Molecules, Biodiversity, Food and Health

Biological Molecules

Biological Molecules

(a) describe how hydrogen bonding occurs between water molecules, and relate this, and other properties of water, to the roles of water in living organisms;

Water is a polar molecule. This is because the oxygen atom pulls the shared electrons towards it, meaning that water is slightly negatively charged at the oxygen and positively charged at the hydrogen ends, so they can form hydrogen bonds with each other. This are continuing breaking and reforming, so the molecules can move around.

Property of water	**Importance**	**Examples**	**Hydrogen bonds**
Solvent	Metabolic processes in all organisms rely on chemicals being able to react together in solution	70-95% of cytoplasm is water. Dissolved chemicals take part in processes such as respiration and photosynthesis in living organisms	If the solute is slightly charged or ionic, they will interact with water molecules. The water molecules will cluster around the charged parts, keeping solute molecules apart
Liquid	The movement of materials around organisms, both in cells and on a large scale in multicellular organisms requires a liquid transport medium	Blood in animals and the vascular tissue in plants use water as a liquid transport medium	Water remains liquid over a large temperature range and can act as a solvent for many chemicals
Cohesion	Water molecules stick to each other creating surface tension at the water surface. Cohesion also makes long, thin water columns very strong and difficult to break	Transport of water in the xylem relies on water molecules sticking to each other as they are pulled up the xylem in the transpiration stream Some small organisms make use of surface tension to 'walk on water'	A drop of water on the waxy surface of the leaf looks almost spherical- it hardly wets the leaf at all. This is because hydrogen bonds pull the water in at the surface. This is cohesion, which also results in surface tension
Freezing	Water freezes, forming ice on the surface. Water beneath the surface becomes insulated and less likely to freeze	Organisms such as polar bears live in an environment of floating ice packs. Lakes tend not to freeze completely, so aquatic organisms are not killed as temperatures fall	Water is unusual because its solid form is less dense than its liquid form. As water cools, its density increases until the temperature drops to 4˚C, the density increases again, so ice floats on water.
Thermal stability	Large bodies of water have fairly constant temperatures. Evaporation of water can cool surfaces by removing heat.	Oceans provide a relatively stable environment in terms of temperature Many land-based organisms use evaporation as a cooling mechanism, for example in panting or sweating	The hydrogen bonds in liquid water restrict the movement of the water molecules, so a relatively large amount of water is needed to increase the temperature of water The evaporation of water uses a relatively large amount of energy, so water evaporating from the surface 'removes' heat energy from the surface
Metabolic	Water takes part as a reactant in some chemical processes	Water molecules are used in hydrolysis reactions and in the process of photosynthesis	

(b) describe, with the aid of diagrams, the structure of an amino acid;

H_2N-CHR-COOH

(c) *describe, with the aid of diagrams, the formation and breakage of peptide bonds in the synthesis and hydrolysis of dipeptides and polypeptides;*

Synthesis

The –OH from one amino acid and the –H from the –COOH from the other are removed to make water, and the C and the N join together via a peptide bond (CONH)

Hydrolysis

A water molecule is used to break the peptide bond. The –H joins back to the N, and the –OH back to the C

(d) *explain, with the aid of diagrams, the term primary structure;*

The sequence of amino acids found in a protein molecule

(e) *explain, with the aid of diagrams, the term secondary structure with reference to hydrogen bonding;*

The coiling or folding of parts of a protein molecule due to the formation of hydrogen bonds formed at the protein is synthesised. The main forms are the α-helix and the β-pleated sheet.

(f) *explain, with the aid of diagrams, the term tertiary structure, with reference to hydrophobic and hydrophilic interactions, disulfide bonds and ionic interactions;*

The overall three-dimensional structure of a protein molecule. It is the result of interactions between parts of the protein molecule such as hydrogen bonding, formation of disulfide bridges and hydrophobic interactions

(g) *explain, with the aid of diagrams, the term quaternary structure, with reference to the structure of haemoglobin;*

Protein structure where a protein consists of more than one polypeptide chain. Haemoglobin has a quaternary structure as it is made up on four polypeptide chains.

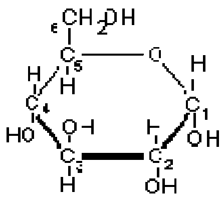
(h) *describe, with the aid of diagrams, the structure of a collagen molecule;*

Made up of three polypeptide chains, each about 1000 amino acids long, wound around each other. Hydrogen and covalent bonds (cross links) form between the chains. The cross links are staggered to make the molecule stronger.

(i) *compare the structure and function of haemoglobin (as an example of a globular protein) and collagen (as an example of a fibrous protein);*

Haemoglobin	**Collagen**
Globular protein	Fibrous protein
Soluble in water	Insoluble in water
Wide range of amino acid constituents in primary structure	Approx. 35% of the molecule's primary structure is glycine
Contains a prosthetic group- a haem	Does not have a prosthetic group
Much of the molecule is wound into alpha-helix structures	Much of the molecule consists of left-handed helix structures

(j) *describe, with the aid of diagrams, the molecular structure of alpha-glucose as an example of a monosaccharide carbohydrate;*



(k) *state the structural difference between alpha- and beta-glucose;*

In α-glucose the –OH on carbon 1 is below the plane of the ring. In β-glucose it is above the chain of the ring.

(l) *describe, with the aid of diagrams, the formation and breakage of glycosidic bonds in the synthesis and hydrolysis of a disaccharide (maltose) and a polysaccharide (amylose);*

Disaccharide

Formation

Water is eliminated as the –OH from one glucose and the –H from an –OH from the other leave. This means that the remaining O joins to the C on the other glucose making a disaccharide

Breaking

Water is used to break the glycosidic bond between the subunits. The –H returns to the O and the –OH returns to C_4

In polysaccharides, there are many glucose subunits joined together by 1,4-glycosidic bonds.

(m) compare and contrast the structure and functions of starch (amylose) and cellulose;

Amylose

Made up of α-glucose

Straight chain

Tends to coil up

Plant storage polysaccharide

Cellulose

Made up of β-glucose

In a chain, alternate glucose subunits are inverted

Forms straight chains

The β-glycosidic bond can only be broken down by a cellulose enzyme, which herbivors have, but humans do not

Forms plant cell walls

(n) describe, with the aid of diagrams, the structure of glycogen;

Mostly like amylase, as in it has many 1-4 glycosidic bonds, but there are 9% 1-6 branches.

(o) explain how the structures of glucose, starch (amylose), glycogen and cellulose molecules relate to their functions in living organisms;

Glucose

Simplists sugar. Used in respiration

Amylose

Insoluble in water so does not affect the water potential of the cell

Glycogen

Because it is so highly branched it can be broken down the glucose very quickly

Cellulose

Hundreds of the polypeptide chains lie side by side forming hydrogen bonds with each other- very strong

The arrangement of macrofibrils in cell wells:

allows water to move in and out easily

determines how a cell can grow or change shape

Cell walls can be reinforced with other substances to provide extra support, or make the walls waterproof

(p) compare, with the aid of diagrams, the structure of a triglyceride and a phospholipid;

Triglyceride

Glycerol plus three fatty acids

Phospholipid

Glycerol plus two fatty acids and a phosphate group

(q) explain how the structures of triglyceride, phospholipid and cholesterol molecules relate to their functions in living organisms;

Triglyceride

Compact energy store

Insoluble in water

Does not affect cell water potential

Phospholipid

Part hydrophilic, part hydrophobic, so ideal basis for cell surface membranes

Cholesterol

Small, thin molecules that can fit into the lipid bilayer giving strength and stability

(r) describe how to carry out chemical tests to identify the presence of the following molecules:

protein (biuret test),

If present, turns from pale blue to lilac

Reducing sugars (Benedict's test),

Add Benedict's, heat to 80˚C. From Blue to orange-red

Non-reducing sugars (Benedict's test),

If Reducing sugars test is negative, boil with hydrochloric acid, cool and neutralise with sodium hydrogencarbonate. Repeat Benedict's test.

starch (iodine solution)

Turns from yellow to blue-black if starch is present

lipids (emulsion test);

Mix the ethanol

Pour into water

If an emulsion forms, a lipid is present

(r) describe how the concentration of glucose in a solution may be determined using colorimetry

Benedict's test reveals the presence of reducing sugars

It results in an orange-brown precipitate

The more reducing sugar there is present, the more precipitate will be formed and the more Benedict's solution will be 'used up'. If the precipitate is filtered out, the concentration of the remaining solution can be measured

This will tell you how much Benedict's solution has been used up, and this can be used to estimate the concentration of reducing sugar in the original sample

Zero the device using a cuvette containing a 'blank'- usually water

Prepare a calibration curve by

Taking a range of known concentrations of reducing sugars

Carry out Benedict's test on each one then filter the precipitate out of each solution.

Use a calorimeter to give readings of the amount of light passing through the solutions

Plot the readings on a graph to show % transmission against concentration

Measure the % transmission of the unknown in the calorimeter

Use this to read the equivalent reducing sugar concentration from the % transmission

Nucleic acids

*(a) state that **deoxyribonucleic acid (DNA) is a polynucleotide, usually double stranded, made up of nucleotides containing the bases adenine (A), thymine (T), cytosine (C) and guanine (G);***

*(b) state that **ribonucleic acid (RNA) is a polynucleotide, usually single stranded, made up of nucleotides containing the bases adenine (A), uracil (U), cytosine (C) and guanine (G);***

(c) describe, with the aid of diagrams,

how hydrogen bonding between complementary base pairs (A to T, G to C) on two antiparallel DNA polynucleotides leads to the formation of a DNA molecule,

There are two types of nucleotide bases- pyramidines and purines. They always pair up together, with the purine Adenine always with the pyramidine Thymine, and the purine Guanine always with the pyramidine Cytosine. There are two hydrogen bonds between A and T, and three between G and C.

The strands are antiparallel because they run in opposite directions- the sugars are pointing in opposite directions.

and how the twisting of DNA produces its 'double-helix' shape;

The antiparallel chains twist like a rope ladder to form the final structure- a double helix.

(d) outline, with the aid of diagrams, how DNA replicates semi-conservatively, with reference to the role of DNA polymerase;

The double helix is untwisted

The hydrogen bonds between the bases are broken apart and the DNa 'unzips' to expose the bases

Free DNA nucleotides are hydrogen bonded onto their exposed complementary bases

DNA polymerade catalyses the formation of covalent bonds between the phosphate of one molecule and the sugar of the next

This continues all the way down the DNA until there are two identical strands

These are 'proof-read' by DNA polymerase to prevent mistakes

*(e) state that **a gene is a sequence of DNA nucleotides that codes for a polypeptide;***

(f) outline the roles of DNA and RNA in living organisms (the concept of protein synthesis must be considered in outline only).

Protein synthesis

The required gene can be exposed by splitting the hydrogen bonds that hold the double helix together in that region

RNA nucleotides form a complementary strand (mRNA). This is a copy of the DNA coding strand

The mRNA peels away from the DNA and leaves the nucleus from the nuclear pore

The mRNA attaches to a ribosome

Then tRNA molecules bring amino acids to the ribosome in the correct order, according to the base sequence on the mRNA

The amino acids are joined together by peptide bonds to give a protein with a specific tertiary structure

Enzymes

*(a) state that **enzymes are globular proteins, with a specific tertiary structure, which catalyse metabolic reactions in living organisms**;*

*(b) state that **enzyme action may be intracellular or extracellular;***

(c) describe, with the aid of diagrams, the mechanism of action of enzyme molecules, with reference to specificity,

The active site of an enzyme is a specific shape, depending on the reaction that it catalyses, meaning that other molecules won't fit into the active site

active site,

The area on an enzyme to which the substrate binds

lock and key hypothesis,

The theory of enzyme action in which the enzyme active site is complementary to the substrate molecule, like a lock and key

induced-fit hypothesis,

The theory of enzyme action in which the enzyme molecule changes shape to fit the substrate molecule more closely as it binds to it

enzyme-substrate complex,

The intermediary formed when a substrate molecule binds to an enzyme molecule

enzyme-product complex

The intermediate structure in which product molecules are bound to an enzyme molecule

lowering of activation energy;

Enzymes reduce the activation enthalpy so the reaction can proceed at a much lower temperature

(d) describe and explain the effects of

pH,

Low pH = lots of H^+ ions

H^+ ions have a positive charge

Either extreme of H^+ ion concentration can interfere with the hydrogen and ionic bonds holding the tertiary structure together.

The pH affects the charge of the amino acids at the active site, so the properties of the active site change and the substrate can no longer bind

At high pH values, a –COOH group will dissociate to become a charged $–COO^-$ group

temperature,

Up to a certain point, increasing temperature will increase the rate of reaction, as there will be more collisions between enzymes and the substrate, and more of these collisions will have the required activation enthalpy for the reaction to proceed.

But heat also makes the molecules vibrate. This puts strain on the inter-molecular bonds, and some of the weaker bonds (hydrogen bond and ionic bonds) may break.

In enzymes there are large numbers of these bonds holding the tertiary structure, and especially the active site, in place.

As the heat increases, more and more of these bonds are broken

The tertiary structure disintegrates further and further

The rate of reaction decreases

If enough of these bonds are broken, the entire tertiary structure will unravel and the enzyme will stop working

This is not reversible and is known as denaturation

enzyme concentration

As enzyme concentration increases, the rate of reaction increases linearly as there are more active sites are available, until the substrate concentration becomes a limiting factor and the rate stops increasing

substrate concentration

As the substrate concentration rises, the rate of reaction rises because there are more substrate molecules to react. At higher concentrations, all of the active sites become filled, so the rate of reaction remains the same

on enzyme activity;

(e) describe how the effects of

pH,

A starch-agar plate is made up by mixing starch with agar. The mixture is poured into a petridish and left to set. It forms a semi-rigid gel in the plate.

Cut wells into each plate using a cork borer

Into each well place the same volume of a different pH buffer solution

Into each well except one, place an identical volume of stock amylase solution

Into the well without the amylase, add an equal volume of distilled water as a control

Incubate for 24h in a dry oven at 35˚C

Flood the plate with an iodine solution and rise with water

Measure the diameter of the cleared zone- this gives an indication of how much substrate has been turned into product

temperature,

Take samples of potato tissue (containing catalase) using a cork borer then stick into discs of equal thickness

Place an equal number of discs in each of seven tissues and place one in each of a range of water baths from 20-80˚C

Place an equal volume of pH 7 buffer and hydrogen peroxide into each of sever separate test tubes and place one in each water bath. Allow to equilibrate.

Taking each in turn, add peroxide/buffer mixture to the potato discs, then fix a stopper and a side arm into the tube. Close the clip.

As oxygen gas is produced in the reaction it pushes the water bubble along the side arm. Time how long it takes for the bubble to move 5cm.

enzyme concentration

Use the reaction as before, but keeping the temperature constant, and instead having a different number of potato discs in each test tube

substrate concentration

As before, but keeping the temperature and the number of potato discs the same and changing the volume of hydrogen peroxide in each test tube

on enzyme activity can be investigated experimentally;

(f) explain the effects of competitive and non-competitive inhibitors on the rate of enzyme-controlled reactions, with reference to both reversible and non-reversible inhibitors;

Competitive inhibitor molecules

Have a similar shape to that of the substrate molecule. This means that they occupy the active site, forming enzyme-inhibitor complexes. These complexes do not lead to the formation of products because the inhibitor is not identical to the substrate.

The level of inhibition depends on the concentrations of inhibitor and substrate. Where the number of substrate molecules is increased, the level of inhibition decreases because a substrate molecule is more likely than an inhibitor molecule to collide with the active site.

Most competitive inhibitors do not bind permamently to the active site. They bind for a short period of time and then leave. Their action is described as reversible, as the removal of the inhibitor form the reaction mixture leaves the enzyme molecule unaffected.

Non-competitive inhibitors

Do not compete with substrate molecules for a place in the active site. Instead, they attach to the enzyme, molecule in a region away from the active site. The attachment of non competitive inhibitors distorts the tertiary structure of the enzyme molecule, leading to the shape of the active site changing. This means that they substrate no longer fits into the active site so the enzyme-substrate complexes cannot form and the reaction rate decreases.

The level of inhibition depends on the number of inhibitor molecules present. If there are enough inhibitor molecules to bind to all of the enzyme molecules presend, then the enzyme controlled reaction will stop. Changing the substrate concentration will have no effect on this form of inhibition

Most non-competitive inhibitors bind permanently to the enzyme molecule. The inhibition is irreversible, and any enzyme molecule bound by inhibitor molecules are effectively denatured.

(g) explain the importance of cofactors and coenzymes in enzyme-controlled reactions;

Cofactors

Ions that increase the rate of enzyme-controlled reactions. Their presence allows enzyme-substrate complexes to form more easily.

Coenzymes

Small, organic, non-protein molecules that bind for a short period of time to the active site. They may bind just before, or at the same time, as the substrate binds. In many reactions, coenzymes take part in the reaction, and like substrate, are changed in some way. Unlike the substrate, coenzymes are recycled back to take part in the reaction again. The role of coenzymes is often to carry chemical groups between enzymes so they link together enzyme-controlled reactions that need to take place in sequence.

Some coenzymes are permanent parts of the enzymes- prosthetic groups. These contribute to the shape of the enzyme.

*(h) state that **metabolic poisons may be enzyme inhibitors**, and describe the action of one named poison;*

Potassium Cyanide acts as a non-competitive inhibitor of the enzyme cytochrome oxidase, which is involved in the oxidation of ATP. When this is inhibited, aerobic respiration cannot occur, and so the organism can only respire anaerobically, which leads to a build up of lactic acid, toxic to the cells.

*(i) state that **some medicinal drugs work by inhibiting the activity of enzymes***

Food & Health

Diet & Food Production

(a) *define the term balanced diet;*

A diet that contains all the nutrients of the nutrients requires for health and growth.

(b) *explain how consumption of an unbalanced diet can lead to malnutrition, with reference to obesity;*

Malnutrition is caused by an unbalances diet. Obesity is called by consuming too much energy and the excess energy is deposited as fat in the adipose tissues. Obesity is the condition in which excess fat deposition impairs health and it usually defined when a person has a BMI (BMI = Mass (kg) / (height (m) ^{2})) of 30 or over. This indicated a body weight of 20% or more above the weight recommended for the height.

BMI	Category
<18.5	Underweight
18.5-25	Healthy
25-30	Overweight
30-35	Obese (class I)
35-40	Obese (class II)
>40	Morbidly obese

(c) *discuss the possible links between diet and coronary heart disease (CHD);*

Excess salt in the diet decreases the water potential of the blood. As a result, more water is held in the blood and blood pressure increases. This can lead to hypertension, which can damage the inner lining of the arteries, which is one of the early steps in the process of atherosclerosis

Saturated fats can cause damage to the heart

45-47% of deaths from cholesterol have been linked to high blood cholesterol levels

(d) *discuss the possible effects of a high blood cholesterol level on the heart and circulatory system, with reference to high-density lipoproteins (HDL) and low-density lipoprotein (LDL);*

Cholesterols are transported around the body in the form of lipoproteins.

High Density Lipoproteins

A combination of unsaturated fats, cholesterol and protein. They tend to carry cholesterol from the body tissues to the liver, where the cholesterol is used to make bile or broken down. Therefore, high levels of HDL are associated with reducing blood cholesterol levels. They cal reduce deposition on the artery walls.

Low Density Lipoproteins

Produced by the combination of saturated fats, cholesterol and protein. They tend to carry cholesterol from the liver to the body tissues. A high blood concentration of LDLs cause dispositions on the artery walls.

Saturated fats decrease the activity of LDL receptors, so as the blood LDL concentration rises; less is removed from the blood, resulting in higher concentrations of LDL in the blood, which are then deposited on the artery walls.

(e) *explain that humans depend on plants for food as they are the basis of all food chains. (**No** details of food chains are required);*

Plants can carry out photosynthesis to convert light energy to chemical energy. They also absorb plants from the soil and manufacture a range of other biological molecules. Herbivores make use of these biological molecules when they eat and digest food. Humans eat both plants and herbivores, gaining our nutrition both directly and indirectly.

(f) *outline how selective breeding is used to produce crop plants with high yields, disease resistance and pest resistance;*

A pair of plants which display the desired characteristics are allowed to reproduce. The offspring produced are sorted carefully to select those with the best combination of characteristics and only those offspring are allowed to reproduce. If this careful selection and controlled reproduction continues for many generations, the required characteristic becomes more exaggerated.

e.g. Tomatoes have been bred with improved disease resistance

(g) *outline how selective breeding is used to produce domestic animals with high productivity;*

(h) A pair of animals which display the desired characteristics are allowed to reproduce. The offspring produced are sorted carefully to select those with the best combination of characteristics and only those offspring are allowed to reproduce. If this careful selection and controlled reproduction continues for many generations, the required characteristic becomes more exaggerated.

e.g. chickens bred for eggs lay over 300 eggs a year, whereas their unselective relatives can lay only 20-30

(h) describe how the use of fertilisers and pesticides with plants and the use of antibiotics with animals can increase food production;

Fertilisers

Replace minerals in the soil which may have been removed by the previous crops. They contain Nitrate, Phosphate and Potassium. They increase the rate of growth and the overall size of crops

Pesticides

Kill organisms that cause diseases in crops. These organisms would reduce yield or kill the crop. Many crops are sprayed with fungicides to reduce fungal growth in the leaves or roots. Sheep are dipped to kill ticks.

Antibiotics

Infected animals can be treated with antibiotics to reduce the spread amongst animals that are intensively farmed in close proximity to each other. Such diseases could reduce the growth performance of the animals and may impair reproduction.

(i) describe the advantages and disadvantages of using microorganisms to make food for human consumption;

Advantages

- **Production of protein can be many times faster than that of animal or plant protein**
- **Production can be increased or decreased according to demand**
- **No animal welfare issues**
- **They provide a good source of protein for vegetarians**
- **The protein contains no animal fat or cholesterol**
- **Single-cell protein production could be combined with removal of waste products**

Disadvantages

- **Many people may not want to eat fungal protein that has been grown on waste**
- **The microorganisms are grown in huge fermenters and need to be isolated from the material on which they grow**
- **The protein has to be purified to ensure it is uncontaminated**
- **The conditions needed to grow the useful organisms are ideal for pathogenic organisms. Care needs to be taken to ensure that the culture is not infected**
- **The protein does not have the taste or texture of traditional protein sources**

(j) outline how

salting,

Dehydrates any organisms as water leaves them by osmosis

adding sugar,

Dehydrates any organisms as water leaves them by osmosis

pickling,

Acid pH denatures any microorganism's proteins and enzymes

freezing,

Retards enzyme activity so their metabolism, growth and reproduction is slow

heat treatment

Kills harmful organisms

irradiation

Kills organisms by disrupting their DNA structure

can be used to prevent food spoilage by microorganisms.

Health and disease

(a) discuss what is meant by the terms health and disease;

Health

A state of mental, physical and social wellbeing

Disease

A departure from good health caused by a malfunction of the mind or body

(b) define and discuss the meanings of the terms parasite and pathogen;

Parasite

An organism that lives on or in another living thing causing harm to its host

Pathogen

An organism that causes disease

(c) *describe the causes and means of transmission of malaria, AIDS/HIV and TB (knowledge of the symptoms of these diseases is not required);*

Malaria

If the host already has malaria, the female anopheles mosquito will suck the parasite gametes into its own stomach
The gametes fuse and the zygotes develop in the mosquito's stomach
Infective stages are formed and these move to the mosquito's salivary glands
When the mosquito bites another person, it injects a little saliva as an anticoagulant
The saliva contains the infective stages of the parasite
In the human host, the infective stages enter the liver where they multiply before passing into the blood again
In the blood they enter red blood cells, where the gametes are produced

HIV/AIDS

The virus enters the body by

- **Exchange of bodily fluids such as blood to blood contact**
- **Unprotected sexual intercourse**
- **Unscreened blood transfusions**
- **Use of unsterilised surgical equipment**
- **Sharing hypodermic needles**
- **Accidents such as 'needlestick'**
- **Across the placenta or during childbirth**
- **From mother to baby during breastfeeding**

It can remain unactive in the body for many years. Once the virus becomes active it attacks and destroys T helper cells in the immune system, effectively rendering the immune system useless

Tuberculosis

The bacteria are contained in the tiny droplets of liquids which are released when an infected person coughs, sneezes or talks. But it takes close contact with an infected person over a long period of time to contract the disease. There are a number of conditions which make contraction and spread more likely

- **Overcrowding- many people eating and sleeping together in one house**
- **Poor ventilation**
- **Poor health- particularly if a person has HIV/AIDS**
- **Poor diet**
- **Homelessness**
- **Living or working with people who are migrated from areas where TB is more common**

TB can also be contracted from the milk or meat of cattle.

(d) *discuss the global impact of malaria, AIDS/HIV and TB;*

Malaria

Kills about 3 million people annually
Affects about 300 million people
Currently limited to areas where the Anopheles mosquito can survive, which is currently the tropical regions.
But, with global warming, the Anopheles mosquito may be able to survive further north, even into parts of Europe.

HIV/AIDS

Spreading into pandemic proportions all over the world
Approximately 45 million people living with HIV/AIDS at the end of 2005
More than half of these are in Sub-Saharan Africa
About 5 million people infected each year
By the end of 2005, nearly 30 million people had died from HIV/AIDS related illnesses
It is thought that the number of people living with HIV/AIDS in China will soon exceed the number in any other country

Tuberculosis

Approximately 1% of the population is infected every year, and 10-15% of those will go on to develop the disease
In 2005 there were 8.8 million new cases of Tuberculosis and 1.6 million people died.
Up to 30% of the world's population may be infected with TB

(e) define the terms

immune response

The specific response to a pathogen, which involves the action of lymphocytes and the production of antibodies

antigen

Molecules that stimulate an immune response

antibody;

Protein molecules that can identify and neutralise antigens

*(e) describe the primary defences against pathogens and parasites (including skin and mucus membranes) and outline their importance. (**No** details of skin structure are required);*

Skin

The outer layer is called the epidermis, which consists of layers of cells. Most of these are called keratinocytes. They are produced by mitosis at the base of the epidermide and migrate out to the surface of the skin. As they migrate, they dry out and the cytoplasm is replaced by keratin. This takes about 30 days. But the time the cells reach the surface they are no longer alive. Eventually the dead cells slough off. The keratinised layer of dead cells acts are an effective barrier to pathogens

Mucous membranes

Oxygen and nutrients must enter our blood, so the body is exposed to infect as they could be harbouring microorganisms.

So, the airways, lungs and digestive systems are protected by mucous membranes. The epithelial layer contains mucus secreting-goblet cells. In the airways, the mucus lines the passages and traps any pathogens that may be in the air. The epithelium also has ciliated cells. The cilia move in a coordinated fashion to waft the layer of mucus up to the top of the trachea where it can enter the oesophagus. It is swalled and passes into the digestive system. Most pathogens in the digestive system are killed by the acid in the stomach (pH 2)

The eyes are protected by antibodies in the tear fluid

The wax in the ear canal traps pathogens

The conditions around the vagina are relatively acidic

(f) describe, with the aid of diagrams and photographs, the structure and mode of action of phagocytes;

Pathogen attachs to phagocyte by antibody and surface receptor

Pathogen engulfed by infolding of phagocyte membrane

Lysosomes release lysins into the phagosome (a vacuole with the pathogen trapped inside)

Harmless products of digestion are absorbed

(g) describe, with the aid of diagrams, the structure of antibodies;

Four polypeptide chains held together by disulfide bridges

Y-shaped

A constant region, which is the same in all antibodies. This enables the antibody to attach to the phagocytic cells and helps the process of phagocytosis

A variable region which has a specific shape and differs from one type of antibody to the next. It ensures that the antigen can attach only to the correct antigen

Hinge regions, which allow a certain degree of flexibility. They allow the branches to move further apart to allow attachment to more than one antigen

(h) outline the mode of action of antibodies, with reference to the neutralisation and agglutination of pathogens;

They attach to the antigens on a pathogen. The pathogen may use these antigens as a binding site, for example, which would bind to the host cell. If the antibody blocks this binding site, the pathogen cannot bind to its host cells- neutralisation.

Some antibodies are larger than the Y-shaped molecule. They resemble many Y-shaped molecules attached together, and so has a number of binding sites, meaning it can attach to multiple pathogens at the same time. If the antigens are all stuck together they cannot enter the host cell-agglutination.

(i) *describe the structure and mode of action of T lymphocytes and B lymphocytes, including the significance of cell signalling and the role of memory cells;*

- **Cell signalling**
  - **The immune response involves a coordinated response between a wide range of cells. To work effectively, these cells need to communicate.**
    - **A body cell is infected by a pathogen**
    - **Lysosomes will attempt to fight the invader**
    - **The pathogens will often be damaged, and parts of the pathogens may be presented on the plasma membrane of the infected cell**
      - **This can have two effects**
        - **Act as a distress signal and can be detected by cells from the immune system**
        - **Act as markers to indicate that the host cell is infected- T killer cells recognise that the cell is infected and must de destroyed**
    - **Pathogen engulfed by macrophage cells from the immune system**
    - **Removal of antigens from pathogens**
    - **Antigens presented on surface of engulfing cells**
      - **They then find the lymphocytes that can neutralise the particular antigen**
    - **Selection of correct T killer cells and T helper cells**
      - **ETIHER**
        - **Reproduction of T helper cells**
        - **Release of interleukins**
        - **Activation of B cells**
        - **Reproduction of B cells**
          - **EITHER**
            - **Some B cells differentiate to make plasma cells**
            - **Plasma cells manufacture antibodies**
          - **OR**
            - **Some B cells differentiate to make B memory cells**
      - **OR**
        - **Reproduction of T killer cells**
        - **T killer cells search for infected cells**
        - **T killer cells attach to infected cells**
        - **T killer cells secrete toxic substances (hydrogen peroxide) into infected cells to kill the cell and the pathogens it contains**
  - **There are a range of cytokines released by cells**
    - **Macrophages released monokines that**
      - **Attract neutrophils**
      - **Stimulate B cells to differentiate and release antibodies**
    - **T cells, B cells and macrophages release interleukins which stimulate the proliferation and differentiation of B and T cells**
    - **Many cells release interferon which can inhibit virus replication and stimulate the activity of T killer cells**
- **Memory cells**
  - **Circulate the body for a number of years, so that if a pathogen presenting the same antigens returns, the memory cells can stimulate the production of plasma cells and antibodies much more quickly.**
- **Structure**
  - **White blood cells with a large nucleus and specialised receptors on their plasma membranes**

(j) *compare and contrast the primary and secondary immune responses;*

- **Primary response**
  - **When the infecting agent is first detected, the immune system starts to produce antibodies, but it takes a few days before the number of antibodies in the blood rises to a level that can fight the infection**
- **Secondary immune response**
  - **The immune system recognises the pathogen if the body is infected again, so the immune system can swing into action more quickly.**
  - **The production of antibodies rises sooner and reaches a higher concentration**

(k) compare and contrast active, passive, natural and artificial immunity;

	Natural	**Artificial**
Passive	Antibodies provided via the placenta or breast milk. This makes the baby immune to diseases that the mother is immune to. It is very useful in the first year of the baby's life, when the immune system is developing.	Immunity provided by injection of antibodies made by another individual (e.g. tetanus)
Active	Immunity provided by antibodies made as a result of infection. A person suffers from disease once and is then immune (e.g. immunity to chicken pox)	Immunity provided by antibodies made in the immune system as a result of vaccination. A person is injected with a weakened, dead or similar pathogen, or with antigens, and this activates his/her immune system (e.g. immunity to TB and influenza)

(l) explain how vaccination can control disease;

Vaccination provides immunity to specific diseases. A person who has been vaccinated has artificial immunity. This is created by the deliberate exposure to antigenic material that has been rendered harmless. The immune system treats the antigenic material as if it was a real disease. As a result, the immune system manufactures antibodies and memory cells. The memory cells provide the long-term immunity.

(m) discuss the responses of governments and other organisations to the threat of new strains of influenza each year;

In the UK there is an immunisation program to vaccinate all over 65s and those who are in 'at risk' groups. In 2006/7, 74% of over 65s were vaccine and 42% of people in the 'at risk' groups.
The strains of flu used in the immunisation program changes every year. Research is undertaken to determine which of the strains of flu are most likely to spread that year.

(n) outline possible new sources of medicines, with reference to microorganisms and plants and the need to maintain biodiversity

Because there are many species of drugs in the tropical rainforest that are yet to be discovered, it is hoped that there are many new medicinal drugs yet to discover. But biodiversity needs to be maintained- plants with medicinal properties should be farmed sustainably so that the species is not wiped out.
Research has been undertaken into the way that microorganisms cause disease. Many use receptors on heir plasma membranes. The receptor sites can be blocked by a drug, and then the disease-causing pathogen cannot gain access to the cell.

(o) describe the effects of smoking on the mammalian gas exchange system, with reference to the symptoms of chronic bronchitis, emphysema (chronic obstructive pulmonary disease) and lung cancer;

Short term

Tar is a combination of chemicals which settles on the inner lining of the airways and alveoli. This increases the diffusion distance for oxygen entering the blood and for carbon dioxide leaving the blood.

The tar paralyses or destroys the cilia on the surface of the airway so they are unable to move the layer of mucus away and up to the back of the mouth. The tar also stimulates the goblet cells and mucus secreting glands to enlarge and release more mucus. The mucus collects in the airways.

Bacteria and viruses that become trapped in the mucus are not removed. They can multiply in the mucus and eventually a combination of mucus and bacteria may block the bronchioles.

The presence of bacteria and viruses means that the lungs are more susceptible to infection. Smokers are more likely to catch diseases such as influenza and pneumonia.

Long term

The mucus and bacteria irritates the airways, and they need to be cleared to get oxygen into the alveoli. This leads to smokers cough to try and shift the bacteria-laden mucus.

This constant cough damages the lining of the alveoli and airways. This lining will eventually be replaced by scar tissue which is thicker and less flexible. The layer of smooth muscle in the bronchioles also thickens. This reduces the lumen of the airway, and the flow of air is restricted.

Frequent infections as a consequence of bacteria and viruses in the mucus inflames the lining of the airways, which damages it. This attracts white blood cells which release enzymes to get out of the blood and into the airways. The enzymes digest parts of the lining of the lungs. The enzyme elastase is used which damages the elastic tissue of the lining the lungs. Loss of elastic tissue in the alveoli can reduce the elasticity of their wall, so the alveolus wall does not push air out as we exhale. The bronchioles collapse, trapping air in the alveoli. This can cause the alveoli to burst as pressure in the lungs increases.

Chronic Bronchitis

Inflammation of the lining of the airways, damage to the cilia and overproduction of mucus

Symptoms

- **Irritation of the lungs**
- **Continual coughing**
- **Coughing up mucus that it often filled with bacteria and white blood cells**

Emphysema

The loss of elasticity in the alveoli which causes them to burst

Symptoms

- **Shortness of breath, especially when exerting themselves**
- **The loss of elasticity makes it harder to exhale**
- **Breathing becomes shallower and more rapid**
- **The blood is less well oxygenated and fatigue occurs**

Lung cancer

- **Continual coughing**
- **Shortness of breath**
- **Pain in the chest**
- **Blood coughed up in the sputum**

(p) describe the effects of nicotine and carbon monoxide in tobacco smoke on the cardiovascular system with reference to the course of events that lead to atherosclerosis, coronary heart disease and stroke;

Nicotine:

Causes addiction

Mimics the effects of transmitter substances at the synapses between nerves. This makes the nervous system more sensitive and smoker feels more alert

Causes adrenaline to be released

Causes constriction of the arterioles leading to the extremities of the body

Makes platelets sticky. This increases the risk that a blood clot or thrombosis may form

Carbon Monoxide

Haemoglobin has a higher affinity for CO than for O_2. Carbon monoxide combines with haemoglobin to form carboxyhaemoglobin, which is very stable. This reduces the oxygen carrying capacity of the blood. Smokers feel this when they exercise. The body will detect lower levels of oxygen and the heart rate will rise

Atherosclerosis

Carbon monoxide can damage the endothelium of the arteries. The damage is repaired by phagocytes. This encourages the growth of smooth muscle and the deposition of fatty substances. The deposits include cholesterol from low-density lipoproteins. These deposits (atheromas) may also include fibres, dead blood cells and platelets.

The atheroma eventually forms a plaque which sticks out into the lumen of the artery. This leaves the artery wall rougher and less flexible. It also reduces the lumen of the artery, reducing blood flow.

Coronary Heart Disease

The coronary arteries carry blood to the heart muscles. They carry blood at high pressure which makes them prone to damage and atherosclerosis. When the lumen of a coronary artery is narrowed by plaques, there is less blood flow to the heart muscle, so they receive less oxygen for respiration.

Angina- A severe pain in the chest which may extend down the left arm or up the neck

Heart attack or myocardial infarction- the death of part of the heat muscle, usually caused by a clot in the coronary artery blocking the flow of blood to the heart muscle

Heart failure- when the heart cannot sustain its pumping action; this can be due to the blockage of a major coronary artery, but there are other types and causes.

Stroke

Death of part of the blood tissue due to the loss of blood flow to that part of the brain.

Two possible causes:

A blood clot floating around in the blood blocks a small artery leading to part of the brain

An artery leading to the brain bursts

(q) evaluate the epidemiological and experimental evidence linking cigarette smoking to disease and early death

Epidemiological

A regular smoker is three times more likely to die prematurely than a non smoker
50% of regular smokers are likely to die of a smoking related disease
The more cigarettes a person smokes per day, the more likely (s)he is to die prematurely, and the younger (s)he is likely to die
A smoker is 18x more likely than a non-smoker to develop lung cancer
25% of smokers die of lung cancer
A heavy smoker (25+ cigarettes per day) is 25 times more likely to die of lung cancer than a non-smoker
The chance of developing lung cancer reduces as soon as a person stops smoking
Chronic Obstructive Pulmonary Disease is rare in non-smokers
98% of people who have emphysema are smokers
20% of smokers have emphysema
It is not easy to link smoking with cardiovascular diseases because there are so many other factors that can contribute to cardio-vascular disease.

Experimental

In the 1960s there were experiments on dogs.

Some dogs were made to breathe smoke from unfiltered cigarettes. They developed changes in their lungs that were similar to those of Chronic Obstructive Pulmonary Disease. They also developed early signs of lung cancer
Some dogs were made to breathe smoke from filtered cigarettes. These doges remained healthier, but their lungs still showed early signs of lung cancer

Biodiversity & Evolution

Biodiversity

(a) define the terms

species,

A group of individual organisms which are very similar in appearance, anatomy, physiology, biochemistry and genetics, whose members are able to interbreed freely to produce fertile offspring

habitat

The place where an organism lives

biodiversity

The range of organisms to be found

(b) explain how biodiversity may be considered at different levels;

habitat,

The range of habitats in which different species live.

species

The differences between species

genetic

Genetic variation between individuals of a species

(c) explain the importance of sampling in measuring the biodiversity of a habitat;

Human activities affect the environment in a variety of ways. Unless we study these affects, we cannot assess the impact that we have. Environmental impact assessments are very important parts of planning processes, and they are sued to estimate the essects of a planned development on the environment

(d) describe how random samples can be taken when measuring biodiversity;

To measure the biodiversity of a habitat, all the individuals of all of the species must be counted. This is impractical, as there are thousands of single celled organisms per square metre of soil.
Instead, the habitat is randomly sampled- random portions of the habitat are selected and studied in detail. Then the results are multiplied up to estimate the numbers in the whole habitat.

Sampling Plants

There are three ways of randomly selecting areas:

- **Taking samples at regular distances across the habitat**
- **Using random numbers to plot coordinates within the habitat**
- **Selecting coordinates from a map and then using a GPS to find the position inside the habitat**

There are two main ways to measure the biodiversity of plants

Random Quadrats

The quadrat is placed at random on the habitat and the plants within the quadrat are identified. Their abundance is then measured in one of three ways:

An Abundance scale

Each species in the quadrat has an abundance score applied to it

Percentage cover

The percentage cover of each plant in the quadrat is estimated. Sometime the quadrat is divided into 100 squares to make this easier

Point frame

A frame holding a number of long needles, usually 10, used to measure percentage cover. Each plant touching the needle is recorded. If the frame is used 10 times, each plant recorded will have a 1% cover.

Transects

A long rope of tape measure is stretched across the habitat, and samples are taken along the line

Line transect

Record the plants touching the line at set intervals

Interrupted belt transect

A quadrat is used at set intervals along the line

Continuous belt transect

A quadrat is used continuously along the transect

Sampling animals

Smaller animals can be trapped, their numbers observed, and the total population estimated. Larger animals cannot be trapped. The must be carefully observed and their numbers estimated.

Sweep netting

Sweeping a net through vegetation. Any organisms caught are released onto a white sheet and counted

Collecting from trees

A white sheet is held under a branch, and the branch is knocked, so any small animals drop onto the sheet

Pitfall trap

A container buried in the soil so that it is just below the surface. Any animals moving though the plants or leaf litter will fall into the container

Tullgren Funnel

Leaf litter is placed in a funnel. A light above the leaves drives the animals downwards as the leaf litter dries out and warms up. They fall through the mesh screen into the jar bellow

Light Trap

An ultraviolet light attracts the insects, which eventually fall into the vessel of alcohol below

(e) describe how to measure species richness and species evenness in a habitat;

Species richness

The number of species in a habitat. They more species present, the richer the habitat. This can be measured using the methods before.

Species evenness

The relative abundance of individuals in each species. This is measures in plants by estimating percentage cover.

In animals

Larger animals are carefully observed and the individuals present are counted

Smaller animals are calculated using the mark and recapture technique

Capture a sample of animals and mark them in a way that will not be harmful to them (C_1)

Release them and leave the traps again

The number captured on the second occasion is C_2. The number of marked animals in the second capture is C_3.

Total population = $(C_1 x C_2)/C_3$

The number of tiny animals in the soil is estimated by taking a sample of soil and sifting through it to find all of the individuals

Sampling water is done in the same way

(f) use Simpson's Index of Diversity (D) to calculate the biodiversity of a habitat, using the formula $D = 1-(\Sigma(n/N)^2)$;

n is the number of individuals of a particular species

N is the total number of individuals for all species

(g) outline the significance of both high and low values of Simpson's Index of Diversity (D);

A high value indicates a diverse habitat. The habitat tends to be stable and able to withstand change

A low value indicated a habitat dominated by a few species. A small change could damage or destroy the whole habitat

(h) discuss current estimates of global biodiversity

It is estimated that there are more than 1,730,000 species in the world and 89,000 in the UK. This is not a measure of biodiversity because they do not take into account the number of individuals in each species, or give any indication of the variation between different species, or within a species.

We cannot be sure how accurate they are because

They do not include any marine species

We cannot be sure that we have found all of the species on earth

Evolution and speciation are continuing

Many species are endangered and some are becoming extinct

Classification

(a) define the terms

classification

The process of sorting living things into groups

phylogeny

The study of evolutionary relationships between organisms

taxonomy

The study of the principles of classification

(b) explain the relationship between classification and phylogeny;

Closely related species are placed in groups together. By knowing the relationship between species, one can put them in the correct group

(c) describe the classification of species into the taxonomic hierarchy of domain, kingdom, phylum, class, order, family, genus and species;

Species are the basic unit of classification. All of the members show some variation, but are essentially the same. As you rise through the ranks of taxa, the individuals grouped together show more and more diversity. There are fewer similarities and the individuals are less closely related.

(c) outline the characteristic features of the following five kingdoms:

Prokaryotae (Monera),

No nucleus
Loop of naked DNA
- **No Chromosomes**

No membrane-bound organelles
Smaller ribosomes
Carry out respiration in mesosomes
Smaller cells
May be free living or parasitic

Protoctista,

Eukaryotes
Mostly single celled
Show a wide variety of forms
Show various plant-like or animal-like features
Mostly free living
Have autotrophic or heterotrophic nutrition

Fungi,

Eukaryotes
Have mycelium which consists of hyphae
Walls made of chitin
Cytoplasm is multinucleate
Mostly free living and saprophytic

Plantae,

Eukaryotes
Multicellular
Cells surrounded by a cellulose cell wall
Produce multicellular embryos from fertilised eggs
Autotrophic nutrition

Animalia;

Eukaryotes
Multicellular
Heterotrophic nutrition
Have fertilised eggs that develop into balls of cells called blastula
Usually able to move around

(e) outline the binomial system of nomenclature and the use of scientific (Latin) names for species;

The binomial system is in Latin, which avoids any confusion caused by using common names, which can be different in different countries. The organism is given two names- the Genus and the Species name, e.g. Homo Sapiens- Homo is the genus and Sapiens is the Species.

(f) use a dichotomous key to identify a group of at least six plants, animals or microorganisms;

A dichotomous key is a way of identifying and naming a specimen. The key provides a series of questions which have two answers, usually 'yes' or 'no'. The answer to each question leads you to another question. Eventually the answers will lead you to the name of the species. A good dichotomous key has one less question than the number of species it can identify.

(g) discuss the fact that classification systems were based originally on observable features but more recent approaches draw on a wider range of evidence to clarify relationships between organisms, including molecular evidence;

Originally the classification systems were based on observable features- single celled organisms with animal-like features were classed as animals, and those that had features similar to plants were classified as plants. But microscopes showed that some single celled organisms act like plants AND animals- Euglena photosynthesise and move, for example, and Fungi do not move, but don't photosynthesise either. In the end, the system was overhauled and ended up with the 5 kingdom classification of today.

Biochemistry can also be used to show the evolutionary relationship between two species- depending the relationship between them, biochemical molecules, such as their DNA, will have evolved differently- Human DNA is more similar to a Monkey's than to a mushroom's. This allows organisms to be classified according to their genetics.

(h) compare and contrast the five kingdom and three domain classification systems

The domain system was suggested after a detailed study of RNA. The scientists believed that two groups of bacteria and all eukaryotes had separate origins and these groups were given the taxonomic structure of domains to support this. They are above the level of kingdom.

Evolution

(a) *define the term variation;*

The presence of variety- differences between individuals

(b) *discuss the fact that variation occurs within as well as between species;*

Variation occurs within a species- eye colour, hair colour, height- as well as between species, which are obvious differences; birds fly whereas dogs do not.

(c) *describe the differences between continuous and discontinuous variation, using examples of a range of characteristics found in plants, animals and microorganisms;*

Continuous variation is where there are two extremes and a full range of values in the middle. Most individuals are close to the mean, but there is a minority at each extreme.

Height in humans

Length of leaves on a tree

Length of stalk of a toadstool

Discontinuous variation is where there are distinct categories and no intermediate values. There may be an equal spread between the categories, or there might be more of one type than another.

Sex

Male or female in mammals, male, female or hermaphrodite in plants

Human blood groups

A, B, AB or O

Some bacteria have flagella, others do not.

(d) *explain both genetic and environmental causes of variation;*

Genetic

Our genes define our characteristics, and the combination of alleles that we inherit from our parents is unique. Unless a person has an identical twin, there is only a remote chance that someone will have the same combination of alleles, which means that everyone's characteristics are unique

Environmental

Many characteristics can be affected by the environment- if a tree that would normally grow to 6m was planted where there was little soil or water, e.g. a rock crevice, it might only grow to 1.5m. If a pet was overfed, it would become obese.

(e) *outline the behavioural, physiological and anatomical (structural) adaptations of organisms to their environments;*

Behavioural

An aspect of behaviour of an organism that helps it to survive the conditions it lives in

An earthworm withdraws into a burrow when touched to avoid being eaten

Physiological/biochemical

An adaption that ensures correct functioning of cell processes

Yeast can produce enzymes to respire different sugars that are present

Anatomical

A structure that enhances the survival of the organism

Bacteria have flagella to enable them to mobe independently

(f) *explain the consequences of the four observations made by Darwin in proposing his theory of natural selection;*

Darwin's four observations were:

Offspring appear genetically similar to their parents

No two individuals are identical

Organisms have the ability to produce large numbers of offspring

Populations in nature tend to remain fairly stable in size

These observations led him to the conclusions that

There is a struggle to survive

Better adapted individuals survive and pass on their characteristics

Over time, a number of changes may give rise to a new species

Because more young are produced than the habitat can sustain, there is competition for food and resources. As all of the offspring are different, some of them are better adapted than others. These better adapted ones get the food and the resources and so live long enough to reproduce, passing on their characteristics. The less well adapted individuals are likely to die before they reproduce, so the population does not grow indefinitely

Over time, the species will accumulate many small variations. Different populations of the same species may have different adaptations, and so eventually the populations become so different that they can no longer breed to produce fertile offspring- they are different species.

(g) *define the term speciation;*

The formation of a new species

(h) *discuss the evidence supporting the theory of evolution, with reference to fossil, DNA and molecular evidence;*

Fossils

Fossils have been found that show similar organisms over a long period of time. They changed slowly and show different adaptations to better suit their environment. There are also many modern species that are similar to the fossils.

DNA

Genes can be compared by sequencing the bases in DNA. Most distantly related species have more differences in their DNA; therefore they must have evolved as a different species further back in time.

Molecules

Two closely related species will have similar, or identical, biological molecules as they will have separated more recently.

(i) *outline how variation, adaptation and selection are major components of evolution;*

1. **Variation must occur before evolution can take place**
2. **Once variety exists, there will be certain variations which give an advantage in the environment**
3. **Individuals with the advantage will survive and reproduce**
4. **Their offspring will inherit the advantageous characteristic**
5. **The next generation will be better adapted to their environment. Over time, the group of organisms becomes well adapted to the environment**

(j) *discuss why the evolution of pesticide resistance in insects and drug resistance in microorganisms has implications for humans*

Pesticides are developed to kill pests. An insecticide applies a very strong selection pressure- all susceptible insects will die, leaving only those with resistance. They will pass on the resistance to the next generation; so that the whole population will be resistant and the insecticide will no longer work.

The same thing happens with antibiotics and bacteria. The antibiotic will kill any microorganisms that don't have a resistance, leaving behind only the ones that do. They pass on their genes to the next generation, and soon the entire population will possess the resistance.

Maintaining Biodiversity

(a) *outline the reasons for the conservation of animal and plant species, with reference to economic, ecological, ethical and aesthetic reasons;*

Evolution has provided answers to many technological questions- the best aerodynamic shape in water, the best shape for a wing etc.

Natural ecosystems perform many processes that are of value to humans:

- **Regulation of atmosphere and climate**
  - **Photosynthesis removes CO_2 and replaces it with O_2**
- **Purification and retention of fresh water**
- **Formation and fertilization of soil**
  - **Without soil, we couldn't grow crops**
- **Detoxification and recycling of wastes**
- **Crop pollination**
- **Growth of timber, food and fuel**

All living organisms have the right to survive and live in the way in which they have become adapted. The loss of habitats and biodiversity can prevent many organisms from living where they should

Studies have shown that patients recover more rapidly from stress and injury when they are exposed to pleasing natural environmental conditions

(b) *discuss the consequences of global climate change on the biodiversity of plants and animals, with reference to changing patterns of agriculture and spread of disease;*

Species that have lost their biodiversity will be unable to evolve to adapt to the changes in temperature and rainfall in their habitat. Their only option will be to move with the changing conditions, which would mean a slow migration towards the poles.

But, there will be obstructions such as:

- **Major Human developments**
- **Agricultural land**
- **Large bodies of water**
- **Humans**

And what about when all of the species have reached the poles and there is nowhere cooler for them to go? They will become extinct.

Domesticated plants and animals have been bred to provide the best yield in specific conditions. If the climate changes, there is little variation amongst the species to enable them to adapt. This means that farmers will have to grow their crops in new environments- crops from Southern Europe in Britain, for example. But, if plants are being grown in new environments, they will be exposed to new diseases and pests which they will not have a resistance to. The higher temperatures will means that the pests will have a longer growing season, and the milder winters will mean that they won't be killed by the cold. A consequence of this will be that there will be even larger infestations in the spring, and the yield won't be large enough to feed everybody.

Human diseases will also migrate. Varieties of tropical diseases may become a problem in Europe.

(c) *explain the benefits for agriculture of maintaining the biodiversity of animal and plant species;*

Agricultural crops have little diversity. As the climate changes, they may no longer be able to grow in their current location. If the biodiversity of wild species are maintained, then farmers could breed their agricultural plants with the similar wild plants that can grow in the new climate, and the resulting offspring will have a high yield, but be able to grow in the warmer conditions.

Resistance to disease could also be bred into agricultural crops from their wild cousins to prevent them being wiped out by new diseases.

(d) describe the conservation of endangered plant and animal species, both in situ and ex situ, with reference to the advantages and disadvantages of these two approaches;

In situ

Species are protected in their natural environment

Advantages	**Disadvantages**
Species are conserved in their natural environment	Protected animals could come out of the reserve to raid crops
Permanently protects biodiversity and representative examples of ecosystems	People continuing to hunt the protected animals for food
Permanently protects significant elements of nature and cultural heritage	Illegal harvesting of timber and other plant products
Allows management of the areas to ensure that ecological integrity is maintained	Tourists feeding protected animals or leaving litter
Provides opportunities for ecologically sustainable land use	
Facilitates scientific research	
Many be possible to restore the ecological integrity of the area	

Ex situ

Species are removed from their natural habitats to be conserved

Animals

Advantages	**Disadvantages**
Some species would become extinct if left in the wild as it is too difficult to protect their environment	Animals are not in their natural environment and many fail to breed successfully
Some captive breeding programs have become so successful that there is now a shortage of habitat to receive the animals	Space is limited and this limits the number of individuals which restricts genetic diversity
	A decrease in genetic diversity results in a lack of variation
	This means that a species is less able to adapt to changing conditions, which can affect animals' ability to breed successfully
	Even if reproduction is successful the animals need to survive reintroduction to the wild, where they need to find food and survive predation
	There can also the difficulties with acceptance by the existing wild members of their species

Plants

Advantages	**Disadvantages**
As part of their life cycle, most plants naturally have a dormant stage- the seed	And collection of wild seeds will cause some disturbance
Seeds are produced in large numbers and so they can be collected from the wild without causing too much disturbance to the ecosystem or damaging the wild population	The collected samples may not hold a representative selection of genetic diversity
Seeds can be stored or germinated in protected surroundings	Seeds collected from the same species in another area will be genetically different and may not succeed in a different area
Seeds can be stored in huge numbers without occupying too much space	Plants bred asexually will be genetically identical- reducing genetic diversity further
Plants can often breed asexually	Conclusions from research based on a small sample may not be valid for the whole species
Botanical gardens can increase the numbers of individuals very quickly	
This provides an ample supply of individuals for research	
Captive-bred individuals can be replanted in the wild	

(e) *discuss the role of botanic gardens in the ex situ conservation of rare plant species or plant species extinct in the wild, with reference to seed banks;*

The Millennium Seed Bank in West Sussex is the largest ex situ conservation project of its kind. It intends to have collected seeds from 10% of the world's plants by 2010. Seeds are kept in cold store and checked periodically to make sure they are viable. These can be used as a genetic resource for future scientists looking for useful genes, and a store for plants that could become extinct with climate change and habitat destruction. Plants may have a variety of uses in the future, e.g. land reclamation following habitat degradation, or providing new medicines.

(f) *discuss the importance of international co-operation in species conservation with reference to*

The loss of habitat and a number of endangered species is a worldwide problem, therefore international cooperation is needed to conserve the species under threat.

The Convention in International Trade in Endangered Species (CITES)

Aims to

Regulate and monitor international trade in selected species of plants and animals
Ensure that international trade does not endanger the survival of populations in the wild
Ensure that trade in wide plants is prohibited for commercial purposes
Ensure that trade in artificially propagated plants is allowed, subject to permit
Ensure that some, slightly less endangered, wild species may be traded, subject to a permit, as agreed by the exporting and importing countries

The Rio Convention on Biodiversity;

Aims to

Conserve biological diversity
Use components sustainably
Have appropriate shared access to genetic resources
Have appropriate sharing and transfer of scientific knowledge and technologies
Have fair and equitable sharing of the benefits arising out of the use of genetic resources

(g) *discuss the significance of environmental impact assessments (including biodiversity estimates) for local authority planning decisions.*

They are a means of assessing the likely significant environmental impact of a development. The EIA ensures that the local planning authority makes it decision in the knowledge of any likely significant effects on the environment. This helps to ensure that the importance of the predicted effects is properly understood by the public and the planning authority before it makes it decision.