OCR (A) Biology GCSE

Topic 6: Global Challenges

Notes

(Content in bold is for higher tier only)

Monitoring and maintaining the environment

Investigating biodiversity (6.1a)

Biodiversity: the variety of different species of organisms on Earth or within an ecosystem. High biodiversity means the ecosystem will be stable, as species would be less dependent on each other for things such as food and shelter.

Quadrats

- Quadrats are used to study ecology, as they make it easier to estimate distribution and abundance of organisms within a large area by looking at a few smaller representative samples.
- A transect is a defined area where the samples will be taken and is used to estimate the number of organisms across the whole area, such as across a whole field.
- The quadrats are placed along the transect and the amount of each organism is counted.
- The quadrats can also be randomly placed across the whole area, rather than using a transect.
- Alternatively, percentage cover can also be estimated but this is subjective and less accurate than counting which gives a quantitative value.
- The accuracy of the quadrat estimations can be improved by doing more samples, repeat testing or completing the sampling over larger transects.

Nets

- Nets are useful for collecting flying insects, such as butterflies
- The nets are swept through long grass and counted
- This is repeated over different areas to get an estimate of population

Pooters

- A pooter is a small jar used to collect animals
- One tube goes over the insect and you suck into the other tube in order to apply suction
- There is a mesh covering to stop insects being swallowed

Pitfall traps

- Pitfall traps are used to sample small insects, such as beetles or spiders
- A container is buried in the ground and the top is covered by a piece of wood with a gap to allow insects to climb in
- The sides of the container are high and smooth to stop the insects crawling out again
- The traps are checked regularly to make sure that the insects are not eaten
- The capture-recapture method is usually used for this
    - Insects that fall into the trap are marked harmlessly and then a few days later the trap is set up again. The number of marked animals in the second sample are recorded and if there are few or none marked then it indicates a large population size.
    - You have to assume that there is no death or movement of animals to other habitats in between the time the two samples are taken and that the marking did not affect the survival rate (e.g. markings did not make them more visible to predators).

Human interactions with ecosystems (6.1b)

Negative impacts

- Land use:
  - More land is being used for houses, farming, shops, roads and factories, which destroys habitats.
- Hunting:
  - Hunting and fishing has led to many species becoming threatened
  - Causes disruption in food webs and therefore environmental imbalances
- Pollution:
  - Sewage, fertiliser and toxic chemicals pollute the water
  - Smoke and acidic gases pollute the air.
  - Landfill and toxic chemicals can result in the pollution of the land.
  - These all lead to the death of plants and animals.
- Deforestation:
  - The cutting down of a large number of trees in the same area, in order to use the land for something else.
  - Occurs in tropical areas to: provide land for cattle and rice fields and to grow crops (e.g. sugarcane, maize) for biofuels which are used to produce energy
  - As trees contain carbon, burning them results in more CO_2 being released into the environment which contributes to global warming. Following deforestation, microorganisms decompose the dead vegetation, producing CO_2 as they respire.
  - Trees take in CO_2 when they photosynthesise, so less trees means less CO_2 is taken in.
  - The number of habitats are reduced, decreasing biodiversity.

Positive impacts

- Preservation of habitats:
  - Maintaining rainforests to ensure habitats are destroyed
  - Preserving areas of scientific areas
  - Protection of rare habitats and development of new habitats
  - Replanting hedgerows as there is a higher biodiversity in them that the surrounding fields
- Reducing the rate of deforestation:
  - Selective logging - trees only felled when they reach a certain height
  - Afforestation - replacing cut down trees
- Breeding programmes:
  - To stop endangered animals becoming extinct
- Recycling:
  - Reduces the amount of land taken up for landfills
  - Reduces the rate at which natural resources are being used up

Benefits and challenges of maintaining local and global biodiversity (6.1c)

Benefits	Challenges
Conservation of species and habitats maintains biodiversity	It can be very expensive and difficult to monitor conservation scheme
Ecotourism brings in money to support conservation and educates people without disrupting their natural environment	It is difficult to get all countries to sign agreements, for example to stop overfishing, and so it may be difficult to have a large impact
Captive breeding programmes can prevent extinction	Captive breeding programmes may mean that some species can not be released back into the wild as they can't hund efficiently
Nature reserves reduce hunting by removing tusks and horns of animals so poachers have nothing to hunt for	Removing tusks and horns can be seen as unethical

The impact of environmental changes on distribution of organisms (6.1d) *Biology only*

Environmental changes affect the distribution of species in an ecosystem:

- **Temperature: Climate change may lead to insects migrating to places in the world which are becoming hotter**
- **Water availability: Populations will migrate to find water**
- **Atmospheric gas composition: Certain pollutants can affect the distribution of organism, e.g lichen cannot grow in places where sulfur dioxide is present.**

Feeding the human race

Biological factors affecting food security (6.2a)

Biology only

An increasing human population means that it is becoming difficult to ensure that everyone is able to have food (food security). Sustainability is an issue because:

- More of the population is becoming wealthy and so their diet changes to an increase in meat and fish consumption
  - These aren less energy efficient than eating plants (remember the loss of energy the further up the food chain you go) and they use a lot more space than crops do.
- Global warming may lead to droughts which will make it more difficult to grow crops.
- New pests and pathogens are constantly entering but the genetic modification and selective breeding of certain crops and animals means increased vulnerability to new pathogens.

Agricultural solution to the growing human population (6.2b)

Biology only

- Hydroponics: growing crops in glasshouses by replacing soil with a mineral solution, allowing for careful control of growth by adjusting temperature etc.
  - However, it is very expensive
- Biological control: release a natural predator into the area where the crops are being grown
  - However, may affect other organisms in the food web and the predator might be hard to control
- Gene technology: modifying crops or animals to have better yields, e.g. plants producing bigger fruits
- Herbicides: used to get rid of competing plants so that the maximum amount of energy and mass is conserved
  - However, reduces biodiversity and may have unintentional health consequences
- Insecticides and pesticides: gets rid of animals that eat the crops so that the maximum amount of energy and mass is conserved
  - However, reduces biodiversity, may pass up the food chain to birds and may have unintentional health consequences

Selective breeding (6.2c)

Selective breeding or artificial selection is when humans breed certain plants or animals which have desirable characteristics. This could be by breeding cows that produce large amounts of milk with cows that have a lot of meat.

Process:

1) Select individuals with desirable characteristics and breed together
2) Choose the best offspring and breed them together
3) Repeat process over many generation until all the offspring have the desired characteristic

Desirable characteristics in plants: disease resistance, large flowers, large fruits

Desirable characteristics in animals: animals producing lots of meat, chickens that lay large eggs

Advantages	Disadvantages
Can produce varieties that can produce more of better quality food to meet the demands of a growing population	Reduced gene pool - leads organisms vulnerable to new pathogens and can increase chances of inherited recessive defects
Can create animals that are more gentle, e.g. domestic dogs	Unforeseen physical problems, e.g. large chickens are sometimes unable to walk

Genetic engineering (6.2d-f)

Genetic engineering is a process where the genome of an organism is modified by introducing desirable characteristics. For example, crops made have more resistant alleles added so that they do not die in winter, therefore improving yields and profits. Another example is bacterial cells that have been engineered to produce human insulin to treat diabetes.

Steps of genetic engineering

1) **Genes from chromosomes are 'cut out' using restriction enzymes leaving 'sticky ends' (short sections of exposed, unpaired bases)**
2) **A virus or bacterial plasmid is cut using the same restriction enzyme to also create sticky ends. This also contains an antibiotic marker gene.**
3) **The loop and gene sticky ends are then joined together by DNA ligase enzymes**
4) **The combined loop is placed in a vector, such as a bacterial cell, and then allowed to multiply as it will now contain the modified gene. As the bacteria grows we can see which ones are resistant to antibiotics. The colonies that are will be the bacteria that are also producing the modified gene, as they were inserted together.**

Benefits and risks of genetic engineering...

Perceived benefits	Perceived risks
It can be very useful in medicine to mass produce certain hormones in microorganisms (bacteria and fungi).	GM crops might have an effect on wild flowers and therefore insects. • GM crops are infertile and these genes could spread into wild plants, leading to infertility in other species, which affects the entire environment. • Growing with herbicides and pesticides can kill insects and other plants, which would reduce biodiversity.

In agriculture it can be used to improve yields by: • Improving growth rates • Introducing modifications that allow the crops to grow in different conditions, e.g. hotter or drier climates • Introducing modifications that allow plants to make their own pesticide or herbicide	People are worried that we do not completely understand the effects of GM crops on human health.
Crops with extra vitamins can be produced in areas where they are difficult to obtain.	Genetic engineering in agriculture could lead to genetic engineering in humans. This may result in people using the technology to have designer babies.
Greater yields can help solve world hunger, which is becoming an increasingly bigger issue due to population growth.	They pose a selection pressure, which could lead to increased resistance in other species, creating super weeds and pests.

Genetic modifications (6.2g)
Biology only

Crops can be genetically modified in order to contain nutrients in countries where it may be difficult to obtain these nutrients naturally. For example, Golden Rice was created with beta-carotene from a daffodil, in order to make vitamin A in the body. In countries where the climate means that a large variety of crops cannot be grown this is a good solution to ensure that less people get deficiencies in nutrients.

Monitoring and maintaining health

Health and disease (6.3a-c)

Health is the state of physical and mental wellbeing. A disease is a disorder that affects the body, organs or cells.

Diseases can be split into two categories:

- Communicable: contagious diseases that can spread between people, caused by a pathogen
  - E.g. chickenpox, malaria, HIV
- Non-communicable: non-contagious diseases
  - E.g. diabetes, heart conditions, neurological diseases, cancer from carcinogens
  - Often caused by lifestyle factors, such as diet, stress, lack of exercise, alcohol

Interactions between diseases

HIV and TB:

- HIV affects the strength of the immune system
- Tuberculosis (TB) is a common bacterial disease that is found in HIV patients because they are more susceptible to infectious diseases

- TB mainly affects the lungs

HPV and cervical cancer:

- Viruses living in cells can trigger cancers
- Most cervical cancer cases are linked with the HPV virus

Communicable diseases (6.3d-f)

Viral infections

Viruses infect and live inside a host cell. They replicate their DNA many times and then burst in order to release the virus and infect nearby cells. Viral infections cannot be treated by antibiotics.

In humans: Human Immunodeficiency Virus (HIV)

- Description: initial flu-like symptoms
- Spread: by bodily fluids, commonly through sexual activities or through injecting drugs and then sharing needles with people infected with HIV
- Prevention: using condoms, not sharing needles, mothers with HIV bottle-feeding children
- Complications: HIV can develop into Acquired Immune Deficiency Syndrome (AIDS) which remains dormant for some time after HIV infection and then attacks the person's immune system
- Treatment: no cure for HIV but people are given antiviral drugs in order to stop its development into AIDS

In plants: Tobacco Mosaic Virus (TMV)

- Description: infects chloroplasts of levels and changes the green to white spots in a mosaic pattern, which means that the tobacco plant cannot photosynthesise properly and will die
- Spread: transmitted by contact between plants
- Prevention: good field hygiene, pest control, growing TMV-resistant strains

Bacterial diseases

In humans: Salmonella (food poisoning)

- Description: bacteria living in the gut of animals spreading when the meat is ingested by humans
- Symptoms: fever, stomach cramps, vomiting, diarrhoea
- Spread: found raw meat and eggs, unhygienic conditions
- Prevention: keeping raw meat away from cooked food, avoid washing it, wash hands and surfaces when handling it, cook food thoroughly

In plants: crown gall disease *(Agrobacterium tumefaciens)*

- Description: transfers some of its own DNA to the infected plant's DNA
- Symptoms: like a cancer and a tumour develops in the stems or roots, plants become stunted

Fungal diseases

In humans: Athlete's foot

- Symptoms: rash found between toes, red or white flaky skin

- Spread: touching infected skin or surfaces, so is commonly found in swimming pool changing rooms
- Treatment: antifungal medication

In plants: barley powdery mildew *(Erysiphe graminis)*

- Description: affects grass plants, such as barley. Eventually the plant can no longer make chlorophyll and therefore cannot photosynthesis
- Symptoms: circular fluffy white growth on leaves, fungus produces spores to reproduce which are spread in the wind, hyphae produced on upper and lower leaf surfaces
- Spread: common in cool, damp environments.
- Treatment: fungicides, removing infected leaves

Protist diseases

In humans: malaria

- Description: enter red blood cells and replicate, then burst to spread pathogen further
- Symptoms: shivering and fevers (caused by the bursting)
- Spread: female Anopheles mosquito is the vector, protist enters human's bloodstream via saliva when mosquito punctures skin to feed on blood
- Prevention: using insecticide coated insect nets while sleeping, removing stagnant water to prevent the vectors from breeding, travellers taking antimalarial drugs to kill parasites that enter the blood.

The spread of communicable diseases can be reduced by visual identification of the disease, screening for antibodies against virus antigens (such as with HIV) or DNA identification (in the case of Agrobacterium as it transfers DNA to the plant).

Defence responses in plants (6.3g and h)
Biology only

Physical defences:

- Bark: external layer of dead cells forming barrier against infection
- Cell wall: made of cellulose
- Leaf cuticle: waxy outer layer to prevent pathogens passing through

Chemical defences:

- Antimicrobial substances: mint and witch hazel produce this to limit the spread of bacteria that were not stopped by physical defences. These are used by humans as antiseptics.
- Poisons: stinging nettles release poison to stop themselves being eaten

Detection of plant diseases (6.3i)
Biology only

ELISA (Enzyme-Linked Immunosorbent Assay)

This can be used to see whether a plant contains a pathogen antigen and is therefore infected

1) **Liquidise plant sample**
2) **Add sample to plastic tube or microtiter plate**
3) **Leave for 5 minutes so that all the proteins in the plant have bound to the plastic**
4) **Wash the wells with buffered salt solution to wash off any excess protein that has not bound to the plastic**
5) **Add blocking agent to block any uncoated plastic and then wash off again with the salt solution**
6) **Add an antibody-enzyme complex specific to the pathogen antigen and then wash off with the salt solution**
7) **Add a colourless substrate that the enzyme will change to a coloured product so if the pathogen antigen is in the liquid the tube will change colour.**

Polymerase chain reaction (PCR)

A process allowing a small section of DNA to be copied billions of times

1) **Add 2 primers, nucleotides and DNA polymerase into tube**
    - **2 primers (short pieces of DNA) are needed to match each end of the DNA segment that is meant to be copied**
    - **DNA polymerase reads the DNA and makes a copy, by attaching nucleotides at at a primer**
2) **The DNA is heated to 95°C to unzip the double helix of DNA and denature it**
3) **It is cooled to 55°C to allow the primers to anneal**
4) **It is heated to 72°C as this is the optimum time for DNA polymerase to work**

Observation

Observation is not only how the plant looks, but also the feel and smell etc. For example: stunted growth, presence of fungus. We can also use microscopy to detect diseased leaves.

The immune system (6.3j-o)

Non-specific defences

The non-specific defence system works to prevent pathogens from entering the body.

1. The skin
    - Acts as a physical barrier
    - It produces antimicrobial secretions to kill pathogens
    - Good microorganisms known as skin flora compete with the bad microorganisms for space and nutrients

2. The nose
    - Has hairs and mucus (sticky substance) which prevent particles from entering your lungs
3. The trachea and bronchi
    - Secrete mucus in order to trap pathogens
    - Cilia (hair-like structures on cells) beat to waft mucus upwards so it can be swallowed
4. The stomach
    - Produces hydrochloric acid that kills any pathogens in your mucus, or food and drink
5. Phagocytic white blood cells
    - One type of white blood cell can do a process called phagocytosis, where the pathogen is engulfed and killed
    - As they are able to do this with any type of pathogen it is a non-specific function

Specific defences

The specific immune system acts to destroy any pathogens which pass through the non-specific immune system to the body.

White blood cells:

As mentioned before, white blood cells work by phagocytosis but they also have specific functions:

1) Producing antibodies (lymphocytes)
    - Each pathogen has an antigen on their surface, which is a structure which a specific complementary antibody can bind to.
    - Once antibodies begin to bind to the pathogen, the pathogens start to clump together, resulting in it being easier for white blood cells to find them.
    - If you become infected again with the same pathogen, the specific complementary antibodies will be produced at a faster rate. The individual will not feel the symptoms of the illness. They are said to be immune.
2) Producing antitoxins
    - WBCs neutralise the toxins released by the pathogen by binding to them.

Platelets:

- Platelets have proteins on their surface that helps them to clump together to heal a wound
- They secrete proteins that result in a clotting cascade, i.e. a chain reaction of different chemical reactions to help with forming clots.

Monoclonal antibodies (6.3m and n)
Biology only

Monoclonal antibodies are identical antibodies, that have been produced from the same lymphocyte (a type of white blood cell). As a result of their ability to bind to only one protein antigen, they can be used to target chemicals and cells in the body and so have many different medical uses, e.g. in pregnancy testing.

How they are produced

1) An antigen is injected into a mouse
2) The mouse produces lymphocytes, which have been stimulated to produce a specific antibody to the injected antigen.
3) Spleen cells from the mouse are removed, as this is where the lymphocytes are produced
4) The spleen cells are combines with human cancerous white blood cells called myeloma cells to form a cell called a hybridoma, which divides indefinitely
5) The hybridoma can divide to produce clones of itself, which all produce the same antibody many times.
6) The antibodies are collected and purified.

Uses

Pregnancy tests:

- A hormone called human chorionic gonadotrophin (hCG) is present in the urine of women who are pregnant.
- There are two sections of the stick.
- The first section has mobile antibodies complementary to the hCG hormone- these antibodies are also attached to blue beads.
- The second section has stationary antibodies complementary to the hCG hormone which are stuck down to the stick.
- The individual urinates on the first section, and if hCG is present it binds to the mobile antibodies attached to blue beads to form hCG/antibody complexes.
- They are carried in the flow of liquid to the second section.
- The stationary antibodies then bind to the HCG/antibody complexes.
- As they are each bound to a blue bead, this results in a blue line.
- This indicates that you are pregnant.

In the diagnosis of cancer:

- Cancerous cells have antigens
- Monoclonal antibodies can be designed to bind to these specific antigens, causing them to clump together
- They may have a marker, such as a fluorescent dye, attached to them to help identify the location of the tumour in the body
- Once the tumour has been identified it can be treated or removed.

- **Monoclonal antibodies have successfully been used to detect and treat prostate cancer in men.**

In the treatment of cancer:

- **Drugs can be attached to the monoclonal antibody so that when it binds to the cancer antigen it can deliver the toxic substance. This is better than radiotherapy or chemotherapy as it will only target cancer cells, reducing the side effects.**
- **They can also encourage white blood cells in the immune system to attack the cancer cells directly.**

Advantages of using monoclonal antibodies	Disadvantages of using monoclonal antibodies
They only bind to specific cells, meaning healthy cells are not affected.	**It is difficult to attach monoclonal antibodies to drugs.**
They can be engineered to treat many different conditions.	**They are expensive to develop.**
We are now able to produce mouse-human hybrid cells to reduce the chance of triggering an immune response.	**As they were produced from mice lymphocytes, they often triggered an immune response when used in humans.**

Prevention and treatment of diseases (6.3o)

Vaccines

Vaccinations involve making an individual immune to a certain disease- they are protected against it before they have been infected. By immunising a large proportion of the population, the spread of the pathogen is reduced as there are less people to catch the disease from (called herd immunity).

Naturally, when you are infected with a pathogen, you feel ill until white blood cells manufacture the correct specific antibody to combat it. Upon a secondary infection, the antibodies can be produced much quicker, so the pathogen can be destroyed and the symptoms are not felt. Vaccinations replicate the first infection so that when the person is exposed to the real disease they do not feel any symptoms, just like in a secondary infection.

- The vaccine contains a dead or inactivated form of the pathogen
- This stimulates white blood cells to produce antibodies complementary to the antigens on the pathogen

Advantages of vaccination	Disadvantages of vaccination
They have eradicated many diseases so far (e.g smallpox) and reduced the occurrence of many (e.g rubella).	They are not always effective in providing immunity.
Epidemics (lots of cases in an area) can be prevented through herd immunity.	Bad reactions (such as fevers) can occur in response to vaccines (although very rare).

Antibiotics

Antibiotics are medicines that that kill bacterial pathogens inside the body, without damaging body cells. They cannot kill viruses as they use body cells to reproduce, meaning any drugs that target them would affect body tissue too. Antibiotics can be taken as a pill, syrup or directly into the bloodstream Different antibiotics are effective against different types of bacteria, so receiving the correct one is important. Their use has decreased the number of deaths from bacterial diseases, such as with Penicillin.

Antibiotic resistance:

- Mutations can occur during reproduction resulting in certain bacteria no longer being killed by antibiotics
- When these bacteria are exposed to antibiotics, only the non-resistant one die
- The resistant bacteria survive and reproduce, meaning the population of resistant bacteria increases
- This means that antibiotics that were previously effective no longer work, making it a huge issue in treating bacterial infections.
- Resistance can be prevented by stopping the overuse of antibiotics, which unnecessarily exposes bacteria to the antibiotics and also to finish courses of antibiotics to ensure that all the bacteria is killed.

Antivirals

Viral diseases cannot be treated using antibiotics but antivirals can be used to stop virus replication. The virus hijacks the cell's normal processes in order to copy its own DNA so it would not be possible to kill the virus without damaging human cells and so stopping replication is the only option.

Antiseptics

These are chemicals that kill foreign microorganisms, commonly used in sterilising a wound to avoid infection and therefore the spread of disease.

Aseptic techniques in culture (6.3p)
Biology only

The effectiveness of antiseptics and antibiotics must first be tested on agar plates.
Aseptic techniques are procedures that are carried out in such as a way to prevent the contamination of pure cultures. For antibiotics the bacteria are grown in laboratory conditions so that the results are accurate.

Process:

1) Work space is cleaned and sprayed with disinfectants to kill any existing bacteria that could cause contamination
2) Glass petri dishes and agar gel are sterilised using an autoclave
3) Agar is poured into the sterile petri dishes and allowed to set
4) Work around a blue Bunsen burner flame to create an updraft so bacteria from the air does not contaminate the agar.
5) Bacterial suspension should be swirled (not shaken) to make sure it is mixed well
6) Sterilise inoculating loop by heating in blue Bunsen burner flame or in pure alcohol
7) Put the mouth of the bacterial bottle in Bunsen burner flame to kill unwanted bacteria on bottle
8) Dip loop into solution and make streaks on the agar plate to allow the creation of separate colonies
9) Place the lid of the petri dish back on and secure with tape, then label the bottom (so even if the lid falls the bacteria is still labelled) and store the plate upside down. The lid should not be fully sealed as oxygen is needed to bacteria to respire aerobically.
10) Incubate at maximum of 25°C to reduce the chances of harmful bacteria growing, which would occur at body temperature (37°C).
11) All contaminated materials should be disposed of and work surfaces should be disinfected.

A zone of inhibition occurs around a bacteria colony that has stopped growing and so indicates that the antibiotic has worked. The zone of inhibition is calculating by using πr^2 by measuring the diameter of the circle and dividing it by two to give the radius. A larger zone of inhibition means that the antibiotic or antiseptic is more effective.

New medicines (6.3q)

Discovering new medicines

- Most new drugs originate from plants that have been used as sources of natural healing for years
- For example, willow bark was used for fever and it was found that the active ingredient salicylic acid was what helped. This has now been used to create aspirin.
- This is one of the reasons that the rainforests being destroyed is worrying - there may be many plants and organisms in nature that can help with modern medicine.

Testing new drugs

1) Preclinical drug trials
    - Drugs are tested using computer models or human cells in a laboratory
    - The first stage is important to see the effect on living cells before it is tested on animals
2) Animal testing
    - In the UK it is legal for medicines to be tested on animals but it is not legal for cosmetic products.
    - Testing on animals allows us to observe any possible side effects, so that the manufacturers can adjust the dosage before it is given to patients.
3) Human clinical trials
    - The drugs are first tested on health volunteers who are continually monitored
    - If they pass this, they are then tested on the target patients in low doses
    - The dose is then increased up to the optimum dosage
    - In human clinical trials they test the drug against placebos (inactive versions of the drug) in a blind trial
        - The volunteer group is split into 2 and half are given the real drug and half the placebo without telling them which one they will be receiving (hence blind trial)
        - This allows scientists to see whether the effect is actually from the drug or from some other factor.

The importance of thoroughly testing drugs has been proved by the case of Thalidomide in the 50s, a drug that was initially created as a sleeping pill but was given to pregnant women to prevent morning sickness. However, it has not been properly tested and it led to many birth defects, with many babies being born with missing limbs.

Non-communicable diseases (6.3r-u)

Non-communicable diseases include cardiovascular diseases (CVD), cancers, type 2 diabetes, liver disease and many others. They are caused by the interaction of many factors, such as genetic factors, diet and other lifestyle factors such as smoking.

Lifestyle factors and NCDs

Exercise and diet

- Obesity leads to high blood pressure, which increases the chances of fatty deposit build up in arteries
- Body fat affects the body’s sensitivity to insulin and so can increase the chances of developing type 2 diabetes

Alcohol

- The liver can regenerate but long-term alcohol abuse can cause long-term damage
- Alcohol causes lipids to build up in the liver, which causes fatty liver disease
- It can also lead to alcoholic hepatitis, where the liver becomes inflamed
- Liver cirrhosis can also occur, where the liver is scarred and can no longer function
- Long-term drinking can cause brain shrinkage, memory loss and psychiatric problems

- The rates of drinking during pregnancy is decreasing worldwide, due to awareness of how it can harm babies.

Smoking

- Smoking damages the lining of arteries, which encourage fatty materials to build up and cause heart attacks or strokes
- Chemicals in cigarettes can increase the chances of blood clots, which can lead to heart attacks
- The carcinogens can lead to lung cancer.
  - The prevalence of lung cancer in women is increasing, whilst in men it is decreasing. This is because, unlike men, there was a continued increase in women smokers in the 60s before the numbers dropped. As lung cancer takes time to develop, we have yet to see the drop in lung cancer in women.
- Carbon monoxide reduces the amount of oxygen that can be carried in red blood cells
- Nicotine increases heart rate, which puts more strain on the heart than needed
- Smoking damages the bronchioles and alveoli and causes inflammation, which causes mucus to build up. This makes it difficult to breathe as chronic obstructive pulmonary disease (COPD) develops.

<u>Cardiovascular disease (CVD)</u>

Cardiovascular disease includes coronary heart disease and heart attacks.

Heart attacks:

1) A build up of cholesterol (caused by saturated fats) causes fatty deposits in the wall of coronary arteries
2) A blood clot can form as blood cannot get through the now narrowed coronary artery properly
3) The blood clot causes a block and so the heart muscle cannot get any oxygen or nutrients
4) This initially causes chest pain (angina) but if it is not treated the heart will be so deprived that the cells start to die and since they cannot regenerate the person has a heart attack.

Risk factors of CVDs:

- Smoking
- High blood pressure
- High salt in the diet
- High levels of saturated fat in diet

Treating CVD:

Lifestyle choices:

- Exercising regularly
- Not smoking
- Losing weight if obese
- Reducing amounts of saturated fats in diet

Statins:

- Drugs that lower the blood cholesterol by reducing its production in the liver

- Given to those with heart disease or those with a high risk of developing it
- Must be taken long-term
- Like all drugs it has side effects and is not suitable for people with liver disease

Stents:
- A wire mesh tube inserted into the coronary arteries to keep them open so blood can flow through properly
- Made of metal alloys to avoid immune rejection

Coronary artery bypass:
- Surgery is sometimes needed in extreme cases
- A blood vessel from one part of the body (e.g. leg) is attached to the coronary artery above and below the blockage (creating a graft) to allow a different path for blood to flow.

Heart transplant
- A donor heart may be needed for heart failure, where the heart cannot pump enough blood and therefore oxygen and nutrients around the body
- There is a very long waiting list and there is a risk of rejection by the body so after the surgery the person will have to be on immunosuppressant drugs for the rest of their life, increasing their risk of catching infectious diseases.
- Plastic artificial hearts can be used whilst patients are waiting for the transplant.

Cancer

Cancer is the result of changes in the cell that lead to uncontrolled growth and division (tumours). Tumours can be either benign or malignant:

Benign	Malignant
Grow slowly	Grow quickly
Grow within a membrane so can be easily removed and do not usually grow back	Cancerous
Do not spread to other parts of the body	Cancer cells detach and travel in the bloodstream to other parts of the body to form secondary tumours (metastasis)

Risk factors:
- Carcinogens (chemicals that cause cancer): damage DNA and therefore increase the chance of mutations
- Age: more likely to develop cancer with age as there have been millions of replications and therefore more chances of mutation occurring
- Genetic factors: for certain cancers, such as breast cancer with the BRCA1 gene
- Lifestyle factors:
    - HPV is spread through sexual intercourse
    - Smoking causes lung cancer

- Alcohol increases likelihood of liver cancer
- Sunbathing increases UV radiation which is linked to skin cancer
- Exposure to asbestos can cause cancers

Growing technology in health (6.3v-x)

Stem cells in medicine

Stem cells have already been described in Topic 2 (2.1d) but they have many applications in medicine.

Benefits	Risks
Can be used to replace damaged cells, such as in type 1 diabetes, multiple sclerosis and paralysis caused by spinal cord injuries	Ethical issues of destroying unused embryos
Bone marrow transplants for adult stem cells can be used to treat blood cell cancers, such as leukaemia	No guarantee in how successful these therapies will be
Can grow whole organs for transplants	Mutations could occur in cultured stem cells
No rejection, as it is made from the body	Difficult to find suitable stem cell donors

Gene technology in medicine

The process of genetic engineering has already been described in section 6.2d.

Human insulin:

One application of genetic engineering that was mentioned was in creating human insulin. Previously, insulin from pigs and other animals were used to treat diabetes but it was not very effective and there was a risk of passing disease or causing an allergic reaction. Therefore, gene technology has revolutionised the production of insulin.

The insulin gene is cut out using restriction enzymes and then inserted into a plasmid using ligase enzymes and this plasmid is then taken up by bacteria to multiply by binary fission. Bacteria are ideal because they reproduce asexually and so all the daughter cells are genetically identical.

Inherited conditions:

Genetic engineering can also be used to treat genetically inherited conditions. The faulty gene can be cut out of the patient's DNA and replaced with a working gene.

Genetic testing for diseases such as Huntington's disease can also be carried out. Huntington's disease does not start showing symptoms until around the 40s, which is usually the time that people have already had children and therefore already passed the genes on. It can therefore be extremely beneficial to test for the disease before starting a family.

The human genome

We have come a long way in understanding the human genome thanks to the Human Genome Project. It has allowed us to understand the genes that cause different diseases and therefore we are able to predict the likelihood of diseases occuring. It has also allowed us to get a better understanding of the effectiveness of treatment by drugs that target genomes.