Biology revision notes – maintenance of life

Most plant cells, like animal cells, have the following parts:

- A nucleus which controls the activities of the cell
- A cytoplasm in which most of the chemical reactions takes place
- A cell membrane, which controls the passage of substance in and out of the cell.

Plant cells also have:

- A cell wall which strengthens the cell

They also often have

- Chloroplasts which absorb light energy to make food
- A permanent vacuole filled with cell sap.

Green plants use light energy to make their own food. They obtain the raw materials they need to make this food from the air and soil.

Photosynthesis equation:
Carbon dioxide + water [+ light energy] = glucose + oxygen.

During photosynthesis:

- Light energy is absorbed by a green substance called chlorophyll which is found in chloroplasts in some plant cells
- This energy is used by converting carbon dioxide and water into sugar (glucose)
- Oxygen is released as a by-product.

The rate of photosynthesis may be limited by:

- Low temperature
- Shortage of carbon dioxide
- Shortage of light

The glucose produced in photosynthesis may be converted into insoluble starch for storage.

Plant cells use some of the glucose produced during photosynthesis for respiration.

Plant roots absorb mineral salts including nitrate needed for healthy growth.

The energy released by plants during respiration is used to build up smaller molecules into larger molecules:

- Sugars into starch
- Sugars into cellulose for cell walls
- Sugars, nitrates and other nutrients into amino acids which are then built up into proteins
- Sugars into lipids for storage in seeds.

For healthy growth plants also need mineral ions including:

- Nitrate – for the synthesis of proteins
- Phosphate – which has an important role in the reactions involved in photosynthesis and respiration
- Potassium – which helps enzymes involved in photosynthesis and respiration work.

The symptoms shown by plants growing in conditions where mineral ions are deficient include:

- Stunted growth and yellow older leaves if nitrate ions are deficient
- Poor root growth and purple younger leaves if phosphate ions are deficient
- Yellow leaves with dead spots if potassium ions are deficient.

Most of the water and minerals that enter a plant root are absorbed by root hair cells.

Carbon dioxide enters leaves by diffusion, i.e. simply by spreading from a higher to a lower concentration.

Plants lose water vapour from the surface of their leaves. This loss of water vapour is called transpiration. Transpiration is more rapid in hot dry and windy conditions. Most plants have a waxy layer (cuticle) on their leaves which stops them losing too much water. Plants living in dry conditions have a thicker cuticle.

Most of the transpiration is through tiny holes called stomata. Plants need stomata to obtain carbon dioxide from the atmosphere. The size of stomata is controlled by guard cells which surround them. If plants lose water faster than it is replaced by the roots, the stomata can close to prevent wilting.

Flowering plants have separate transport systems for water and nutrients:

- Xylem tissue transports water and minerals from the roots to the stem and leaves
- Phloem tissue carries nutrients such as sugars from the leaves to the rest of the plant including the growing regions and the storage organs.

Water often moves across boundaries by osmosis.
Osmosis is the diffusion of water from a dilute to a more concentrated solution through a partially permeable membrane that allows the passage of water molecules but not solute molecules.

In plants, the surface area of the root is increased by root hairs, and the surface area of leaves by the flattened shape and internal air spaces.

Substances are sometimes absorbed against a concentration gradient. This requires the use of energy from respiration. The process is called active transport. It enables plants to absorb ions from very dilute solutions.

When water moves into plant cells by osmosis it increases the pressure inside the cell. The cell walls are sufficiently strong to withstand the pressure. It is this pressure which keeps the cells rigid (maintains their turgor) and hence provides support.

Plants are sensitive to light, moisture and gravity:

- Their shoots grow towards light and against the force of gravity
- Their roots grow towards moisture and in the direction of the force of gravity

Plants produce hormones to co-ordinate and control growth.

The responses of plant roots and shoots to light, gravity and moisture are the result of unequal distribution of hormones, causing unequal growth rates.

The hormones which control the processes of growth and reproduction in plants can used by humans to

- Reproduce large numbers of plants quickly by stimulating the growth of roots from cuttings
- Regulate the ripening of fruits on the plant and during transport to customers
- Kill weeds by disrupting their normal growth patterns.

We detect features of the world around us using our senses. Processing this information and coordinating the actions which we make in response to it, is the job of our nervous system.

The nervous system enables humans to react to their surroundings and coordinate the their behaviour. Cells called receptors detect stimuli (changed in the environment). These include:

- Receptors in the eyes which are sensitive to light
- Receptors in the ears which are sensitive to sound
- Receptors in the ears which are sensitive to changed in position and enable us to keep our balance.
- Receptors on the tongue and in the nose which are sensitive to chemicals and enable us to taste and smell
- Receptors in the skin that are sensitive to touch and pressure and temperature changed.

Information from receptors passes along cells (neurones) in nerves to the brain. The brain coordinates the response.

Some responses to stimuli are automatic, rapid and are called reflex actions.

In a simple reflex action, electrical impulses pass from a receptor along a sensory neurone to the spinal cord or brain, then along a motor neurone to a muscle or gland. The muscle or gland brings about the response.

The eye includes sclera, cornea, iris, pupil, lens, ciliary muscle, suspensory ligament, retina and optic nerve.

In the eye:

- The tough outer sclera has a transparent region at the front called the cornea
- The muscular iris controls the size of the pupil and hence the amount of light reaching the retina
- The lens is held in position by suspensory ligaments and ciliary muscles

- The retina contains the receptor cells which are sensitive to light.

Light from an object enters the eye through the cornea. The curved cornea and the lens produce and image on the retina. The receptor cell in the retina send impulses to the brain along sensory neurones in the optic nerve.

The shape of the lens can be altered, by contraction or relaxation of the ciliary muscles, to focus near or distant objects respectively.

Electrical impulses transmit information from receptor cells along sensory neurones to the central nervous system that includes the brain and the spinal cord.

Reflex actions often involve three neurones called sensory, relay and motor neurone. In such a reflex action:

- Impulses from a receptor pass along a sensory neurone to the central nervous system
- At a junction (synapse) between a sensory neurone and a relay neurone in the central nervous system, a chemical is released which causes an impulse to be sent along a relay neurone
- A chemical is then released at the synapse between a relay neurone and a motor neurone in the central nervous system, causing impulses to be sent along a motor neurone to the organ (the effector) which brings about the response
- The effector is either a muscle or a gland
- A muscle responds by contraction, a gland by releasing (secreting) chemical substances.

To survive our bodies must keep themselves at just the right temperature, have just the right amount of water and sugar in the bloodstream etc. the body has automatic systems which constantly monitor and control these things.

Humans need to remove waste products from their bodies and to keep their internal environment relatively constant.

Waste products which have to be removed from the body include:

- Carbon dioxide produced by respiration – most of this leaves the body via lungs when we breathe out
- Urea produced in the liver by the breakdown of excess amino acids – this is removed by the kidneys in the urine, which is temporarily stored in the bladder.

Internal conditions which are controlled include:

- The water content of the body – water leaves the body via the lungs when we breathe out and via the skin when we sweat, and excess is lost via the kidneys in the urine.
- The ion content of the body – ions are lost via the skin when we sweat and excess are lost via the kidneys in the urine
- Temperature – to maintain the temperature at which enzymes work best.

Sweating helps to cool the body. More water is lost when it is hot, and more water has to be taken as drink or in food to balance this loss.

Many processes within the body are coordinated by chemical substances called hormones. Hormones are produced by glands and are transported to their target organs by the bloodstream.

The blood glucose concentration is controlled by the hormones insulin and glucagons which are released (secreted) by the pancreas.

Diabetes is a disease in which a person's blood sugar may rise to a fatally high level because the pancreas does not produce enough of the hormone insulin. Diabetes may be treated by careful attention to diet by injecting insulin into the blood.

The kidneys help maintain the internal environment by:

- First filtering the blood
- Re-absorbing all the sugar
- Re-absorbing the dissolved ions needed by the body
- Re-absorbing as much water as the body needs
- Releasing urea, excess ions and excess water as urine.

The kidneys produce dilute urine if there is too much water in the blood or concentrated urine if there is too little water in the blood. If the water content of the blood is too low, the pituitary gland releases a hormone called ADH into the blood. This causes the kidneys to re-absorb more water and results in a more concentrated urine. If the water content of the blood is too high, less ADH is released into the blood. Less water is re-absorbed in the kidneys resulting in a more dilute urine. Sugar and dissolved ions may each be actively absorbed from the kidney tubules against a concentration gradient.

Body temperature is monitored and controlled by the thermoregulatory centre in the brain. This centre has receptors sensitive to the temperature of blood flowing through the brain. Also temperature receptors in the skin send impulses to the centre giving information about skin temperature.
If the core body temperature is too high:

- Blood vessels supplying the skin capillaries constrict to reduce the flow of blood through the capillaries
- Muscles may 'shiver' – their contraction needs respiration which releases some energy as heat.

The blood glucose concentration of the body is monitored and controlled by the pancreas.

If the blood glucose concentration is too high, the pancreas secretes insulin into the blood. This causes the liver to convert glucose into insoluble glycogen and store it.

If the blood glucose concentration it too low, the pancreas secretes glucagon which causes the liver to convert glycogen into glucose and release it into the blood.

Solvents:

- Affect behaviour
- May cause damage to the lungs, liver and brain.

Alcohol:

- Affects the nervous system by slowing down reactions and may lead to lack of self-control unconsciousness or even coma
- May cause damage to the liver and brain.

Drugs change the chemical processes in people's bodies to that they may become dependent or addicted to them and suffer withdrawal symptoms without them. Nicotine is the addictive substance in tobacco.

Tobacco smoke contains substances which can help to cause:

- Lung cancer
- Other lung diseases such as bronchitis and emphysema
- Disease of the heart and blood vessels.

Tobacco smoke also contains carbon monoxide which reduces the oxygen-carrying capacity of the blood. In pregnant women this can deprive a fetus of oxygen and lead to a low birth mass.