AQA Biology GCSE

Homeostasis and Response

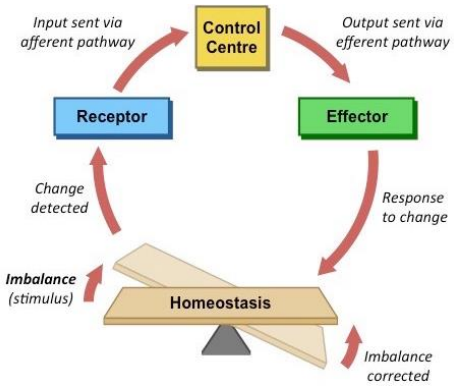
Principles of Homeostasis

Part 1 - Define homeostasis

Homeostasis is the regulation of a cell or organism to maintain stable optimum conditions in response to internal and external changes. Homeostatic mechanisms are so important for your survival that they are automatic. This means your body constantly makes adjustments without you having to consciously think about it.

Our body has two main systems which it uses to maintain a constant internal environment:

- **Nervous** responses: These use nerves to transfer electrical signals from the receptors to the brain and spinal cord (co-ordinators) and then to effectors.
- **Hormonal** responses: These use hormones which are released from various organs and travel through the blood stream to various effectors.

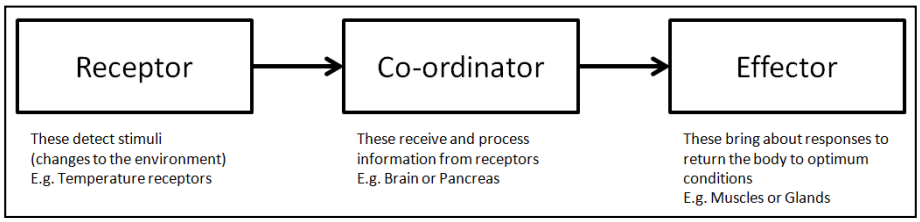


Part 2 - Why is it important to control your internal environment

Humans, like all mammals need to maintain a constant internal environment. If our core body temperature, blood glucose levels, or water levels change too much we can get very ill or even die. You have learned that high temperature or extreme pH can denature enzymes - break bonds causing their active sit to change shape. Enzymes are the main reason for homeostasis.

Part 3 - Describe the key elements of control systems

Receptors in sense organs (ears, eyes, nose, tongue, and skin) detect a stimulus and send the information to coordinators where the information is processed. The brain, the spinal cord and the pancreas are all examples of coordinators. Coordinators do not actually bring about the change themselves – effectors do. An effector is any part of the body that produces a response. Effectors are either glands or muscles which carry out the body's responses to stimuli.



Muscles cause movement (through contraction) and glands release hormones which bring about changes in the body. (response)

Recall Questions

Instruction: *Answer these questions in your exercise book. Use the notes above to help you (like a comprehension)*

1. Define 'homeostasis'.
2. Name three key internal conditions that need to be controlled through homeostasis.
3. Name the cell type that detects stimuli in the internal or external environment.
4. Name the component in the nervous system that processes the stimuli information.
5. Name the component in the nervous system that bring about responses to stimuli.

Lesson 2 – The structure and function of the human nervous system

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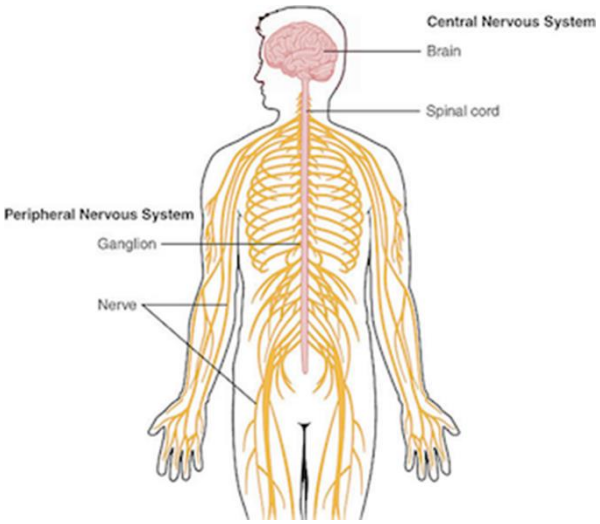


Part 1 - State the components of the nervous system and describe what a stimulus is

The central nervous system is made up of the brain and spinal cord. Nerves branch out from the spinal cord to all parts of your body. Nerves are made of bundles of neurones (nerve cells); these connect receptors to the CNS and the CNS to effectors e.g muscles. Receptors are cells which detect stimuli (changes in the environment). Receptors are found in huge numbers in our sense organs, which help us to detect and respond to changes in our surroundings.

Part 2 - Give examples of sense organs and their stimuli

- **Sight** – is detected by **light sensitive cells in the retina of the eye**, which react to **light intensity.**
- **Smell** – is detected by the cells lining the inner surface in the nasal cavity, which react in the presence of **chemicals**.
- **Taste** – is detected by **taste buds in the tongue**, and the first part of the oesophagus which react in the presence of **chemicals**.
- **Touch** – is detected by **pressure receptors** in the skin which react to **pressure** changes on the skin.
- **Sound** - is detected by **sound receptors** in the inner ear which react to **vibrations in the air.**
- **Stretch** – is detected by **muscle fibres** which react to a **change in length** of cells if they are stretched.

Part 3 - Explain how your nervous system enables you to respond to changes in your surroundings

stimulus → receptor → coordinator → effector → response

A stimulus is detected by a receptor which sends electrical signals along neurones to the coordinator (brain/spinal cord). The brain then sends electrical signals down neurones which stimulate the effector to cause a response e.g muscle contraction. An example could be that the skin detects a hot object which sends electrical signals along neurones to the brain which sends electrical signals to the muscles in the arm which contract to move the hand away

Recall Questions

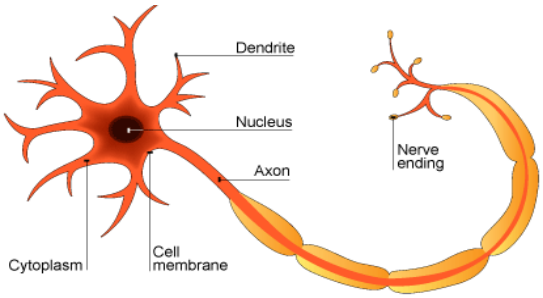
Instruction: *Answer these questions in your exercise book. Use the notes above to help you (like a comprehension)*

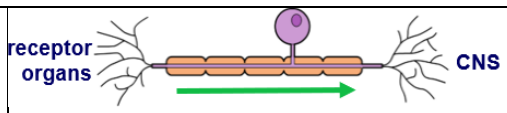
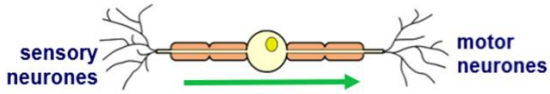
1. *What is a stimulus?*
2. *What is the name for the cells which detect changes in the environment?*
3. *What kind of signal passes along neurones?*
4. *State the function of a neurone.*
5. *Define 'effector'*
6. *Name two types of effectors.*
7. *Name the two coordination centres that make up the central nervous system.*

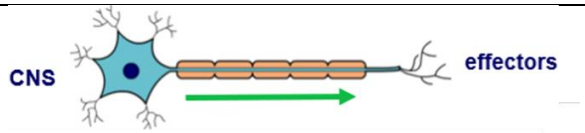
Reflex Actions

Part 1 – Describe the structure and function of neurones and the synapse between them

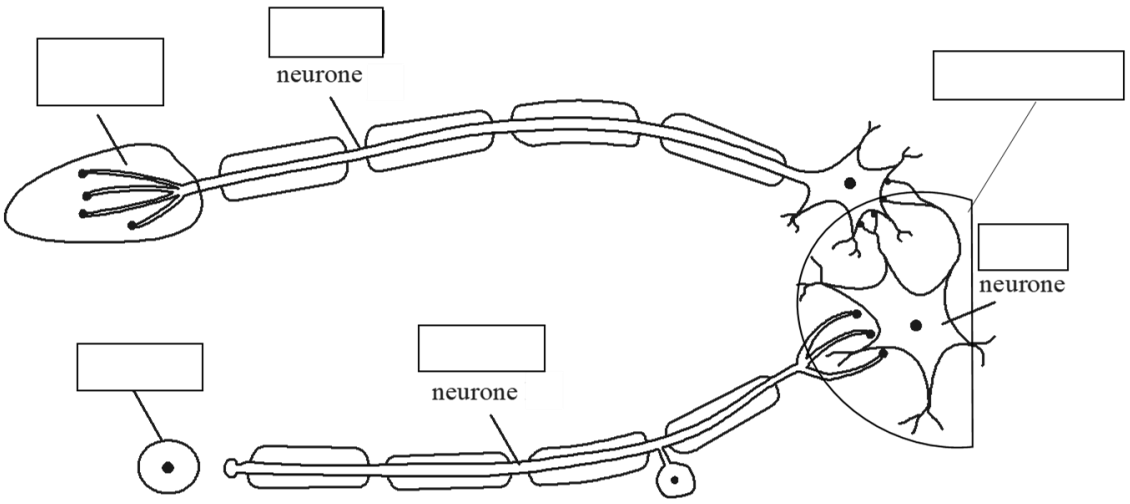
The nervous system is made of nerve cells (neurones). Neurones are specialised cells which can carry electrical impulses along their long thin cytoplasm, called an **axon**. Neurones come in 3 main forms **sensory** neurone, **relay** neurone and **motor** neurone.



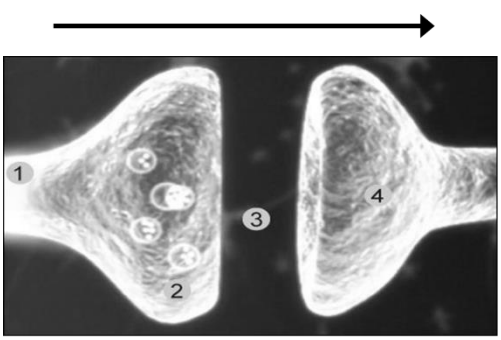
Sensory neurone		These connect receptors to the coordinator. The cell body is on the neurone fibre
Relay neurone		These coordinate the correct response to the stimulus. The cell body is in the spinal cord.

Motor neurone		These send the signal from the coordinator to the effector. The cell body is at the beginning of the neurone

Task: Add the labels to the diagram of a reflex arc



Receptor | Relay | Sensory | Effector | Motor | Co-ordinator

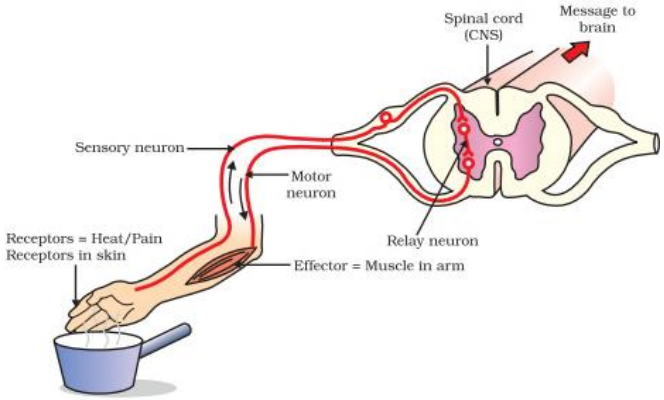


When an electrical impulse arrives at the end of a neurone a chemical (a **neurotransmitter**) is released.

The chemical diffuses across the gap and bind with receptor molecules on the membrane of the next neuron.

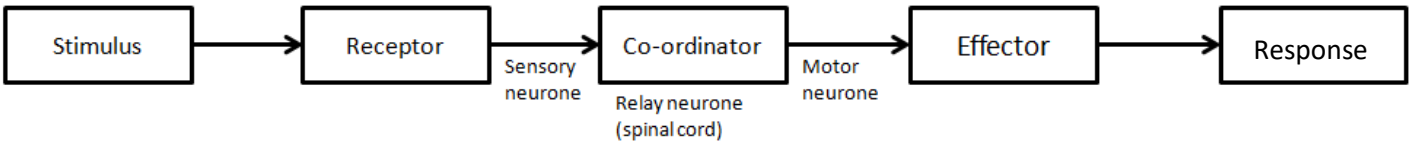
Sets off another electrical impulse in the next neurone.

Where a nerve ends and joins to another there is a gap. This gap is known as a **synapse**. At the synapse the electrical signal is transferred into a chemical signal that diffuses across the gap. The synapse is important as it allows the nervous system to direct the signal to the right location



Part 2 - Describe the reflex arc

Automatic responses which happen so fast you do not even have time to think, are called reflexes. The response occurs without having to 'think' about it – they do not involve the conscious part of the brain. The relay neurones in the spinal cord coordinate the response and your body will respond without the need for you to think about it. A good example is in the eye. When the light levels are low and it is dark your iris contracts and your pupil gets bigger. If you move into the light, your eyes detect the increase in light and automatically your iris will relax and the pupil will shrink.



Task: Complete the table below to show the stages of the reflex arc. The example of the eye has been completed for you

Stages of reflex arc	**Moving from a dark room to a light room**	**Touching a hot saucepan**
Stimulus	Increase in light intensity	
Receptor	Light receptors in eye	

Neurone that sends signal to coordinator	Sensory neurone	
Coordinator	Relay neurone in spinal cord	
Neurone that sends signal to effector	Motor Neurone	
Effector	Muscle (Iris)	
Response	Pupil gets smaller	

Part 3 - Explain why reflexes are important

The main reasons for reflexes is to avoid danger to protect the body from harm, for example bright light entering the eye could damage the retina. Thinking about the response would be too slow so the reflex arcs are designed to be very fast. Examples of reflex actions include:

- When light acts as a stimulus, the pupil of the eye changes in size.
- Sudden jerky withdrawal of hand or leg when pricked by a pin.
- Coughing or sneezing, because of irritants in the nasal passages.
- Knees jerk in response to hitting the shin/lower leg.
- The sudden removal of the hand from a sharp object.
- Sudden blinking when an insect comes very near to the eyes.

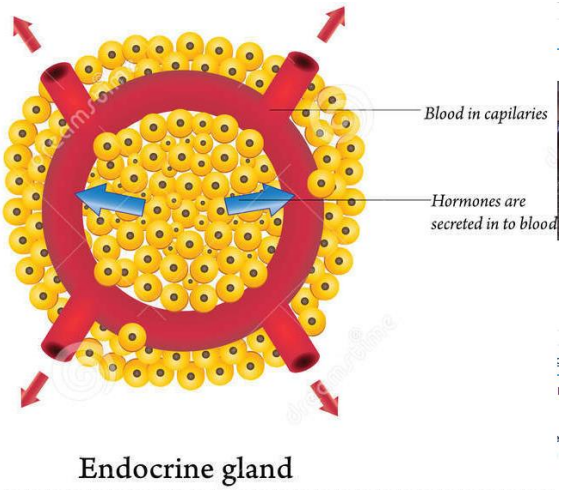
Recall Questions

Instruction: *Answer these questions in your exercise book. Use the notes above to help you (like a comprehension)*

1. Name the type of neurone that carries impulses to the central nervous system.
2. Name the type of neurone that carries impulses away from the central nervous system.
3. Name two types of effectors.
4. Where is the cell body found in the sensory neurone?
5. Where is the cell body found in the motor neurone?
8. What are reflex actions?
9. Name the three types of neurones that are involved in coordinating reflexes.

10. Where is the relay neurone found in a reflex arc?
11. Illustrate the reflex pathway in a flowchart, showing all the components involved.
12. What are synapses?
13. How is information passed through the synapse?

Principle of hormonal control

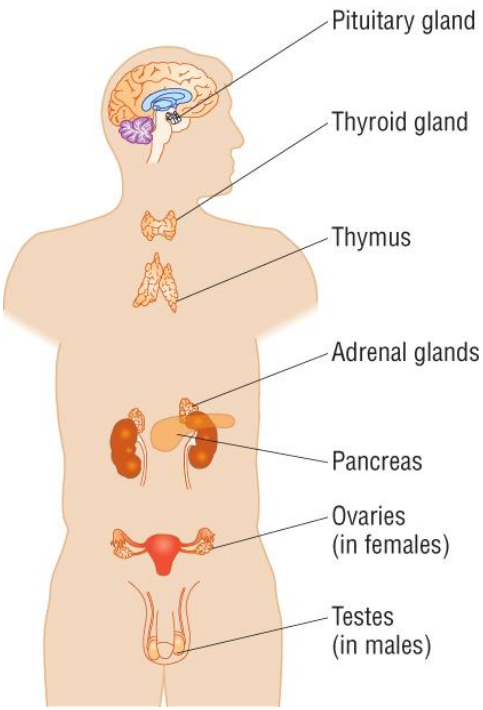


Endocrine gland

Part 1 - Define a hormone

Hormones are chemical messages secreted by the glands of the endocrine system. Hormones are released directly into the blood stream by endocrine glands, they travel to cells in the blood. The cells receiving the hormone have a specific complementary receptor on their plasma membrane, which the hormone binds to. These cells are the target cells.

Part 2 - Describe the main organs of the endocrine system



The pituitary gland is found in the brain, it controls many organs directly and indirectly with hormones. It is therefore known as the master gland.

The thyroid gland produces thyroxine which controls the rate that glucose is used up in respiration.

The thymus gland promotes the production of white blood cells

The adrenal glands produce adrenaline which increases heart and breathing rate and raises blood sugar levels. These are essential for the fight or flight response to danger.

The pancreas secretes insulin and glucagon to control blood glucose levels.

The ovaries produce oestrogen, progesterone and testosterone and control female sexual characteristics and reproduction

The testes produce testosterone which control male sexual characteristics and reproduction

Part 3 – Compare hormonal and nervous control

Nervous Control	**Hormonal Control**
Works by electrical signals in neurones	Hormones (chemicals) transported in bloodstream
Travel fast and have an instant effect	Travel slower and may take longer to have an effect
Response is over quickly	Response is long lasting
Impulse acts on individual cells (localised effect)	Widespread effect on different organs

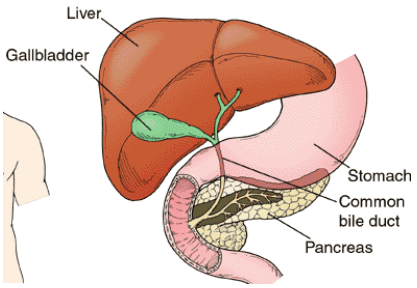
Recall Questions

Instruction: *Answer these questions in your exercise book. Use the notes above to help you (like a comprehension)*

1. How does the endocrine system bring about a change in our internal environment?
2. What are hormones?
3. Name the 'master gland' that secretes a variety of hormones.
4. State one difference between the effects of hormones compared to the nervous system.

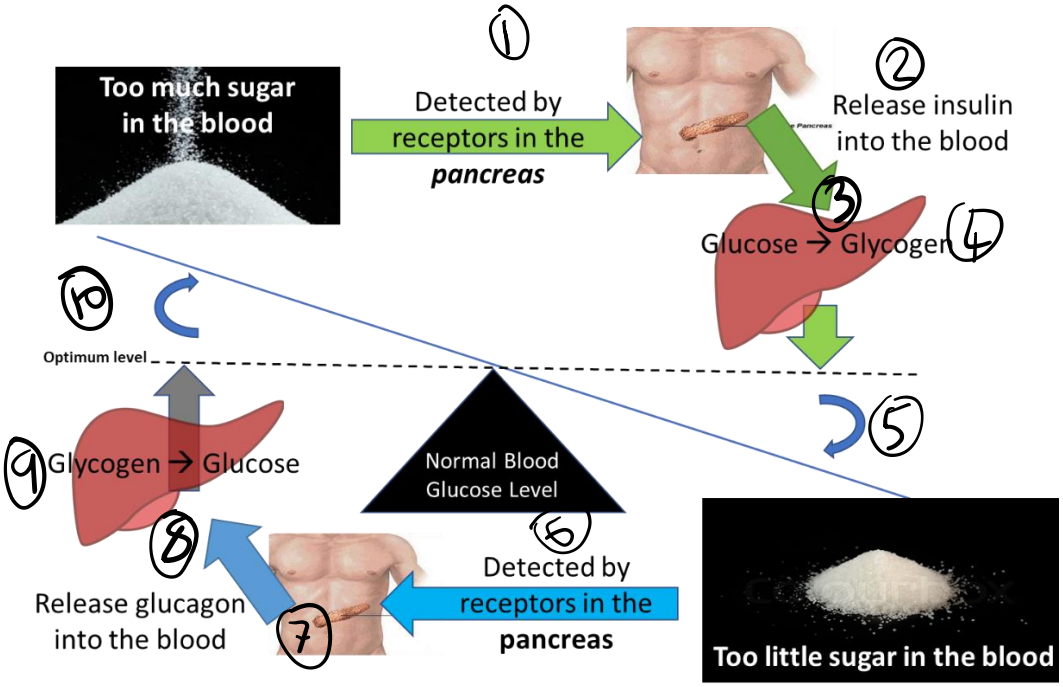
The control of blood glucose levels

Part 1 - Describe the role of the pancreas in monitoring and controlling blood glucose concentration



Insulin is the hormone that reduces blood sugar level. It is secreted and released by cells in the pancreas when they detect high levels of glucose in the blood. Once insulin is released into the blood stream it's target organ is the liver. When the liver detects insulin it converts glucose in the blood into glycogen and stores it to lower the blood glucose level.

Part 2 - Describe how insulin controls blood glucose levels in the body



When you eat your blood sugar rises:

1. The pancreas detects the rise in blood glucose
2. The pancreas secretes **insulin** into the blood stream
3. The insulin travels to the liver
4. The liver absorbs the glucose and converts it into glycogen
5. Blood glucose returns to normal

When you exercise your blood sugar falls:

6. The pancreas detects the fall in blood glucose
7. The pancreas secretes **glucagon** into the blood stream
8. The glucagon travels to the liver
9. The liver converts glycogen to glucose and releases it into the blood
10. Blood glucose returns to normal

Part 3 - Explain the causes of diabetes

We need a supply of glucose in our blood so that our cells can respire efficiently. The problem is glucose is soluble so affects the osmotic potential of the blood plasma. If there is too much sugar in the blood then water will leave the red blood cells, by osmosis through the cell membrane. This causes the red blood cells to shrivel and become unable to carry oxygen. Conversely, if there is too little glucose in the plasma then the water will move from the plasma to the red blood cells by osmosis. This causes the red blood cells to swell and even burst.

Diabetes is a disorder where a person cannot control their blood glucose concentration on their own. It comes is two forms summarised below:

	Type 1	Type 2
Caused by	Body's immune system accidently attacking pancreas cells	Poor diet and obesity over a long period of time
Effect	Pancreas no longer makes insulin	Liver is unable to recognise insulin in the blood
Consequence	Blood sugar rises	Blood sugar rises

Recall Questions

Instruction: *Answer these questions in your exercise book. Use the notes above to help you (like a comprehension)*

1. Name the hormone that decreases blood glucose level.
2. Name the hormone that increases blood glucose level.
3. Name the organ the produces hormones to control blood glucose level.
4. State an effect of insulin.
5. State an effect of glucagon.
6. What is glycogen?
7. What is type 1 diabetes?
8. What is type 2 diabetes?

Treating diabetes

Part 1 - Describe how type 1 diabetes can be treated

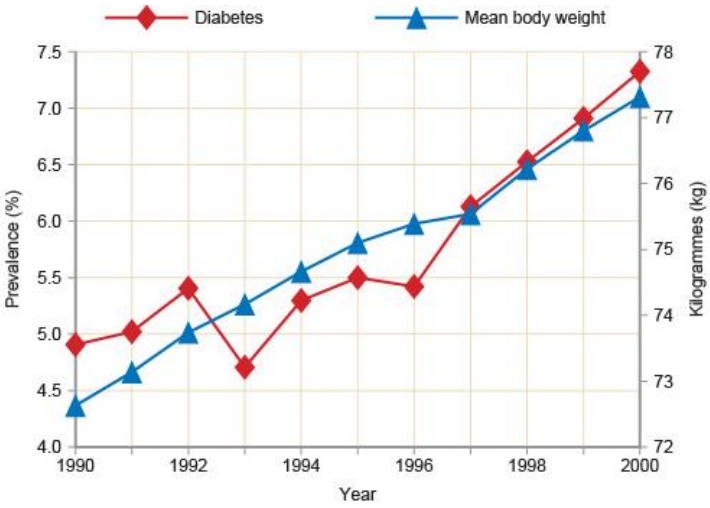
Type 1 diabetes is a disorder in which the pancreas fails to produce enough insulin, this is because the body's own immune system accidently attacking pancreas cells. This means people are usually born with Type 1 diabetes and it can be detected from an early age. Common symptoms of diabetes include producing excess urine, feeling thirsty, losing weight or feeling tired.

It can be treated by injecting insulin when blood sugar levels become too high. You have already learned how human insulin is produced from genetically engineered bacteria. This means that people with type 1 diabetes have to monitor their blood sugar levels throughout the day by testing their blood.

They can help to control their blood glucose level by being careful with their diet, and eat foods that will not cause large increases in blood sugar level.

Part 2 - Describe how type 2 diabetes can be treated

In type 2 diabetes the person's body cells no longer respond to insulin produced by the pancreas. It is more common in older people. Recently the levels of obesity in the general population have risen due to an increase in sugary diets and a drop in exercise. Obesity is a risk factor for diabetes and there is a correlation between body mass and levels of type 2 diabetes. It can be treated with a carbohydrate controlled diet and exercise regime. Medication can also be taken to lower blood sugar levels by improving the way your body handles insulin.



Part 3 - Explain how type 1 diabetes could be cured

People who suffer from type 1 diabetes can receive a pancreas transplant from an organ donor who has died. A pancreas transplant would allow people with type 1 diabetes to produce insulin again. It's not a routine treatment because it has risks, and treatment with insulin injections is often effective. Research is also looking into producing healthy pancreas tissue using stem cells.

Recall Questions

Instruction: *Answer these questions in your exercise book. Use the notes above to help you (like a comprehension)*

1. Name one symptom of diabetes.
2. Name a risk factor for type 2 diabetes.
3. Name a treatment for type 1 diabetes but not type 2 diabetes.
4. Name a method to cure type 1 diabetes.
5. Name one treatment for type 2 diabetes.

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