AQA Biology GCSE

Topic 2: Organisation

Notes

(Content in bold is for higher tier only)

Principles of Organisation

- Cells make up all living things.
- A tissue is a group of specialised cells with a similar structure and function. They can be made of more than one type of cell. Examples include muscular tissue or epithelial tissue.
- Organs are formed from a number of different tissues, working together to produce a specific function. An examples is the stomach, which has muscular tissue and epithelial tissue.
- Organs are organised into organ systems, which work together to perform a certain function. The stomach is part of the digestive system, along with organs such as the liver and small intestine.

Animal Tissues, Organs and Organ Systems

The Human Digestive System (4.2.2.1)

The digestive system is an organ system, as it is made up of organs working together to perform a certain function. The food you eat is large and insoluble and needs to be broken down in order for it to be in a form that can be absorbed by cells.

It is made up of the following organs:

1. Glands (salivary glands and the pancreas) which produce digestive juices containing enzymes which break down food.
2. The stomach produces hydrochloric acid to kill bacteria and to provide the optimum pH for the protease enzyme to work.
3. The small intestine is where soluble molecules are absorbed into the blood.
4. The liver produces bile which is stored in the gall bladder, which helps with the digestion of lipids.
5. The large intestine absorbs water from undigested food to produce faeces. This passes out of your body through the rectum and anus.

Enzymes: biological catalysts (a substance that increases the rate of reaction without being used up)

- Enzymes are present in many reactions so that they can be controlled.
- They can both break up large molecules and join small ones
- They are protein molecules and the shape of the enzyme is vital to its function.
- This is because each enzyme has its own uniquely shaped active site where the substrate binds.

<u>The Lock and Key Hypothesis</u> (a simplified explanation of how enzymes work):

1. The shape of the substrate is complementary to the shape of the active site, so when they bond it forms an enzyme-substrate complex.
2. Once bound, the reaction the reaction takes place and the products are released from the surface of the enzyme

Enzymes require an optimum pH and temperature, because they are proteins.

- The optimum temperature is a range around 37 degrees celsius (body temperature)
    - The rate of reaction increases with an increase in temperature up to this optimum, but above this temperature it rapidly decreases and eventually the reaction stops.
    - When the temperature becomes too hot, the bonds in the structure will break
    - This changes the shape of the active site, so the substrate can no longer fit in
    - The enzyme is said to be denatured and can no longer work
- The optimum pH for most enzymes is 7, but some that are produced in acidic conditions, such as the stomach, have a low optimum pH
    - If the pH is too high or too low, the forces that hold the amino acid chains that make up the protein will be affected
    - This will change the shape of the active site, so the substrate can no longer fit in
    - The enzyme is said to be denatured and can no longer work

As molecules need to be broken down in the digestive system in order to be absorbed into the bloodstream, enzymes are vital. They are released by cells in many different places and they are specific to a certain type of molecule.

1. Carbohydrases convert carbohydrates into simple sugars
    - Example: amylase breaks down starch into maltose
        - It is produced in your salivary glands, pancreas and small intestine (most of the starch you eat is digested here)
2. Proteases convert proteins into amino acids
    - Example: pepsin which is produced in the stomach, other forms can be found in pancreas and small intestine
3. Lipases convert lipids into fatty acids and glycerol
    - Produced in the pancreas and small intestine

Soluble glucose, amino acids, fatty acids and glycerol pass into the bloodstream to be carried to all the cells around the body. They are used to build new carbohydrates, lipids and proteins, with some glucose being used in respiration.

There are a number of tests that can be carried out to determine whether a solution is made up of carbohydrate, protein or lipid.

- Benedict's test for sugars (turns brick red)
- Iodine test for starch (turns blue-black)
- Biuret test for protein (turns purple)
- Emulsion test for lipids (add ethanol which results in a cloudy layer if a lipid is present) OR
- Sudan III test for lipids (red layer forms on top)

Bile is produced in the liver and stored in the gallbladder. It is then released into the small intestine. It has two roles:

1. It is alkaline to neutralise the hydrochloric acid which comes from the stomach- the enzymes in the small intestine have a higher (more alkaline) optimum pH than those in the stomach.
2. It breaks down large drops of fat into smaller ones (emulsifies it). The larger surface area allows lipase to chemically break down the lipid into glycerol and fatty acids faster.

Rate of Enzymatic Reactions

You can investigate the effect of pH on an enzyme controlled reaction by carrying out a reaction at different pH's and timing how long it takes for the product to form.
The practical detailed on the specification involves the breakdown of starch to maltose by amylase. It uses iodine, which turns blue-black in the presence of starch.

- A drop of iodine is put in each well in a spotting tile
- Using a water bath or electric heater, warm a solution of amylase, starch and a buffer solution (this is the independent variable, so is changed each time you repeat the experiment)
- At regular points in the experiment, take drops of the solution and place in the wells
- The starch is no longer present and has been completely broken down when the iodine solution remains brown as opposed to blue-black
- The time for this to occur is recorded and the rate is calculated from the equations: 1000/time
- The experiment should be repeated at different pH values while controlling all other factors which may affect the rate, such as temperature

In experiments where you are measuring how much of a product forms over time or how much of a reactant is used up, you should calculate the rate using the equation: rate = change/time

The Heart and Blood Vessels (4.2.2.2)

The heart is an organ in the circulatory system. The circulatory system carries oxygen and nutrients to every cell in the body and removes the waste products.

The heart pumps blood around the body in a double circulatory system. This means there are two circuits.

- 1: Deoxygenated blood flows into the right atrium and then into the right ventricle which pumps it to the lungs to undergo gaseous exchange
- 2: Oxygenated blood flows into the left atrium and then into the left ventricle which pumps oxygenated blood around the body

Structure of the heart:

- Muscular walls to provide a strong heartbeat
- The muscular wall of the left ventricle is thicker because blood needs to be pumped all around the body rather than just to the lung like the right ventricle.
- 4 chambers that separate the oxygenated blood from the deoxygenated blood
- Valves to make sure blood does not flow backwards
- Coronary arteries cover the heart to provide its own oxygenated blood supply

Process:

1. Blood flows into the right atrium through the vena cava, and left atrium through the pulmonary vein.
2. The atria contract forcing the blood into the ventricles.
3. The ventricles then contract, pushing the blood in the right ventricle into the pulmonary artery to be taken to the lungs, and blood in the left ventricle to the aorta to be taken around the body.
4. As this happens, valves close to make sure the blood does not flow backwards.

The natural resting heart rate (around 70 beats per minute) is controlled by a group of cells found in the right atrium that act as a pacemaker- they provide stimulation through small electrical impulses which pass as a wave across the heart muscle, causing it to contract. Without this, the heart would not pump fast enough to deliver the required amount of oxygen to the whole body.

An artificial pacemaker can be used if the individual has an irregular heartbeat. It is an electrical device that produces a signal causing the heart to beat at a normal speed.

The body contains three different types of blood vessel:

1. Arteries carry blood AWAY from the heart
    - Layers of muscle in the walls make them strong
    - Elastic fibres allow them to stretch
    - This helps the vessels withstand the high pressure created by the pumping of the heart
2. Veins carry blood TOWARDS the heart
    - The lumen (the actual tube in which blood flows through) is wide to allow the low pressure blood to flow through
    - They have valves to ensure the blood flows in the right direction
3. Capillaries allow the blood to flow very close to cells to enable substances to move between them
    - One cell thick walls create a short diffusion pathway
    - Permeable walls so substances can move across them

The rate of blood flow is calculated from volume of blood/number of minutes.

The lungs are found in the thorax (top part of your body) and are protected by your ribcage. They supply oxygen to your blood and remove carbon dioxide.

The gas exchange system is made up of the:

- Trachea (the windpipe, air moves through here)
- Intercostal muscles (which contract and relax to ventilate the lungs)
- Bronchi (air from the trachea move into these, lead to each lung)
- Bronchioles (bronchi split into these and air moves in)
- Alveoli (bronchioles lead to the alveoli, air sacs where gaseous exchange occurs)
- Diaphragm (separates the lungs from the digestive organs, moves down causing inhalation)

Ventilation:

1. The ribcage moves up and out and the diaphragm moves down causing the volume of the chest to increase.
2. Increased volume results in lower pressure.
3. Air is drawn into the chest as air moves from areas high pressure (the environment) to low pressure (the lungs).
4. The opposite happens when exhaling.

Gas exchange:

1. Upon inhalation, the alveoli fill with oxygen.
2. The blood in the capillaries surrounding the alveoli is deoxygenated (ithas come from the pulmonary vein). It has lots of carbon dioxide as this is a product of respiration.
3. Oxygen diffuses down its concentration gradient into the capillary bloodstream, which has a low concentration of oxygen.
4. Carbon dioxide diffuses down its concentration gradient from the blood to the alveoli

Alveoli are adapted for this to take place in a number of ways:

- They are very small and arranged in clusters, creating a large surface area for diffusion to take place over
- The capillaries provide a large blood supply, maintaining the concentration gradient
- The walls of the alveoli are very thin, meaning there is a short diffusion pathway

You can calculate breathing rate by doing number of breaths/number of minutes.

Blood (4.2.2.3)

Blood is made up of plasma, red blood cells, white blood cells and platelets.

1. Plasma
    - This is liquid that carries the components in the blood: red blood cells, white blood cells, platelets, glucose, amino acids, carbon dioxide, urea, hormones, proteins, antibodies and antitoxins
2. Red blood cells
    - They carry oxygen molecules from the lungs to all the cells in the body
    - Their bioconcave disc shape provides a large surface area
    - They have no nucleus allowing more room to carry oxygen
    - They contain the red pigment haemoglobin, which binds to oxygen and forms oxyhaemoglobin
3. White blood cells
    - They are a part of the immune system, which is the body's defence against pathogens (microorganisms that can produce disease)
    - They have a nucleus
    - There are a number of types:
        - 1- Those that produce antibodies (small proteins that clump them together) against microorganisms
        - 2- Those that engulf and digest pathogens

- ○ 3- Those that produce antitoxins to neutralise toxins (poisons) produced by microorganisms

4. Platelets
   - They help the blood clot form at the site of a wound
   - The clot dries and hardens to form a scab, which allows new skin to grow underneath while preventing microorganisms from entering
   - Small fragments of cells
   - No nucleus
   - Without them, cuts would result in excessive bleeding and bruising

Coronary heart disease: a non-communicable disease

This is when the coronary arteries that provide blood to the heart become blocked with the build up of fatty material. This results in less blood flowing to the heart, reducing its oxygen supply. This may lead to a heart attack. (Non-communicable = non-infectious)

Solutions:

- Stents (metal mesh tubes inserted in arteries) - keeps the arteries open to allow blood to flow through.
  - ✓ They are effective in lowering the risk of a heart attack
  - ✓ The recovery time from surgery is quick
  - ` Risk of a heart attack during the procedure, or that infection could occur following it.
  - ` There is a chance that blood clots can form near the stent (called thrombosis)
- Statins (drugs that decrease the levels of LDL (bad) cholesterol- which would otherwise lead to coronary heart disease)
  - ✓ They reduce the risk of strokes, coronary heart disease and heart attacks
  - ✓ They increase the levels of HDL (good) cholesterol
  - ` Need to be taken continuously which may be an inconvenience
  - ` Can produce side effects
  - ` May not have an immediate effect as it only slows down the rate it is deposited

Other problems:

Faulty valves - when a heart valve becomes stiff so cannot open or it is damaged so it leaks, blood flows in the wrong direction which means that the heart does not work as efficiently as it should.

Solutions:

- Replacing it with a biological valve (pigs or cattle)
  - ✓ Works very well
  - ` Only last 12-15 years
- Replacing it with a mechanical valve (manmade)
  - ✓ Last for a long time
  - ` Constant medication is needed to stop blood from clotting around the valve

Heart failure- can be solved with a heart transplant

- A heart transplant requires a donor who has recently died
- These are not always available, so an artificial may be used whilst waiting

✓ Less likely to be rejected by the immune system- metal and plastic are not recognised as foreign

` Surgery temporarily leaves the body exposed to infection

` As it is mechanical parts of it could wear out and the motor could fail

` Blood clots could form, leading to strokes

` To prevent the above, drugs are taken to thin the patients blood- this affects the individuals bleeding if they are hurt

Extreme blood loss- can be solved by giving artificial blood

- It is a salt solution that can keep people alive even if they lose ⅔ of their red blood cells

✓ This means the patient has more time to produce new blood cells

` But it can only be used for short periods of time- then a blood transfusion has to take place

Health Issues (4.2.2.5)

Health is a state of physical, mental and social well-being, not merely the absence of disease. Disease is one factor that can cause ill health. Other factors are diet, stress and life situations.

Diseases can fall into two categories:

1. Communicable diseases- these are infectious as they are caused by pathogens (bacteria, viruses, fungi), and are passed on from one person to another. An example is the flu.
2. Non-communicable diseases- these are not passed on from person to person. An example is heart disease.

It is important to remember that diseases can interact through one causing another or making its effects worse. Examples of this:

- If the immune system of an individual is poor, then they are more likely to become infected with a communicable disease as the body is less able to fight off any pathogens.

- Infections by viruses in certain parts of the body can trigger the growth of cancers. For example, liver cancer can result from infection by hepatitis virus.

- The infection by a pathogen, leading to an immune response, can trigger allergic reactions to things in the environment. The reaction may be rashes, or an increase in the severity of asthma attacks.

- The reduction in physical health preventing the individual from carrying out many tasks and/or reducing their life expectancy can lead to mental illness, such as depression.

Many other factors may affect health...

- Diet: Eating too little or too much food, not enough nutrients or the wrong type of food prevents you from having a good, balanced diet. This can have a big effect on mental and physical health, causing issues such as type 2 diabetes or obesity.

- Stress: Physical and mental stress places strain on our bodies. This can lead to problems such as heart disease, cancers and mental illnesses.

- Life situations: Where you live, your financial status, your ethnic group, your access to medical care and the levels of hygiene in your area are some examples of factors which may affect your physical and mental health. They can lead to communicable diseases such as diarrhoea and malaria, or non-communicable diseases like heart disease.

Disease incidence information is often displayed on frequency tables and diagrams, bar charts, histograms and scatter diagrams. You need to be able to use and interpret this information, and find correlations between variables.

The Effect of Lifestyle on Non-Communicable Diseases

Non-communicable diseases are not infectious, but there are a number of risk factors that increase the likelihood of them occurring. The human and financial cost of such diseases is high. Huge numbers of people die from non-communicable diseases each year, each potentially having a large effect on their family or local community, emotionally and financially. There is a financial effect on nations as well, with research into such diseases and treatment being so expensive. Globally, an effect is seen too when diseases affect working age populations.

Risk factors can either be aspects of a person's lifestyle (e.g the type of food they eat), or substances in the person's body (asbestos fibres, material used in buildings, found in airways) or environment (UV rays from the sun).

If one factor increases as another increases, they are correlated. To prove causation (correlation), scientists need to find a causal mechanism, an explanation of how one influences another.
Examples:

Cardiovascular disease
- Diet containing lots of LDL (bad) cholesterol results in arteries becoming blocked, increasing blood pressure
- Smoking damages the walls of arteries
- Exercise lowers blood pressure, reducing strain on the heart

Type 2 diabetes
- Obesity affects the body's metabolism- fat molecules are released into the blood which can affect the cells uptake of sugar

Liver and brain function
- Alcohol causes fatty liver, which can lead to liver failure
- Alcohol can damage nerve cells in the brain

Lung disease and lung cancer
- Smoking damages the cells in the lining of the lungs

Pregnancy
- Smoking and alcohol can cause many damaging effects on the unborn child

Cancer
- Carcinogens such as ionising radiation can lead to cancers

Cancer (4.2.2.7)

Cancer is the result of changes in cells that lead to uncontrollable growth and division, forming a tumour. This tumour may not be cancerous.

They can be:
1. Benign- growths of cells contained in one place, usually within a membrane
    - Not cancerous
    - It grows until there is no more room
    - It does not invade other tissues
    - If it causes pressure or damage to an organ, it can be dangerous
2. Malignant- the tumour grows and spreads to other tissues
    - Cancerous
    - The tumour may split up, resulting in cells being carried in the bloodstream or lymphatic system
    - They can travel to and stay in another organ, potentially causing secondary tumours
    - The cancer cells divide more rapidly and have a longer life span in comparison to normal cells

Lifestyle risk factors for cancer:
- Smoking (lung, mouth, bowel, stomach and cervical cancer)
- Obesity (bowel, liver and kidney cancer)
- UV light (skin cancer)
- Viral infection (liver cancer from hepatitis B and C, cervical cancer from HPV)

Genetic risk factors for cancer:
- You can inherit certain genes which increase the likelihood of getting cancer

Plant tissues, organs and systems

Plant tissues (4.2.3.1)

Plants are made up of many different tissues to allow it to carry out its function.

Tissue	Features	Function
Epidermal tissue covers the whole plant.	Covered with a waxy cuticle.	Helps to reduce water loss by evaporation, as the waxy cuticle prevents water from moving out.
Palisade mesophyll tissue found underneath the epidermal tissue.	Has lots of chloroplasts (photosynthesis takes place within these structures).	Having many chloroplasts means photosynthesis can happen rapidly. They are

		positioned at the top of the leaf so they receive lots of light.
Spongy mesophyll tissue found underneath the palisade mesophyll.	Has lots of air spaces.	This allows gases to diffuse in and out of cells.
Xylem is found in the roots, stems and leaves.	Made up of dead cells joined together, creating a continuous tube. Strengthened with a substance called lignin, but this has some holes in it along the tube called bordered pits.	Allows the movement of water and mineral ions from the roots to the stem and leaves, where it evaporates and leaves the plant. This called the transpiration stream. Lignin makes it strong and waterproof, so water will not leave except at bordered pits, allowing minerals to go to specific places in the plant.
Phloem is found in the roots, stems and leaves.	Elongated cells with holes in the cell walls (the end walls are now called sieve plates). Many organelles from the cells are removed so cell sap can move through.	Food substances can be moved in both directions, from the leaves where they are made for use, or from storage (underground) to parts of the plant that need it. This process is called translocation.
Meristematic tissue is found at the tips of shoots and roots.	It is able to differentiate into different types of plant cell.	This allows the plant to grow.

The leaf is a plant organ, and has the following tissues: epidermis, palisade, spongy mesophyll, xylem and phloem, and guard cells (these surround the stomata and control the opening and closing of them, depending on the water availability).

Plant organ system (4.2.3.2)

The roots, stem and leaves form a plant organ system for transport of substances around the plant. Root hair cells, xylem and phloem have important roles within this. Their adaptations are explained above and in topic 1 (Cell structure- cell specialisation).

Translocation is the movement of food substances made in the leaves up or down the phloem, for use immediately or storage.

Transpiration is the loss of water of water vapour from the leaves and stems of the plant. It is a consequence of gaseous exchange, as the stomata are open so that this can occur.

- Water also evaporates at the open stomata
- As water molecules are attracted to each other, when some molecules leave the plant the rest are pulled up through the xylem
- This results in more water being taken up from the soil resulting in a continuous transpiration stream through the plant

The rate of transpiration is affected by the same factors that affect the rate of evaporation.

Factor	Effect
Increase in temperature	The molecules move faster, resulting in evaporation happening at a faster rate and therefore the rate of transpiration increases. The rate of photosynthesis increases, meaning more stomata are open for gaseous exchange, so more water evaporates and the rate of transpiration increases.
Increase in relative humidity (the measure of the concentration of water vapour in the air in comparison to the total concentration of water that air can hold)	If the relative humidity is high, then there will be a reduced concentration gradient between the concentrations of water vapour inside and outside the leaf, resulting in a slower rate of diffusion. This will decrease the rate of transpiration.
Increased air movement (wind)	If more air is moving away from the leaf due to it being blown away, then the concentration of water vapour surrounding the leaf will be lower. This will mean there will be a steeper concentration gradient resulting in diffusion happening faster. This will increase the rate of transpiration.
Increase in light intensity	This leads to an increased rate of photosynthesis, so more stomata open to allow gaseous exchange to occur. This means more water can evaporate, leading to an increased rate of transpiration.

Measuring the uptake of water by the plant gives an indication to the rate of transpiration, because water is only taken up if water leaves the plant. This is observed by using a potometer, which involves placing a plant in a tube of water, and measuring the distance travelled by a bubble.

Guard cells close and open stomata.

- They are kidney shaped
- They have thin outer walls and thick inner walls
- When lots of water is available to the plant, the cells fill and change shape, opening stomata (they are also light sensitive)
- This allows gases to be exchanged and more water to leave the plant via evaporation
- More stomata are found on the bottom of the leaf, allowing gases to be exchanged whilst minimising water loss by evaporation as the lower surface is shaded and cooler.