future directions for further research, of a non-infectious disease using an example from one of the non-infectious diseases categories listed above*

Atherosclerosis

Figure 14.4 STAGES OF ATHEROSCLEROSIS



- **The main underlying cause of cardiovascular disease**
- A disease in which plaques that are made up of fat, cholesterol, calcium and other substances build up in the walls of arteries
- There is no single cause to the disease, rather there are many factors of varying influence such as:
 - Excessive amount of alcohol
 - Smoking (active or passive)
 - Breathing in pollutants
 - Stress and nervous tension
 - No regular exercise
 - Consume a diet with excess in fats, salts kJ etc

Effects:

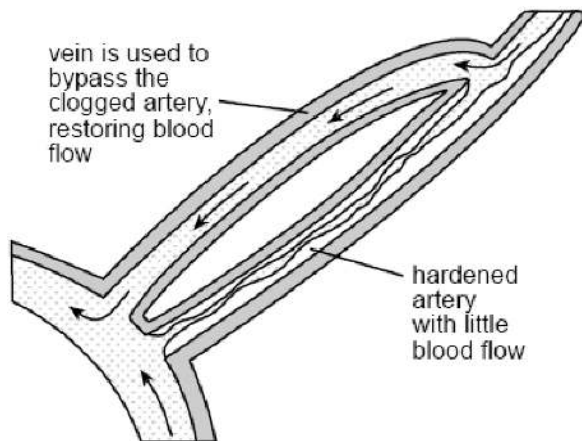
- Plaques harden over time, narrowing the opening of the arteries and restrict the blood flow
- When the plaques open, they form a blood clot that can further limit the flow of oxygen-rich blood to organs and other parts of the body
- If it occurs in one of the two main coronary arteries that supply blood to the heart, this results in a heart attack

Management:

- Simple lifestyle management choices such as eating a healthy diet, leading a healthy lifestyle to maintain weight, quitting smoking

Treatment:

- **Cholesterol Reducing Drugs**
 - These can slow the build up of plaque, e.g. statins lower low density lipoproteins
- **Balloon Angioplasty**
 - a procedure performed to open or widen a narrowed coronary artery
 - A catheter with a balloon attached is inserted in an artery in the groin, and when it reaches the area of obstruction or narrowing in the coronary artery the balloon is inflated.
 - Inflating the balloon causes the plaque inside the artery to crack and widens the artery. The balloon is inflated and deflated repeatedly until the artery is open and blood flow is restored.
- **Stents**
 - Devices inserted in the narrow area of a coronary artery which is mounted on a balloon catheter which is inflated to expand the stent of the artery
 - The catheter is then withdrawn, leaving the stent in place. The stent widens the artery, helping to keep it open



- **Bypass Surgery**
 - When an artery is unable to be opened with forms of angioplasty, the heart may be bypassed.
 - Veins from other parts of the body are removed and placed in an area to bypass the blocked artery. This restores blood flow around the blockage
- **Future Directions for Further Research**
- The pharmaceutical industry is constantly investigating new drugs and ways to treat cardiovascular conditions.
- Medical surgery techniques and equipment for surgery are regularly being upgraded and improved, e.g. the constant development of endoscopy using robotic systems, lasers and computer imaging has greatly assisted surgeons in accessing, seeing and carrying out their tasks.

DOT POINTS:

- *evaluate the method used in an example of an epidemiological study*
- *evaluate, using examples, the benefits of engaging in an epidemiological study*

Epidemiology

- **The study of the incidence, distribution, cause and possible control of diseases and other factors relating to health**
- can be used to study both infectious and non-infectious diseases as well as events such as suicides, car accidents and work-related accidents
- There are three main types of epidemiological studies:
 - Descriptive: A study of the patterns of distribution within and across populations.
 - Analytical: A study used to collect more data, which is then statistically analysed to test hypotheses as to the likely cause(s) of the disease.
 - Intervention: A study that measures the effectiveness of interventions, such as a treatment or the effectiveness of a public health campaign.
- Epidemiological studies should:
 - Be conducted over a long period of time
 - Have a large sample size (thousands)
 - collect a range of relevant data from a large group of both affected and unaffected people
 - have participants that represent a broad range of society and lifestyles
 - use control groups who are not exposed to the potential cause of disease but are

	<p>similar in all other respects to the test group → cohort studies</p> <ul style="list-style-type: none">○ use control groups who are not exposed to the potential cause of disease but are similar in all other respects to the test group○ collect data on the incidence, prevalence, mortality and morbidity rates of the disease being studied○ analyse the data to identify patterns and trends in the occurrence of the disease○ identify the possible cause of the disease and any risk factors○ develop a management plan with strategies to control or eliminate the disease○ evaluate the effectiveness of control and treatment programs <ul style="list-style-type: none">● A cause and effect relationship must be evident in an epidemiological study, where a number of criteria must be met which include:<ul style="list-style-type: none">○ There must be a high risk that the disease develops when a person is exposed to the possible cause.○ There must also be consistency in the results found by researchers in each study carried out.○ It must be shown that higher levels of the cause lead to a greater risk of developing the disease.○ There must be a particular time relationship, with the cause occurring before the disease.
<p>Epidemiology and the Cause of Lung Cancer</p>	<ul style="list-style-type: none">● Smoking and Carcinoma of the Lung● Hypothesis Summary: Significant increase in deaths attributed to cancer of the lung in England was due to:<ul style="list-style-type: none">○ Atmospheric pollution○ Smoking of tobacco● Methodology:● 20 hospitals in London had partaken in the study● Whenever a patient at one of the hospitals were presenting carcinoma of the lung, a researcher would visit the hospital and ask the patient questions surrounding their lifestyle, over the period of a year● Smoking habits were assessed by asking whether patients:<ul style="list-style-type: none">○ Whether they had smoked at any period of their lives○ The ages at which they started and stopped

	<ul style="list-style-type: none">○ The amount which they were in the habit of smoking before the onset of illness○ The main changes in their smoking history and maximum they had ever been in the habit of smoking○ The varying proportions smoked in pipes and cigarettes○ Whether or not they inhaled <ul style="list-style-type: none">● A smoker was defined as a person who had smoked as much as one cigarette a day for as long as one year. <p>Evaluation:</p> <ul style="list-style-type: none">● Large sample size of 2,475 patients.● Clear control group with controlled variables (same age and sex) between populations.● Data collected from a wide range of hospitals.● Consistent use of the same interviewers and questionnaire throughout the study.● Thorough investigation of patients' history, including smoking habits and other lifestyle factors.● Long duration of the study.● Suggested improvements: Consider including data from hospitals outside of London to account for environmental variables and monitor individuals over a larger portion of their lives.
Benefits of Epidemiological Studies	<ul style="list-style-type: none">● Potentially saves lives as it allows the cause of disease to be determined and which populations are affected, which then guides the development of strategies to control disease and improve public health.● Studies have identified associations between exposure to environmental substances (environmental risk factors) and adverse health effects● Studies have identified behavioural or lifestyle risk factors● Studies have led to breakthroughs in understanding genetic factors involved in the predisposition to and development of some cancers● Studies have uncovered the cause of a high incidence of an unpredictable disease

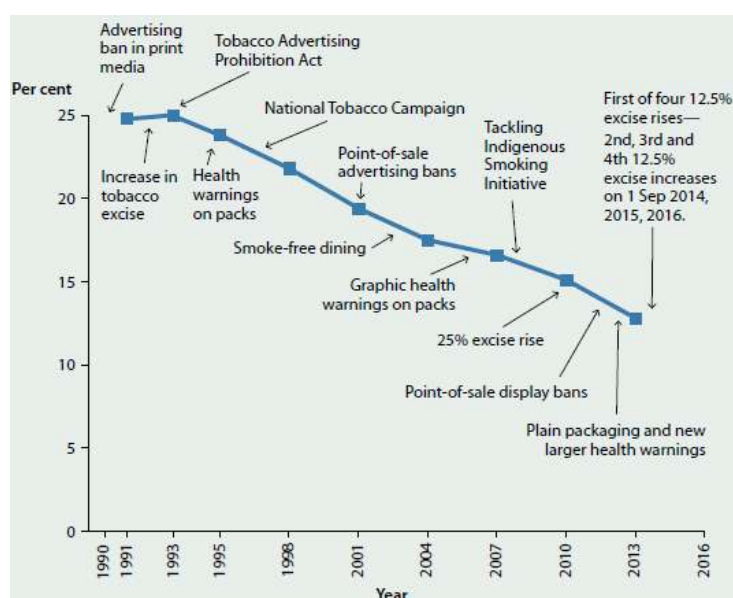
Inquiry Question 4:

How can non-infectious diseases be prevented?

DOT POINTS:

- *use secondary sources to evaluate the effectiveness of current disease-prevention methods and develop strategies for the prevention of a non-infectious disease, including but not limited to:*
 - educational programs and campaigns
 - genetic engineering

Educational Programs and Campaigns



- Use strategies to provide information and educate the population about the effects of a disease and the risk factors that increase the chance of developing that disease
- Case Study 1: Smoking and Lung Cancer: Tobacco Control
- Over the years the Australian government has implemented strategies such as:
 - staged excise increases on tobacco products
 - education programs
 - national tobacco campaigns
 - plain packaging of tobacco products
 - labelling tobacco products with updated and larger graphic health warnings
 - prohibiting tobacco advertising, promotion and sponsorship
 - providing support for smokers to quit, including through nicotine replacement therapies on the Pharmaceutical Benefits Scheme.
- Case Study 2: UV Radiation and Skin Cancer
- The first major move to prevent sun-related skin cancers was the Slip! Slop! Slap! campaign in the 1980s
 - Evolved into SunSmart campaign
- In addition to direct messaging of the community through advertising and more recently through social media, public health messages are targeted at schools, workplaces, the fashion industry, the television and movie industries and the surf lifesaving community, among many others.
- Australians are now highly sun aware, with higher sunscreen and sun protection usage

Screening Programs

- Involves simple tests to look for particular changes or early signs of disease, before the disease has developed or symptoms arise
- Are not 100% accurate because the human body changes over time
- Cancer screening
- Prenatal screening
- Newborn screening

Genetic Engineering

- The possibility of curing mutation diseases with genetic engineering
- Recombinant DNA
 - Mass produce of medical products such as insulin (refer mod 6 for process)
- Gene Therapy
 - Involves the correction of genetic disorders by introducing a normal, functioning gene into cells
 - achieved by inserting corrected gene sequences into a cell where a defect has occurred
 - Has been used to treat SCID
- Genetic Engineering to Produce Vaccines to Prevent Some Cancers
 - Genetic engineering techniques are used to produce vaccines such as Gardasil and Cervarix, which are effective in preventing infection by HPV
 - Vaccines are nearly 100% effective in preventing cervical and other associated cancers when administered before sexual activeness
- Embryo Pre-Implantation Genetic Testing
 - If parents are aware that one or both posses an allele for a certain genetic disease or disorder, they can undergo this process
 - IVF occurs and the embryo is tested for the known genetic condition
 - Embryos that are free of the genetic disease/disorder or are carriers are retained for implantation, preventing the condition in the offspring

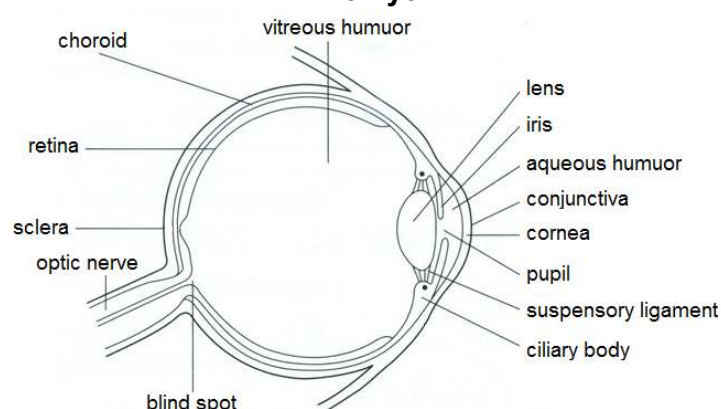
Inquiry Question 5:

How can technologies be used to assist people who experience disorders?

DOT POINTS:

- explain a range of causes of disorders by investigating the structures and functions of the relevant organs, for example:
 - hearing loss
 - visual disorders
 - loss of kidney function

The Eye



The light coming from an object enters the eye through the cornea and the pupil.

The lens focuses the light rays to form a real, inverted and highly diminished image on the retina.

The sensory cells (rods and cones) of the retina get activated and generate electric signals.

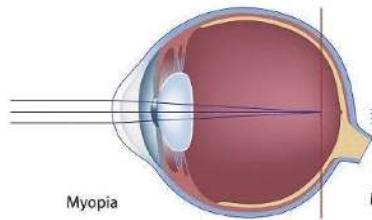
Optic nerves send electric signals to the brain.

The brain interprets these signals and renders the erect image of the object.

- The organ of the body which humans use to see

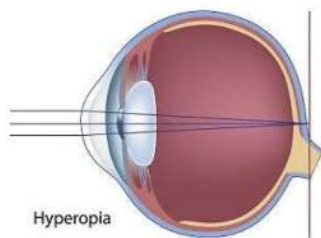
Part	Anatomy and Function
conjunctiva	A membrane covering the outer part of the eye. Has a protective function and also keeps the eye moist. Protects the cornea at the front of the eyeball against friction
cornea	Transparent front section of the eye ball; admits light in; refracts light to help form an image on the retina
sclera	The white of the eye, a tough coat of fibres; protects the eyeball against mechanical damage, maintains shape of eyeball
choroid	Inner layer of eye consisting of dark pigments that prevent light from scattering (prevents internal reflection); also contains the blood vessels that nourish the retina
retina	Innermost layer of the eye; contains photoreceptor cells that detect changes in the light; image is formed here and is sent via sensory neurones to the brain
ciliary body	A pigmented muscular structure; contracts and relaxes to adjust the amount of light entering the eye; alters the size of the pupil
lens	A transparent biconvex disc which refracts light to allow focusing of an image onto the retina
aqueous humour	A watery fluid; maintains the shape of the eye; located at the front of the eye; also helps to bend light
vitreous humour	A jelly-like fluid; maintains the shape of the eye; located behind the lens
suspensory ligament	Works in association with the ciliary muscles to support the lens and alter the shape of the lens so objects can be focused onto the retina
optic nerve	Consists of bundles of sensory neurons; the image formed in the retina is turned into an electrical message and is transmitted as impulses to the brain

Visual Disorders: Myopia



- **Myopia is short-sightedness**
- A person with myopia sees objects that are close clearly but objects in the distance are out of focus
- The general cause of Myopia is that the eyeball is too long, causing the light rays from distant objects to be focused in front of the retina rather than on the retina
 - Other possible reasons can be extreme curvature of the cornea or extra bulging shape of the lens

Visual Disorders: Hyperopia



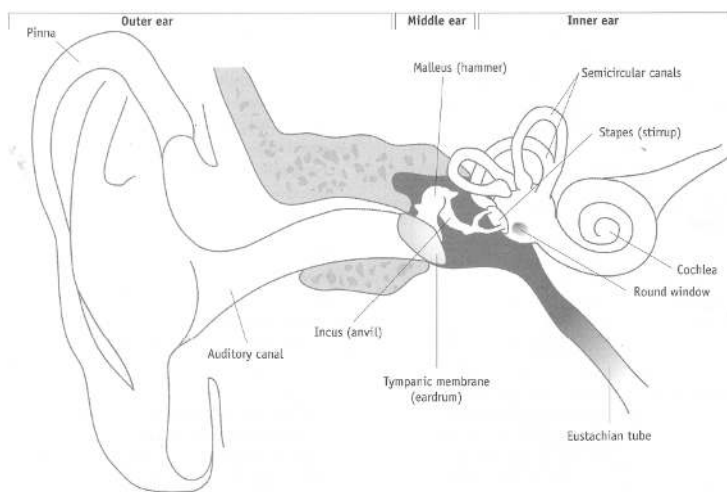
- **Hyperopia is long-sightedness**
- A person with hyperopia sees objects that are in the distance clearly but close objects are out of focus
- The general cause of hyperopia is that the eyeball is too short or poor accommodation of the lens, causing the light rays from distant objects to be focused behind the retina rather than on the retina

Visual Disorders: Catarax



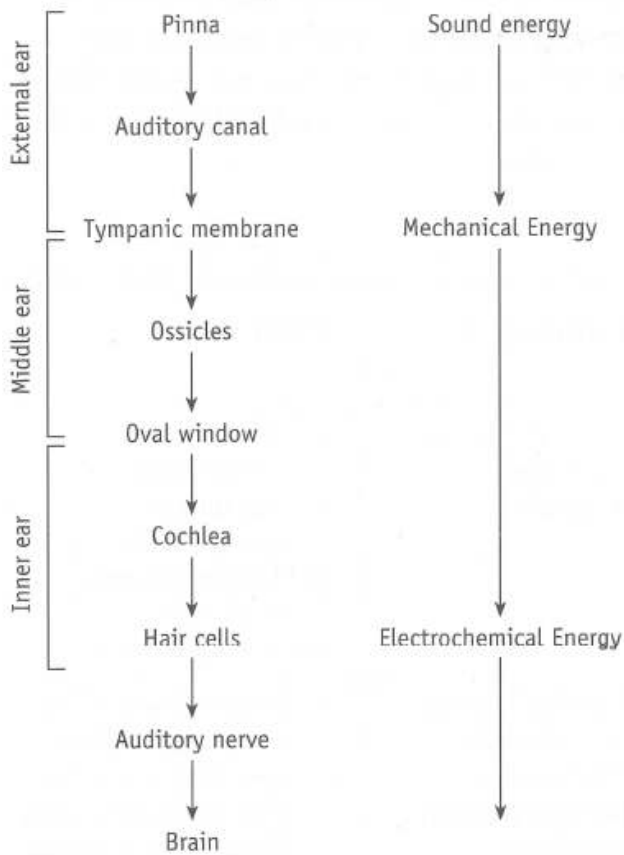
- **The clouding of the lens, which reduces the transmission of the light through the lens**
- Causes the blurred vision of both near and far objects, and increased sensitivity to the glare of bright sunlight

The Ear



- **The part of the body which detects sound and changes it into frequencies**

Structure	Description of Anatomy	Function / Role
pinna	large fleshy external part of the ear consisting of cartilage and skin	collects sound and channels it into the ear
tympanic membrane	the eardrum - a membrane that stretches across the ear canal and separates the middle ear from the outer ear	vibrates when sound waves reaches it and transfers these vibrations into the middle ear (hammer)
ear ossicles	three tiny bones, the hammer (attached to eardrum), anvil and stirrup	amplify the vibrations from the tympanic membrane and passes them onto the oval window on the cochlea
oval window	membrane covering opening to the inner ear. Attached to stirrup	picks up the vibrations from the ossicles and passes them onto the fluid in the cochlea



round window	membrane located just below the oval window	bulges outward into the middle ear to allow pressure differences in the cochlea by allowing the movement of fluid in the cochlea when vibrations are transferred
cochlea	2.5cm long narrow fluid-filled-coiled tube containing the organ of Corti	changes mechanical energy into electrochemical
organ of Corti	a structure within the cochlea that contains sound receptor cells (hair cells)	location of the hair cells that transfer vibrations into electrochemical signals
auditory nerve	the nerve that travels from the ear to the brain	transmits electrochemical signals to the brain
semi-circular canals	3 narrow tubes, filled with fluid and hair cells - at right angles to each other - attached to the cochlea	hair cells detect orientation in space in response to gravity (not related to hearing)

Path of Sound Through the Ear

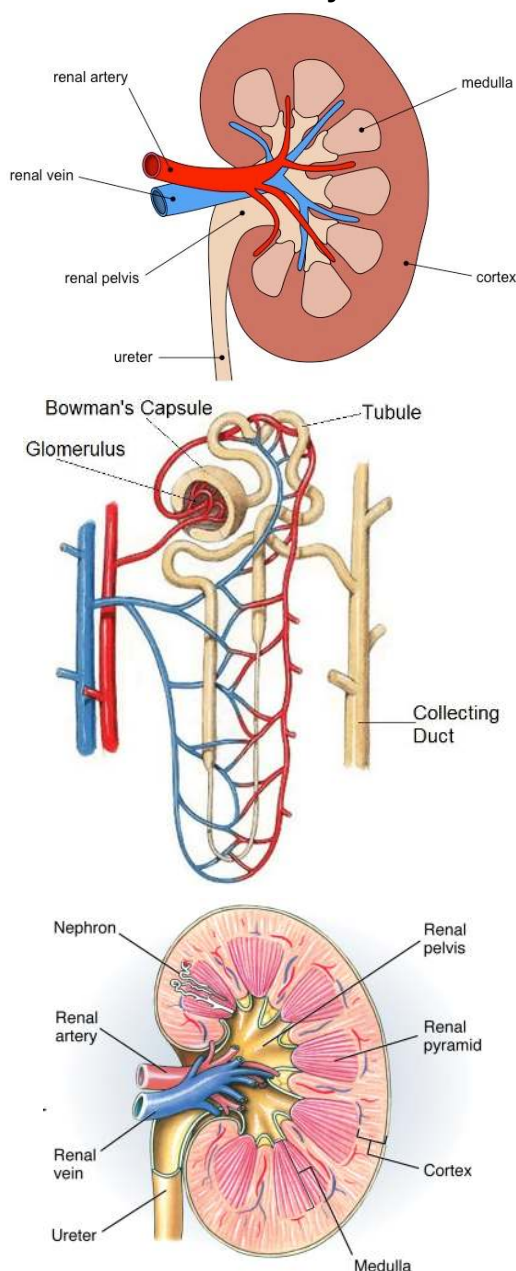
- Sound waves are collected by the pinna and travel down the auditory canal to the tympanic membrane, which vibrates at the same frequency as the sound. When sound waves reach the tympanic membrane, sound energy is converted into mechanical energy.
- The first of the ossicles is attached to the tympanic membrane, and this bone (hammer) begins to vibrate, amplifies the vibration and then passes the vibration on to the other two ossicles (anvil and stirrup), which also amplify the vibration.
- The stirrup is attached to the oval window, which begins to vibrate and causes the fluid in the cochlea to vibrate at the same frequency.
- The moving fluid in the cochlea bends the hair cells in the organ of Corti. The hair cells convert the mechanical energy into an electrochemical signal that is transmitted to the brain via the auditory nerve.
- Different sounds move hair cells of different lengths. Louder sounds move them more. This allows the brain to distinguish various sounds.

Hearing Loss

- Caused by the damage to one or more structures of the ear
- There are two main types of hearing loss:
 - **Conductive hearing loss due to problems with the ear canal, ear drum, middle ear or ear ossicles**
 - Blocked ear canal → excessive earwax
 - Infection in ear canal
 - Perforated ear drum

- Benign tumour
- Sensorineural hearing loss due to problems with the inner ear.
 - Damage to the hair or nerve cells in the cochlea → ageing, exposure to excessive noise
 - Hairs are damaged and electrical signals are not transmitted efficiently
 - Severe cochlea damage
 - Head trauma

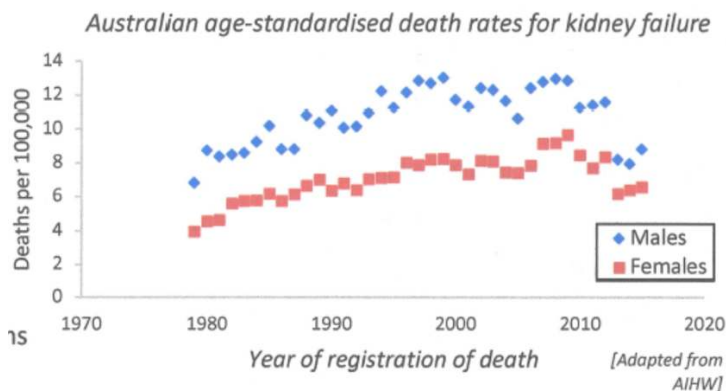
The Kidney



- **Bean-shaped organs in the abdomen, one on either side of the backbone**
- The kidneys have two vital jobs to do:
 - excretion - the elimination of harmful and unwanted products of metabolism
 - osmoregulation - the control of body water and salt levels.
- Blood is processed to filter out waste products, and balance salt and water levels.
- Waste products are collected as urine, which moves from the kidneys to the bladder
- Filtering is performed by microscopic structures called nephrons, situated across the cortex and the medulla
 - There are a million nephrons within the kidney
- **Filtration:**
 - Capillaries are wound around nephron structures, providing an area where nutrient exchange can occur
 - When the blood first enters the kidneys, the capillaries are squeezed into a tight wound structure called the glomerulus
 - Glomerulus is so compact that all fluid in the blood (besides red blood cells) are squeezed out into the Bowman's capsule
 - The Bowman's capsule filters blood from the capillaries based on size
 - Only small particles such as water and dissolved materials can enter the nephron
- **Reabsorption & Secretion**
 - The filtrate that was collected in the Bowman's capsule travels along a tubule of a nephron.
 - Most substances such as glucose, water, salt, and nutrients are reabsorbed for further use in the body
 - The filtered blood exits the kidney via the renal vein

- Any substances that do not get reabsorbed exit the nephron via the collecting duct and are then transported as urine
- The urine from all the nephrons in each kidney is taken away via tubes called the ureters to be stored in the bladder and is then released into the external environment via the urethra

Kidney Disease & Failure

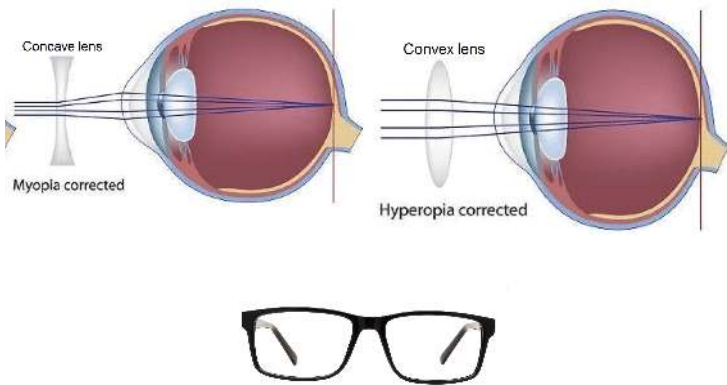


- Kidney disease is when your kidneys are damaged in some way and are not filtering your blood effectively.
- Kidney failure, also called end-stage renal disease (ESRD), is the last stage of chronic kidney disease
- When your kidneys fail, it means they have stopped working well enough for you to survive without dialysis or a kidney transplant
- Is sometimes called a silent disease as there are often few or no symptoms until late in development of chronic kidney disease
 - may be loss of up to 90% of kidney functionality before any symptoms of concern are noted
- Glomerulonephritis
 - inflammation of kidney filters – causing red blood cells and proteins to leak into urine.
- Diabetic nephropathy
 - kidney damage resulting from type 1 and type 2 diabetes - the walls of the capillaries in the glomerulus are damaged and large protein molecules enter the nephron tubule
- Reflux nephropathy
 - kidney damage caused by a leaking valve in the bladder allowing urine to flow back into the kidney
- Hypertension
 - High blood pressure leading to nephrosclerosis → is a progressive disease of the kidneys that results from sclerosis (hardening) of the small blood vessels in the kidneys. As a result, reduced renal blood flow causes chronic undersupply of blood and oxygen to the renal tissues
- Polycystic kidney disease
 - cysts in both kidneys, not detectable until adolescence, and often heritable). These cysts make the kidneys much larger than normal and damage the renal tissue

DOT POINTS:

- investigate technologies that are used to assist with the effects of a disorder, including but not limited to:
 - hearing loss: cochlear implants, bone conduction implants, hearing aids
 - visual disorders: spectacles, laser surgery
 - loss of kidney function: dialysis
- evaluate the effectiveness of a technology that is used to manage and assist with the effects of a disorder

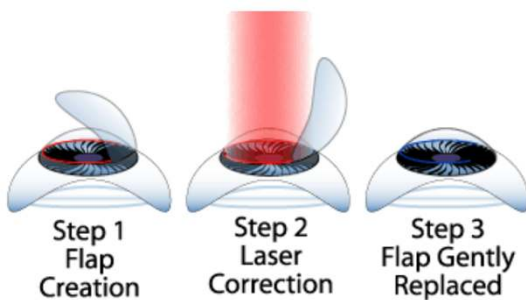
Spectacles (Glasses)



- Prescription spectacles and contact lenses are artificial lenses designed to correct the refractive errors of myopia and hyperopia
- Myopia is corrected by using glasses or contact lenses that are concave in shape
 - This causes the light rays to diverge slightly before entering the eye so that the image is then focused on the retina.
- Hyperopia is corrected by using glasses or contact lenses that are convex in shape
 - This causes the light rays to converge slightly before entering the eye so that the image is then focused on the retina.

Advantages	Disadvantages
<ul style="list-style-type: none"> Affordable Unlikely to cause side effects Are available anywhere 	<ul style="list-style-type: none"> Inconvenient, uncomfortable Can be broken or lost

Laser Eye Surgery



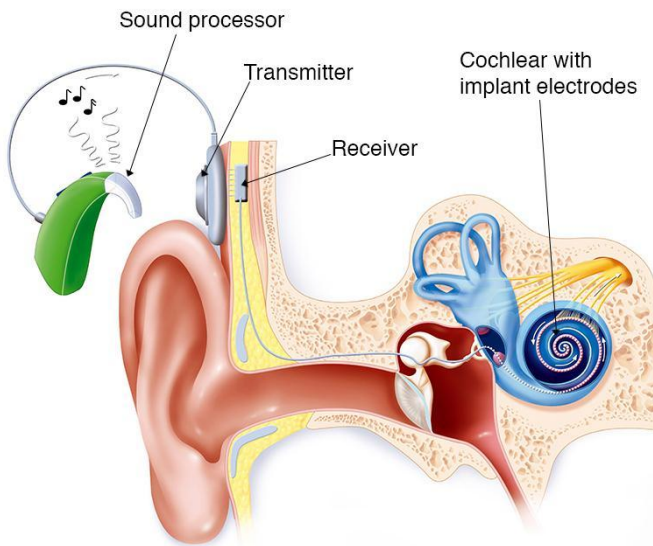
- A laser is used to reshape the cornea so that the light is refracted at the correct angle

Process:

- Local anesthetic is applied using eye drops
- The eye lid is held open by a lid separating device
- An ultrathin flap is made in the top layers of the cornea using a laser
- The corneal flap is temporarily lifted back
- A cool laser is used to remove corneal tissue to correct the shape of the cornea
- The corneal flap is returned to its correct position

Advantages	Disadvantages
<ul style="list-style-type: none"> Quick procedure Effective and permanent 	<ul style="list-style-type: none"> Expensive Not everyone qualifies Permanent changes

Cochlear Implants



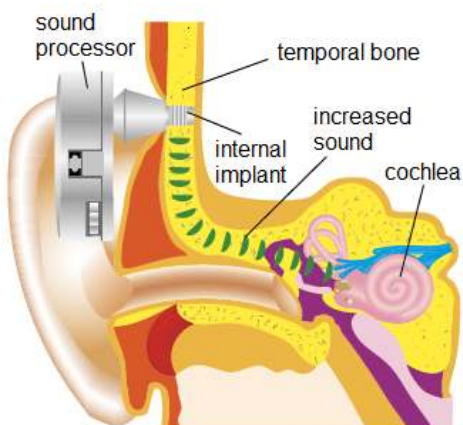
- A sound processor worn behind the ear which has a microphone that picks up sounds in the person's environment
- Used to treat severe to profoundly deaf people with missing or damaged hair cells in the cochlea

Process:

- Microphone picks up sounds in the environment
- Sound processor then converts the sound into an electrical impulse that passes through the skin via radio waves to a receiver that has been surgically inserted into the skull
- The receiver converts the digital code into electrical impulses and sends them along electrodes into the cochlea
- Impulse directly stimulates cochlea
- The signals are recognised by the brain as sound, allowing the person to hear

Advantages	Disadvantages
<ul style="list-style-type: none"> • Life-changing for profoundly deaf people • Helps improve clarity of speech and development of listening 	<ul style="list-style-type: none"> • Risk of infection • Expensive • Do not restore a person's hearing completely • Post-op complications

Bone Conduction Implants

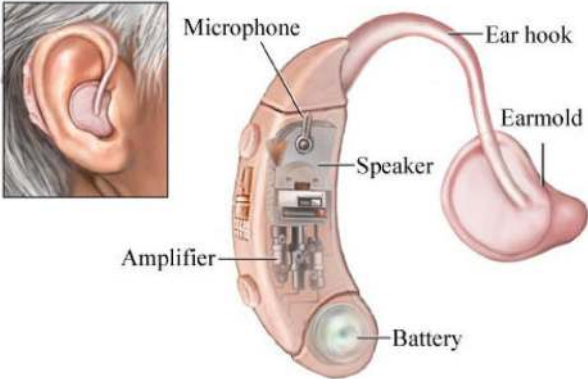


- An external sound processor attached to an implant that is surgically placed in the bone behind the ear
- Helps people with outer or middle ear problems that block or restrict the flow of sound waves such as collapsed ear canals

Process:

- The sound processor picks up sound via the microphone.
- Sound is converted into vibrations which are sent to the bone integrated implant
- Bone naturally conducts the vibrations to the inner ear (cochlea). There, the vibrations are naturally transformed into signals that are sent to the brain where they are perceived as sound

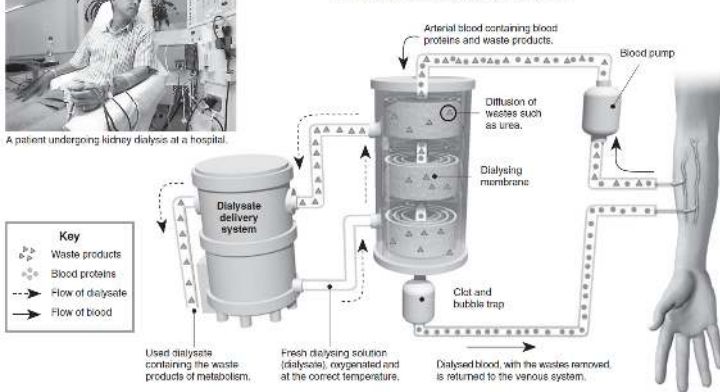
Advantages	Disadvantages
<ul style="list-style-type: none"> • Sound processor is in 	<ul style="list-style-type: none"> • Possibility of infection

	<table><tr><td>direct contact with bone resulting in better sound than a hearing aid</td><td><ul style="list-style-type: none">• New growth of bone around the implant can fail</td></tr></table>	direct contact with bone resulting in better sound than a hearing aid	<ul style="list-style-type: none">• New growth of bone around the implant can fail		
direct contact with bone resulting in better sound than a hearing aid	<ul style="list-style-type: none">• New growth of bone around the implant can fail				
<div><div>Hearing Aids</div><div></div></div>	<ul style="list-style-type: none">• Electronic devices that can amplify sounds entering the external ear and are worn behind the ear or in the ear canal• Are useful when there has been damage to the outer or middle ear but not if there is severe damage to the inner ear or auditory nerve <p>Process:</p> <ul style="list-style-type: none">○ The microphone first picks up the sounds and converts them into electrical signals○ An amplifier then strengthens these signals○ A receiver then converts the signals back to sound○ The speaker then plays the sound directly into the external ear○ The sound wave is then channelled into the auditory canal to follow the normal pathway to tympanic membrane, ossicles, cochlea and then auditory nerve <table><tr><th>Advantages</th><th>Disadvantages</th></tr><tr><td><ul style="list-style-type: none">• Improves a person's everyday life• Inexpensive• Balance out frequency levels in both ears</td><td><ul style="list-style-type: none">• Hearing aids can be uncomfortable to wear at the beginning• Some hearing aids can have acoustic feedback and amplify background noises</td></tr></table>	Advantages	Disadvantages	<ul style="list-style-type: none">• Improves a person's everyday life• Inexpensive• Balance out frequency levels in both ears	<ul style="list-style-type: none">• Hearing aids can be uncomfortable to wear at the beginning• Some hearing aids can have acoustic feedback and amplify background noises
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<div>Kidney Dialysis</div>	<ul style="list-style-type: none">• A machine designed to remove wastes from the blood• There are two main types of kidney dialysis:• Haemodialysis• Most common type of kidney dialysis which makes use of dialysers or artificial kidneys <p>Process:</p> <ul style="list-style-type: none">• The patient's blood is pumped from an artery• The blood is pumped to a dialyser where it flows through tubes made of semipermeable membrane 'dialysis tubing'				



A patient undergoing kidney dialysis at a hospital.

Principles of Kidney Dialysis



- Dialysis fluid (dialysate) has a composition similar to blood except that the concentration of wastes is low.
- As the blood circulates through the dialysis tubing, urea and excess salts diffuse out of dialysate, but glucose and amino acids do not pass through because they are too large to fit through the small pores in the membrane
 - It flows in the opposite direction to the blood on the outside of the dialysis tubes.
 - Heparin is administered to stop the blood from clotting in the dialysis tubing
- The machine continually discards used dialysate as wastes build up in it
- Blood is then returned to the patient through the vein
 - Usually takes up to 5 hours for the procedure to complete and patients generally need to administer this 3 times a week
- **Peritoneal**
- The patient's own peritoneal membrane is used as a filter
 - Membrane found in abdomen and is also semi-permeable, allowing wastes but not red blood cells through

Process:

- a saline solution is passed into the peritoneum of the patient by a catheter
- Wastes diffuse from the body fluids and pass through the membrane that lines the peritoneum into the saline solution, which is then drained out by another catheter
- The benefit of this is that the circulation of blood isn't used, minimising the risk of blood clotting and infection

Advantages	Disadvantages
<ul style="list-style-type: none"> • Allows for removal of metabolic wastes when kidneys no longer function • Provides a long-term solution • Most hospitals offer dialysis 	<ul style="list-style-type: none"> • Works only by passive, not active transport, so not all wastes can be filtered • Requires repeated, large blocks of time • Does not cure kidney disease