Coordination and response [part 2]

Syllabus Statements *Checklist*

Core

Hormones in humans

- Define a hormone as a chemical substance, produced by a gland and carried by the blood, which alters the activity of one or more specific target organs ☐
- Identify specific endocrine glands and their secretions, limited to adrenal glands and adrenaline, pancreas and insulin, testes and testosterone and ovaries and oestrogen ☐
- Describe adrenaline as the hormone secreted in 'fight or flight' situations and its effects, limited to increased breathing and pulse rate and widened pupils ☐
- Give examples of situations in which adrenaline secretion increases ☐
- State the functions of insulin, oestrogen and testosterone ☐

Homeostasis

- Define homeostasis as the maintenance of a constant internal environment ☐
- Name and identify on a diagram of the skin: hairs, hair erector muscles, sweat glands, receptors, sensory neurones, blood vessels and fatty tissue ☐
- Describe the maintenance of a constant internal body temperature in humans in terms of insulation, sweating, shivering and the role of the brain (limited to blood temperature receptors and coordination) ☐

Tropic responses

- Define gravitropism as a response in which parts of a plant grow towards or away from gravity ☐
- Define phototropism as a response in which parts of a plant grow towards or away from the direction from which light is coming ☐
- Investigate gravitropism and phototropism in shoots and roots ☐

Hodder education. IGCSE biology workbook. 2014
Oxford Revision Guide IGCSE biology 2015.
Letts Cambridge Biology Learning Guide. 2016
Biology at Glance ,Judy Dodds. 2015.CRC press

Adopted from Cambridge IGCSE Biology 0610. Syllabus for examination in 2016, 2017 and 2018.

Syllabus Statements *Checklist*

Supplement

Hormones

- Discuss the role of the hormone adrenaline in the chemical control of metabolic activity, including increasing the blood glucose concentration and pulse rate ☐
- Compare nervous and hormonal control systems in terms of speed and longevity of action ☐

Homeostasis

- Explain that homeostasis is the control of internal conditions within set limits ☐
- Explain the concept of control by negative feedback ☐
- Describe the control of the glucose concentration of the blood by the liver and the roles of insulin and glucagon from the pancreas ☐
- Outline the symptoms and treatment of Type 1 diabetes (detail of β cells is not required) ☐
- Describe the maintenance of a constant internal body temperature in humans in terms of vasodilation and vasoconstriction of arterioles supplying skin surface capillaries ☐

Tropic Responses

- Explain phototropism and gravitropism of a shoot as examples of the chemical control of plant growth ☐
- Explain the role of auxin in controlling shoot growth, limited to:
  - auxin made in shoot tip (only) ☐
  - auxin spreads through the plant from the shoot tip
  - auxin is unequally distributed in response to light and gravity
  - auxin stimulates cell elongation
- Describe the use in weedkillers of the synthetic plant hormone 2,4-D ☐

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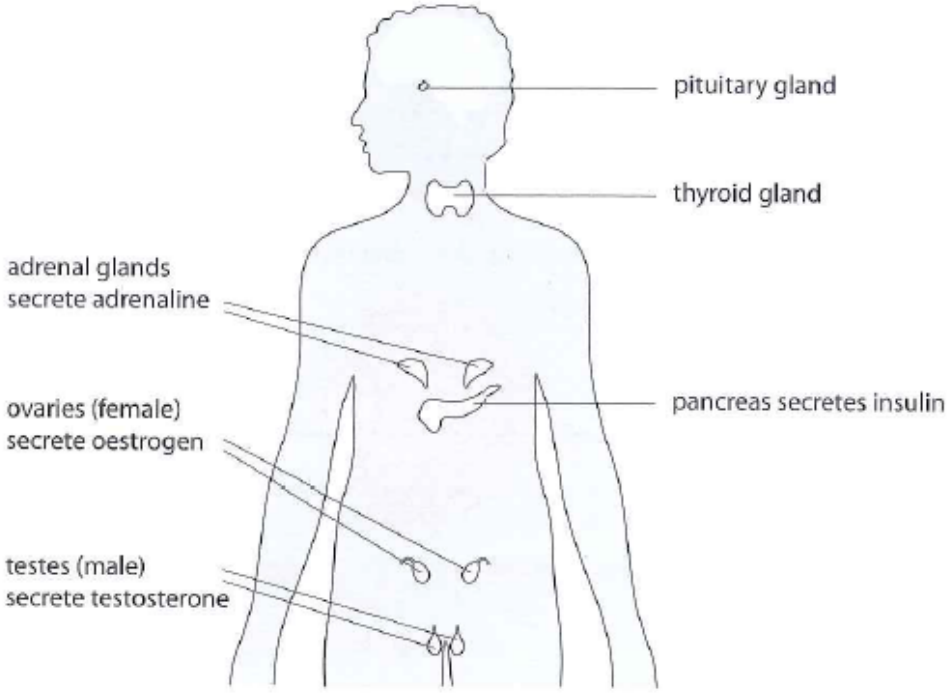
Define a hormone as a chemical substance, produced by a gland and carried by the blood, which alters the activity of one or more specific target organs
Identify specific endocrine glands and their secretions, limited to adrenal glands and adrenaline, pancreas and insulin, testes and testosterone and ovaries and oestrogen
State the function of insulin, oestrogen and tesosterone

Define Hormones. How do they reach their target organs?

Hormones are chemicals that are produced by various **endocrine glands**. They are transported to all parts of the body dissolved in the blood plasma. Each hormone affects one or more **target organs**.

Positions of endocrine glands in humans



Fill in the details below using your textbook. One example has been done for you.

Hormone	Gland that secretes it	When secreted	Function
adrenaline	adrenal glands	when you are frightened or excited	increases breathing rate; increases pulse rate; widens pupils. This is called the fight or flight response.
insulin	pancreas	when blood glucose concentration is too high	causes liver to reduce the concentration of glucose in the blood
testosterone	testes	from puberty onwards	produces male secondary sexual characteristics
oestrogen	ovaries	from puberty onwards	produces female secondary sexual characteristics; helps to regulate the menstrual cycle

Some hormones are used illegally in sports. Why are they illegal and which hormone do you think will be beneficial in sport?

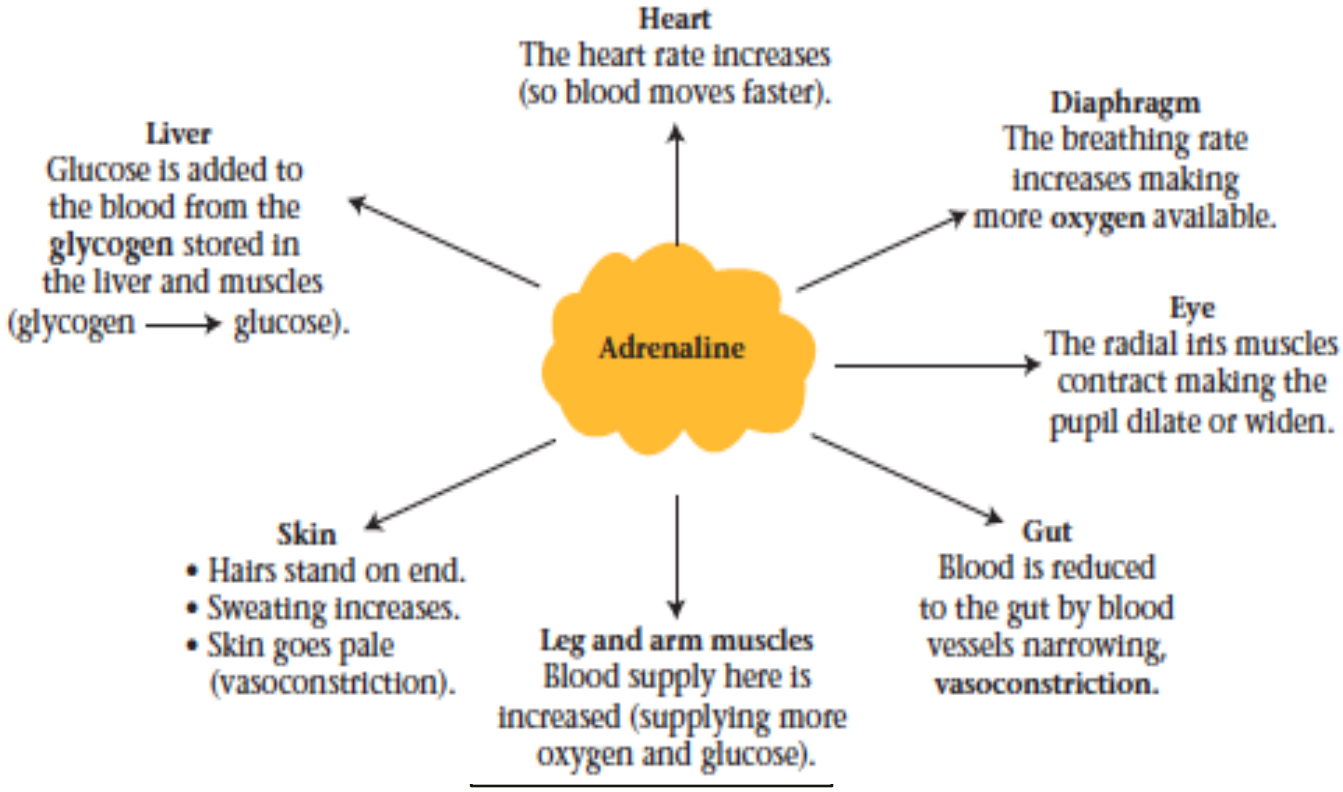
testosterone to build up muscles and strength
ADH to loose water

Describe adrenaline as the hormone secreted in 'fight or flight' situations and its effects, limited to increased breathing and pulse rate and widened pupils
Discuss the role of the hormone adrenaline in the chemical control of metabolic activity, including increasing the blood glucose concentration and pulse rate

When is the adrenaline released by our body?

Adrenaline is released whenever the body is under stress, e.g. when we are angry, nervous, or terrified. Adrenaline diffuses from the adrenal glands into the blood and is carried to several target organs where it has its effects.

The diagram below list the target organs of the adrenaline. Annotate the diagram with the effects of adrenaline release on specific organs



Adrenaline is involved in the chemical control of metabolic activity. How does it helps the body to prepare for vigorous action?

- Causing the concentration of glucose in the blood to increase. This provides more fuel for respiration, so that muscle cells can release more energy to use for contraction. This could help with fleeing from a predator, or fighting it.
- Causing the pulse rate to increase. This increases the rate at which oxygen and glucose are delivered to muscles, so that they can respire faster and release more energy.

Compare nervous and hormonal control systems in terms of speed and longevity of action

- Hormones act more slowly than nervous impulses. This is because hormones travel to their target organs in the blood, whereas nervous impulses travel very swiftly along neurones as electrical signals.
- Hormones act for a longer time than nervous impulses. This is because hormones remain in the blood for a while before they are broken down, whereas nervous impulses only happen at an instant in time.

Define homeostasis as the maintenance of a constant internal environment
Explain the concept of negative feedback Mechanism

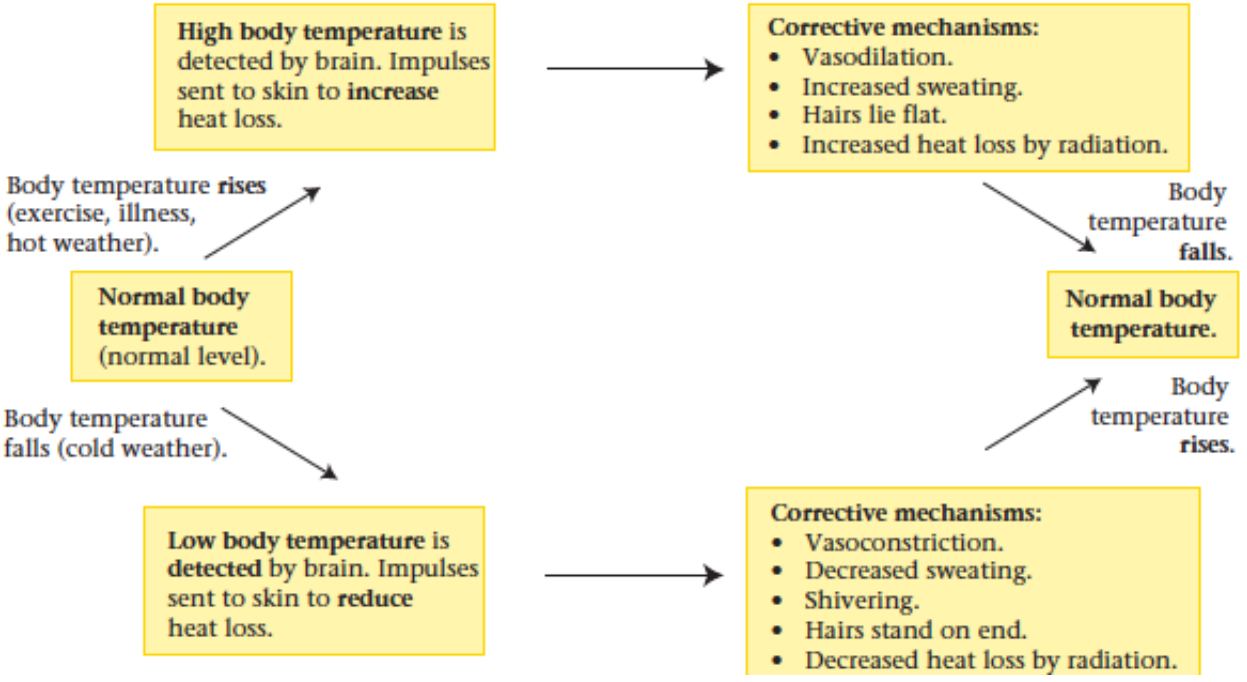
Define homeostasis. Why is it important for humans to maintain constant internal environment.

This means keeping a **constant internal environment**. Cells can then function most efficiently and an organism stays healthy. In humans, it is important that temperature, sugar level and water levels stay constant.

Humans need to maintain the level of three key changes to optimum body requirements. Fill in the table below referring to the changes in body and action taken to bring it back to optimum.

Condition	Controller	Organ involved	Hormone
Temperature	Brain	Skin	None
Water level	Brain	Kidneys	Anti-diuretic hormone (ADH)
Sugar level	Pancreas	Liver	Insulin and glucagon

Diagram illustrating an example of negative feedback Mechanism in our body.



Define the term ”negative feedback”. What are the two key elements involved in the negative feedback loop.

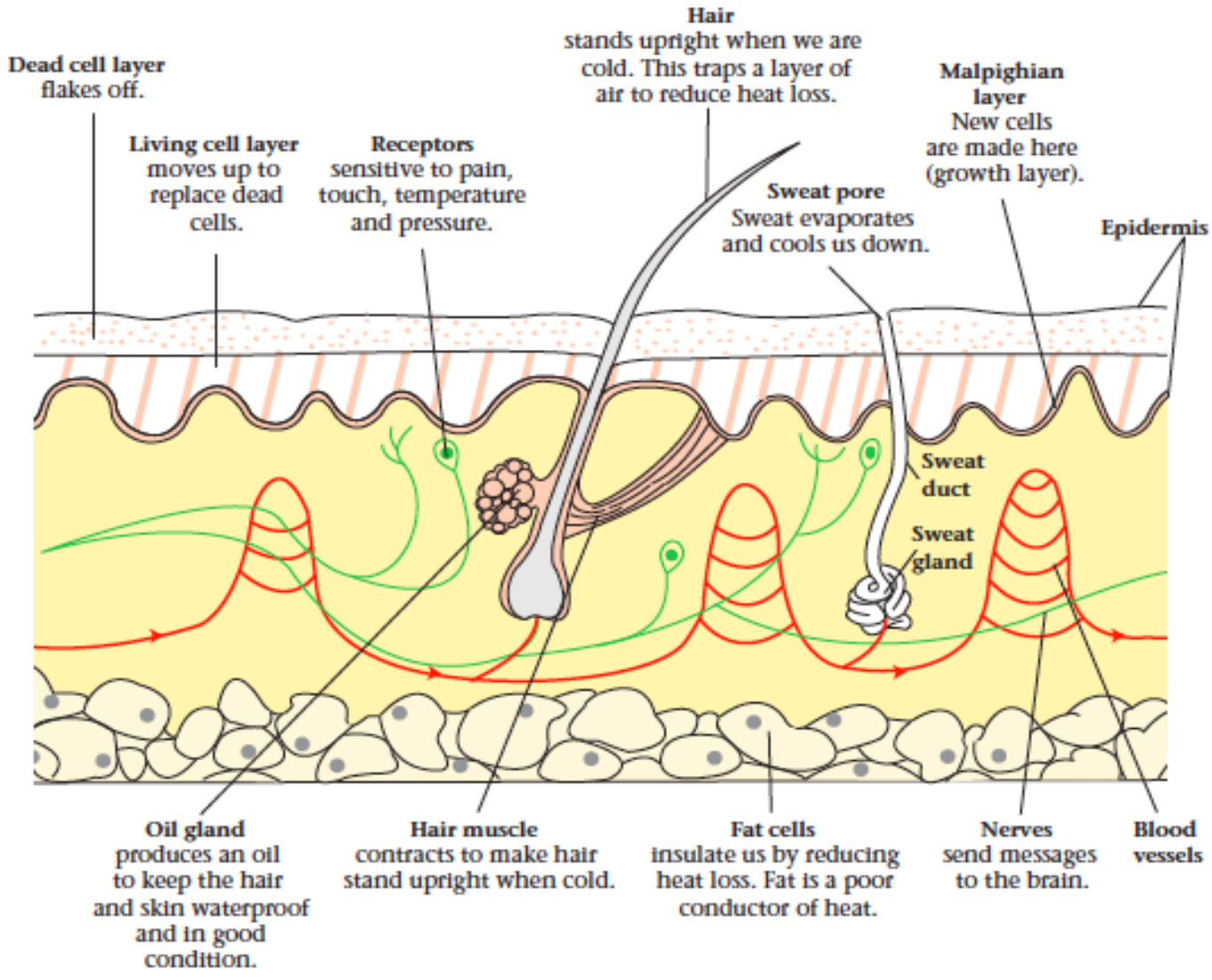
Negative feedback is a mechanism that helps to keep a varying factor within set limits.

Negative feedback involves:

- a **receptor** that detects a change in a factor, for example a rise in blood temperature;
- an **effector** that responds to the change by bringing the factor back towards normal, for example by lowering the blood temperature.

Name and identify on a diagram of the skin: hairs, hair erector muscles, sweat glands, receptors, sensory neurones, blood vessels and fatty tissue

Identify and annotate the diagram of the skin below.



Excess fat from food is stored as fat under the skin.

What is the function of skin?

Functions of the skin

- It is waterproof and stops us drying up.
- It stops the entry of germs.
- It helps to control our body temperature.
- It has sense receptors which keep us aware of danger.

Skin plays crucial role in maintaining constant body temperature. How is the blood flow controlled? Use an example to illustrate change in blood flow and name the vessels involved in the process

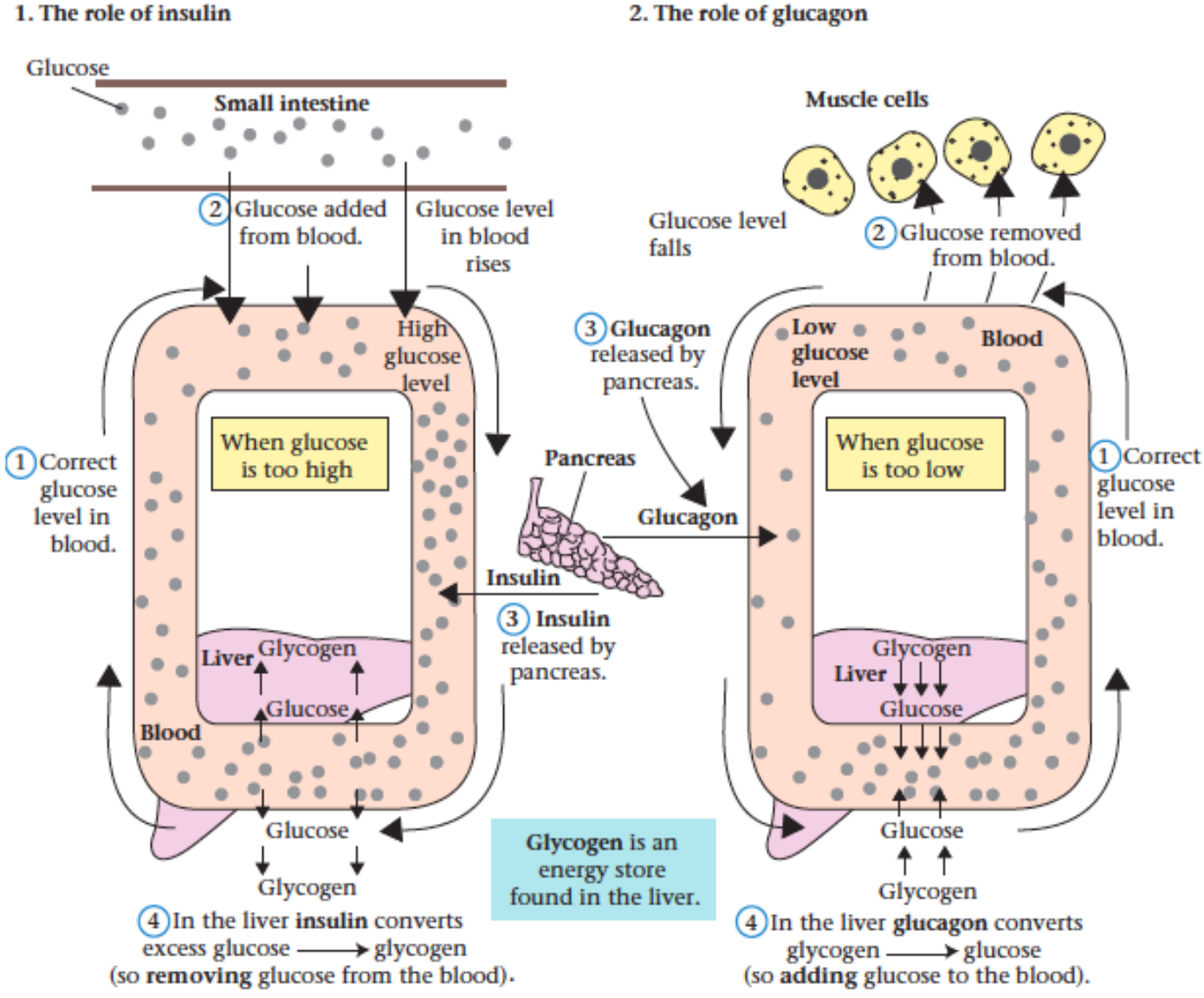
blood vessels in the skin helps to regulate body temperature. Arterioles that supply blood to capillaries near the skin surface can become narrower (vasoconstriction) or wider (vasodilation). If the arterioles becomes narrower, less blood is delivered to the surface capillaries, and blood is diverted beneath the fat layer. This reduces heat loss from the blood to air.
if the arterioles become wider, more blood flows through the surface capillaries. More heat can therefore be lost to air from blood.

Describe the control of the glucose concentration of the blood by the liver and the roles of insulin and glucagon from the pancreas

Why is it important to control the blood glucose level? (hint: function of glucose, consequence of high and low glucose?

It is important to keep blood glucose concentration within set limits. Glucose is needed by cells for the release of energy by respiration. If blood glucose concentration falls too low, cells may run short of energy. If its concentration rises too high, this reduces the water potential of the blood, so that water may move out of cells down the water potential gradient. Cells may become short of water, which damages them.

Role of insulin and glucagon in blood glucose level maintenance



Refer to the diagram above, Describe changes in the blood glucose level after a person have a meal or exercise?

When blood glucose concentration rises too high:

- the pancreas secretes the hormone **insulin** into the blood;
- insulin is carried in the blood to the liver;
- insulin stimulates the liver to take up glucose from the blood;
- the liver changes glucose into the polysaccharide glycogen, and stores it.

When blood glucose concentration falls too low:

- The pancreas secretes the hormone **glucagon** into the blood.
- Glucagon is carried in the blood to the liver.
- Glucagon stimulates the liver to break down glycogen into glucose.
- The liver releases glucose into the blood.

Outline the symptoms and treatment of Type 1 diabetes (detail of β cells is not required)

Explain the term “diabetes”

Diabetes, often referred to by doctors as diabetes mellitus, describes a group of metabolic diseases in which the person has high blood glucose (blood sugar), either because insulin production is inadequate, or because the body's cells do not respond properly to insulin, or both.

When is a person considered Type 1 Diabetic? Why does this condition require constant monitoring? (hint: what happens after and between meals?

Type 1 diabetes

In some people, their own immune system attacks and destroys the cells in the pancreas that secrete insulin. This results in **type 1 diabetes**.

After a meal, a person with type 1 diabetes may have blood glucose concentrations that rise much higher than normal. This is because there is no insulin to stimulate the liver to convert the extra glucose in the blood into glycogen.

Between meals, the blood glucose concentration may fall much lower than usual. The body cells gradually use up glucose in respiration. But there is little or no glycogen in the liver to be converted to glucose to top up the glucose concentration in the blood.

What are the symptoms of diabetes?

- feeling very thirsty; this happens because a high concentration of glucose in the blood decreases its water potential; the brain perceives this as meaning you need more water in the body;
- having glucose in the urine; this happens when blood glucose concentration rises so high that the kidneys are unable to absorb all the glucose back into the blood;
- blurred vision; this happens because the changes of concentration (water potential) of the blood cause osmosis to occur, which can change the shape of the lens in the eye;
- feeling very tired between meals; this happens when the blood glucose concentration drops very low, as there is not enough glucose to provide energy to cells through respiration.

How is the person with Type 1 Diabetes treated?

Type 1 diabetes is treated with a combination of diet and insulin injections.

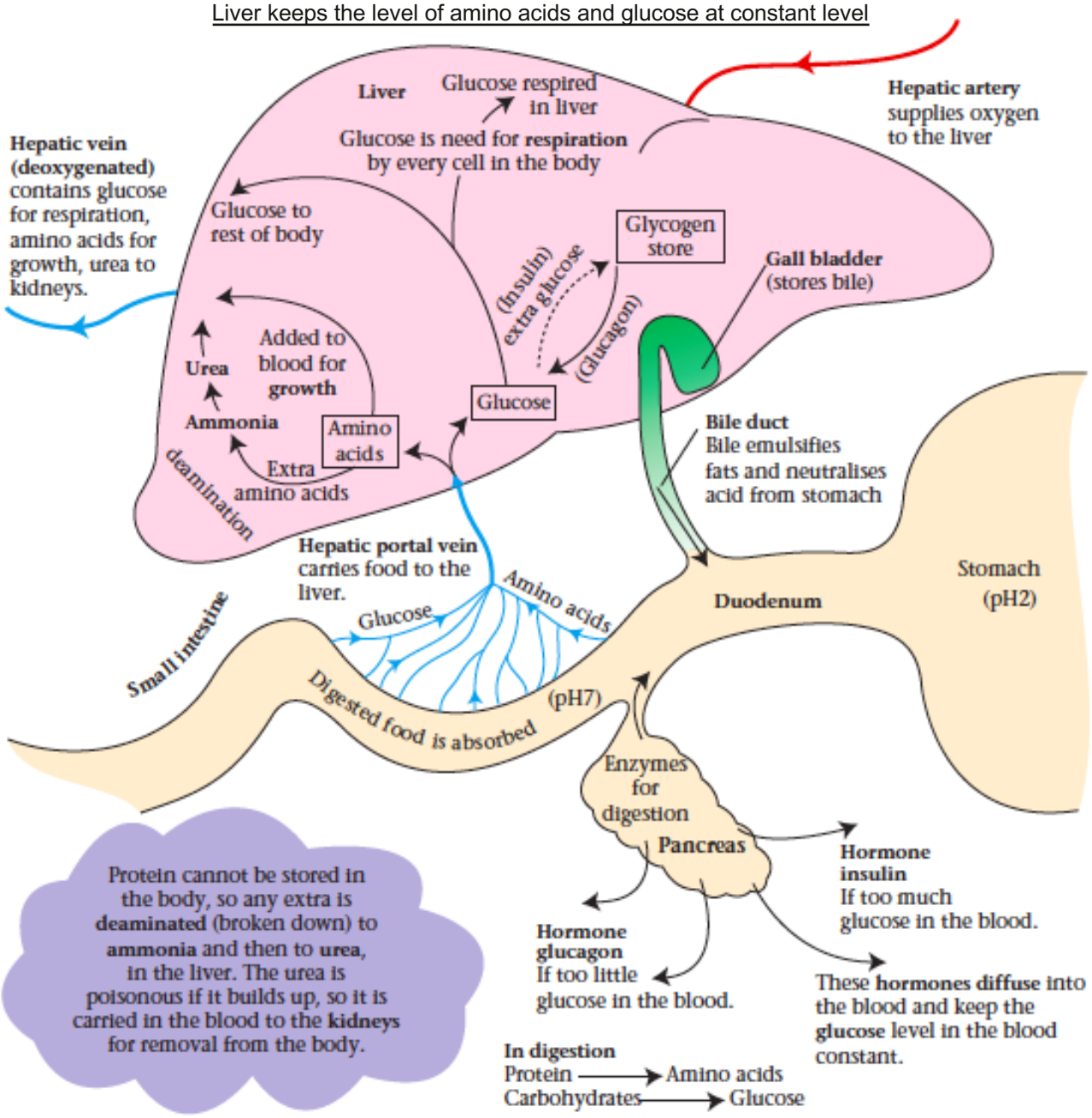
- The person needs to eat regular, small meals, to try to even out their intake of carbohydrate through the day. The quantity that they need will depend on the level of activity that they do.
- They can inject insulin after a meal, to reduce any ‘spikes’ in the blood glucose concentration.

How is the Type 1 diabetes different from type 2?

Type 1 is a genetic disorder where immune system attacks its own beta cells in pancreas, so the person is unable to produce sufficient insulin
Type 2 diabetes is a lifestyle disease where cells stop or respond less to the actions of insulin.

Extension (Liver role in homeostasis)

Liver keeps the level of amino acids and glucose at constant level

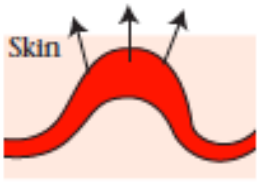
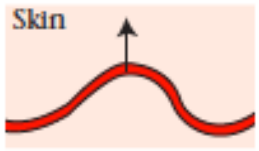
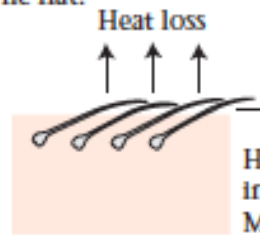
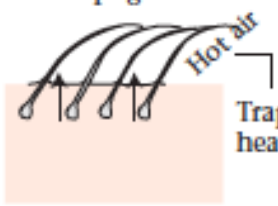


Glucose and amino acids are carried in hepatic portal vein to liver. Fill in the table below describing the fate of glucose and amino acids in liver.

Fate of glucose	Fate of amino acids
• Some glucose is respired by the liver. • Some glucose is added to the hepatic vein and carried to other body cells, for respiration. • Excess glucose is converted to **glycogen** in the liver and stored. • The hormone **insulin**, secreted by the pancreas, converts glucose to glycogen. • If glucose levels fall in the blood, the hormone **glucagon** from the pancreas, causes the conversion of glycogen back to glucose.	• Some amino acids are used by the liver cells for growth. • Some amino acids are added to the hepatic vein and carried to other body cells for growth. • Excess amino acids are deaminated, broken down to ammonia and then converted to urea which is less poisonous (in the liver). • Urea is added to the hepatic vein and carried to the kidneys for removal in the urine.

Describe the maintenance of a constant internal body temperature in humans in terms of insulation, sweating, shivering and the role of the brain (limited to blood temperature receptors and coordination)

Fll in the blanks in the table below showing the maintenance of constant internal body temperature

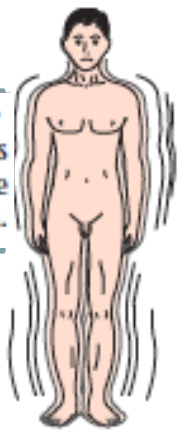
Structure in skin	**Too hot** (sun, exercise, fever)	**Too cold** (cold weather, few clothes)
Sweat glands	Hot  More sweat evaporates.  Evaporation produces cooling. Sweat duct Sweat gland **Increased sweating** cools us down.	Cold  Less sweat.  **Less sweating,** less evaporation, less cooling.
Blood vessels	Increased heat lost by radiation.  Skin **Vasodilation** Blood vessels **widen** allowing more warm blood close to the surface. This increases heat loss.	Little heat lost by radiation.  Skin **Vasoconstriction** Blood vessels **narrow** so less blood flows near the surface, reducing heat loss.
Hairs	Hairs lie flat.  Heat loss Hot air not trapped in air space. More heat is lost by radiation. Heat loss increases Temperature falls → Back to normal	Hairs stand upright.  Hot air Trapped air is heated by body. Hair muscle contracts causing goose pimples. This traps air which acts as an **insulator**. This reduces heat loss by radiation. Heat loss decreases Temperature rises → Back to normal

Explain the term "Vasodilation"

When heat needs to be lost, the arterioles in the skin **dilate** – that is, their muscular walls relax and the arterioles widen, increasing the diameter of their lumens allowing more blood to flow. More blood enters the capillaries and they widen accordingly. More blood flows to the sweat glands and more sweat is extracted from the blood and passed up to the skin surface to increase evaporation.

Shivering

This muscular activity warms us up as it increases the rate of respiration.



Remember: *It is arterioles that dilate or constrict as they have muscles in their walls. Capillaries do not move up or down the skin*

1 A man experience a sudden loud bang. This results in release of adrenaline. Outline the effects of adrenaline on his body?

Any three from: causes heart rate to increase, blood supplies muscles with oxygen and glucose more quickly, blood supply to skin reduced, blood supply to digestive organs is reduced, blood is diverted to vital organs, liver is stimulated to convert glycogen to glucose.

2 Complete the following table which compares Nervous and endocrine system

Feature	Nervous	Hormonal (endocrine)	ENDOCRINE
form of transmission	electrical impulses	chemical/ hormones	
transmission pathway	nerves	blood vessels	
speed of transmission	fast	slow	
duration of effect	short term	long term	

3 With reference to glucose levels in blood, describe the role of negative feedback in homeostasis?

Pancreas acts as a sensor in negative feedback and acts as an effector by secreting hormones.If glucose levels rise above normal, change is sensed by the pancreas. Insulin is secreted by the pancreas and passed into bloodstream. Insulin instructs the liver to remove excess glucose from the blood. Glucose is converted to glycogen and stored. Rate of respiration in the liver is increased to use up glucose. Glucose levels return to normal. If glucose levels fall below normal the pancreas stops secreting insulin and starts to secrete glucagon. Glucagon instructs the liver to convert glycogen to glucose. Glucose is passed into the blood, returning glucose levels to norma

4 A person with type 1 diabetes has a meal with high sugar content. Describe the symptoms he may experience and how his condition could be treated.

concentration of glucose increases resulting in hyperglycaemia. it usually makes the person unwell as they will experience dry mouth, blurred vision and feel very thirsty. their heart rate & breathing rate may increase. they need to monitor the glucose level and do inject themsevles with insulin regularly.

5a. An athlete runs a race in hot conditions. Describe the role of blood vessels and sweat in reducing the body temperature of athlete to normal.

Increase in sweating – sweat is secreted onto the skin surface. Water from sweat evaporates, taking heat from the skin surface.
Vasodilation – arterioles dilate to allow more blood to flflow near the skin surface, so more heat is lost through radiation.

5b. During the race, Athlete's muscle require more glucose to respire. How does the body provide extra glucose?

The drop in glucose is detected by the pancreas. It secretes glucagon. This is transported to the liver in the blood. In the liver, glucagon converts glycogen to glucose

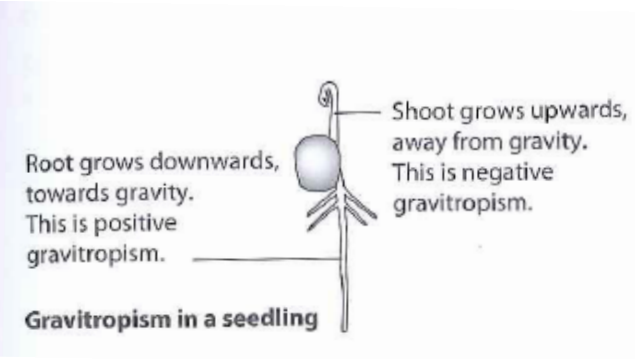
Tropic Responses

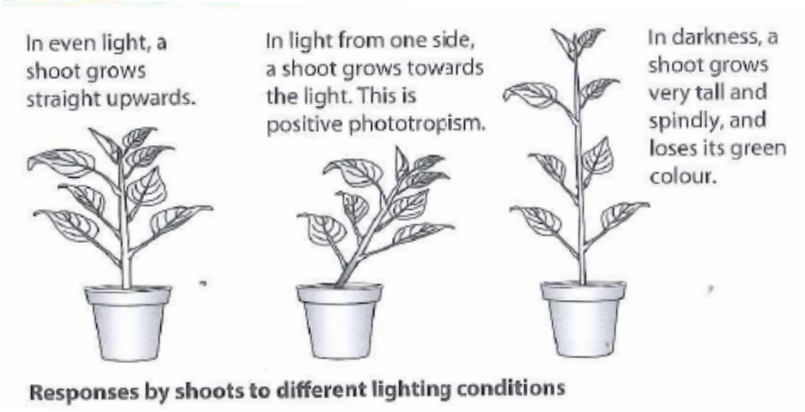
Define gravitropism and phototropism. Investigate tropism in roots and shoots

Define the following terms

Terms	Definition
Tropism	plant's response to stimuli by changing its direction of growth
Gravitropism	a response in which parts of plant grow towards or away from gravity
Phototropism	a respinse in which parts of plant grow towards or away from direction from which the light is coming
Auxin	a plant hormone that is made in tip of shoot and stimulates cells to elongate
Meristems	A meristem is the tissue in most plants containing undifferentiated cells

Shoot and root response to the different stimulus





How do plants respond to different stimulus? (*one example has been done for you*)

Stimulus	Shoot	Root	Response called
Light	Grows towards	Grows away from	Phototropism
Gravity	Grows away from	Grows towards	Geotropism

alled

Explain the role of auxin in controlling shoot growth

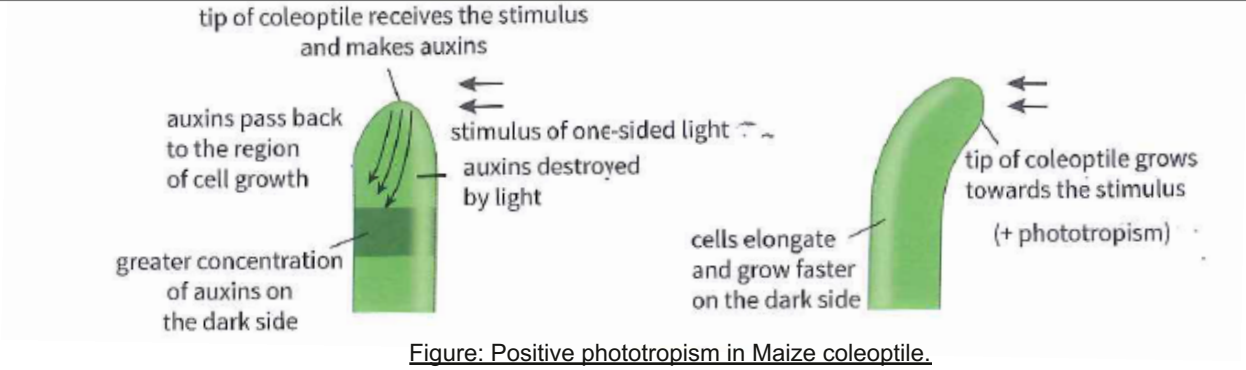
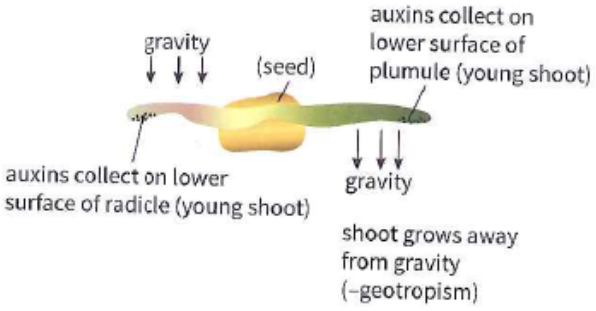


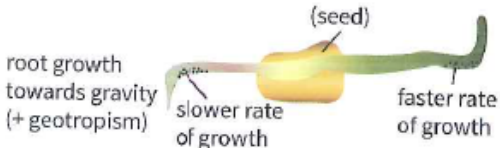
Figure: Positive phototropism in Maize coleoptile.

How does tropism take place? **(explain)**

In plants, the very tip(apex) of shoots and roots have cells (receptor cells) specialised to receive stimuli. The elongating cells that occur just beyond(or behind) the region of cell division are the effector cells and the link between the two is growth hormones called auxin. Auxin sre manufactures at the tip of the shoot or root and in solution in water, pass back to the growth regions. A differential concentration of auxins causes a differential growth on one side of the shoot or root.

Investigate tropism in roots and shoots

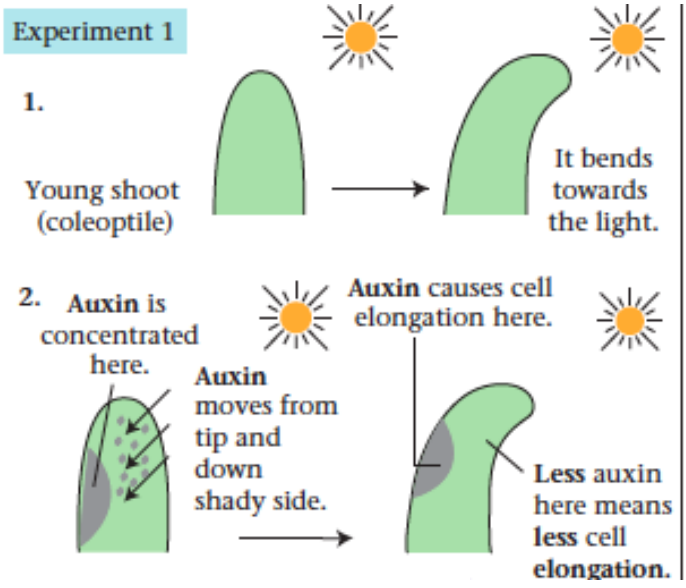


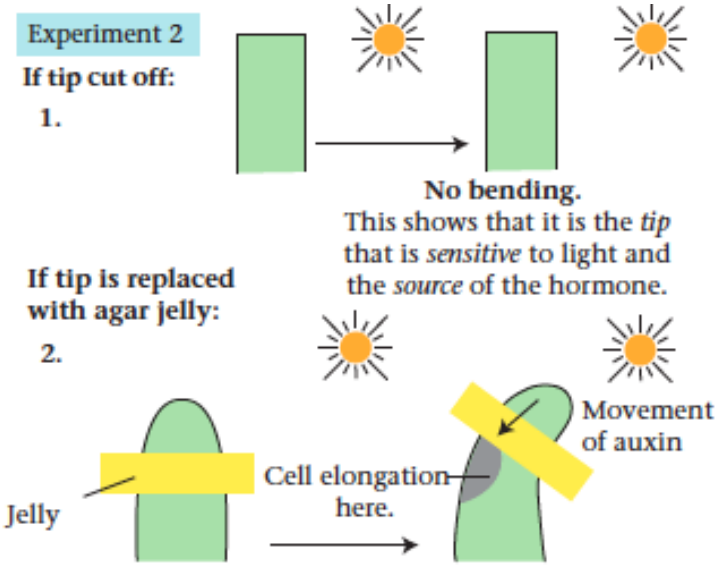


Explain the response of shoot to gravity?

Auxins accumulate on the lower side of (horizontal) shoots and roots due to gravity. However, **auxins** have the **opposite effect** on the **rate of growth of cells** in the root to that on cells of the shoot. In **roots**, they **slow down** the rate of growth. In **shoots**, they **speed up** the rate of growth.

Thus, a horizontal root grows downwards (positive [+] geotropism) and a horizontal shoot grows upwards (negative [–] geotropism) (Figure 14.4).





What causes the bending in experiment 1?

Bending is caused by unequal distribution of auxin.
More auxin causes more growth on one side of the tip.

What is the purpose of doing experiment 2? What can be learnt from it?

The auxin produced in the tip must **diffuse** through the jelly and concentrate on the shady side. Here *cell* **elongation causes bending.** This shows that the **hormone** can move by **diffusion.** Light, gravity, and water cause growth movements in plants called **tropisms.** Tropisms are controlled by auxins.

Will the result be same if we replace agar jelly with mica plates? Why?

no as mica plates will not allow diffusion of auxins to take place hence there will be no change in growth.

Describe the use in weedkillers of the synthetic plant hormone 2,4-D

Discuss the application of auxin in agriculture.

Auxins are used in **agriculture** to improve production of fruit. They can cause **fruit formation** in grapes without fertilisation. This results in seedless grapes. Auxins are used to encourage **root growth** in cuttings (rooting powder) and to prevent the growth of side branches from the stem. They are also used as **weed killers**. Some auxins are absorbed through leaves, so broad leaved plants absorb more causing their death. Lawns are kept free of broad leaved plants by this method. The auxins cause plants to grow rapidly,disrupting their normal growth pattern. These plants develop long weak stems and die.

Quick Test

1 Name the chemical found in plants that control tropism? auxin

2 State the effect of shining one sided light on the plant shoot?

plants respond by growing towards the source of light by bending towards it.

3 Explain how the effect in (2) is achieved in a shoot.

If a shoot is exposed to light from one side, More auxins are moving in the shaded side (from the tip of the shoot) On this side, cells are stimulated to absorb more water, plant grows more. Shoot bends toward the light

4 Define the term “herbicide”

a substance that is toxic to plants, used to destroy unwanted vegetation

5 Describe and explain how synthetic herbicide can be used as herbicide.

Weedkillers (herbicide) are synthetic plant hormones, similar to auxins. If these chemicals are sprayed on to plants they can cause rapid, uncontrolled growth and respiration, resulting in the death of the plant. Some plant species are more sensitive than others to synthetic plant hormones, so weedkillers can be selective

6 An astronaut working in the condition of zero gravity sets up germinating seeds in a dark box with radicle growing horizontally. A day later the radicle has continued to grow horizontally. With reference to auxin, explain why radicle has not grown vertically downwards.

when the root is growing at an angle to the force of gravity, gravity causes the auxin to collect on the lower side which reduces the amount of elongation of cells on the lower side of root, so the root starts to curve as it grows until it is in line with gravity force. In zero gravity, auxin is evenly distributed so the cells all around radicle are stimulated to grow longer. hence it keeps growing horizontally

1 If the glucose in the blood rises above its normal concentration, insulin is secreted to bring the concentration back to normal.

(a) (i) Suggest one explanation for a rise in the concentration of glucose in the blood.

ref. to recent meal / intake of carbohydrate food AW ; [1]

(ii) Name the organ that secretes insulin.

pancreas [1]

(iii) Describe the role of the liver in bringing the concentration of glucose in the blood back to normal.

ref. to glucose absorbed from blood
ref. to conversion to glycogen ;
ref. to increased rate of respiration ; [2]

(iv) State the term that describes how a substance, such as glucose, in the body is maintained at a constant level.

homeostasis ; [1]

(b) Diabetics are unable to control their blood glucose levels naturally.

Human insulin can now be made using bacteria that have been genetically engineered.

(i) Insulin is a protein. Suggest why insulin has to be injected rather than taken by mouth.

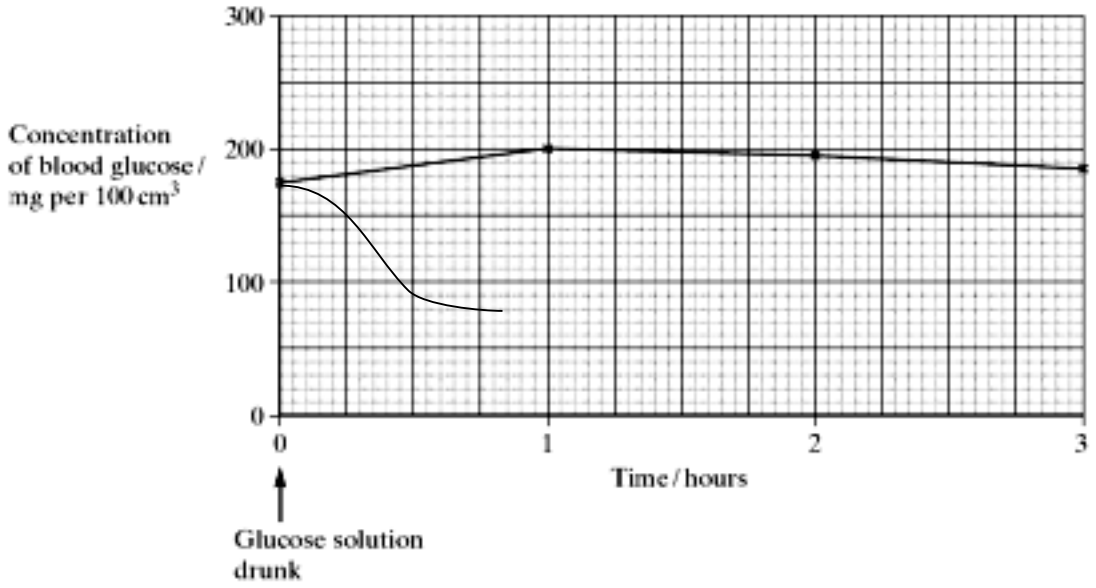
intake by mouth would result in digestion in the stomach AW ;
due to presence of + protease / pepsin ; [2]

(ii) Explain how bacteria can be genetically engineered and used to make human insulin.

insulin gene removed from human + DNA / chromosome ;
ref. to restriction + endonuclease / enzyme ;
ref. to plasmid cut open AW ;
ref. to use of ligase + in placing insulin gene into plasmid ;
ref. to formation of recombinant DNA ;
ref. to insertion of plasmid into host bacterial cell AW ;
ref. to culture of bacteria ;
ref. to use of + fermenter / bioreactor ; [4]

[Total: 11]

2 . Some people produce no insulin. As a result they have a condition called diabetes. In an investigation, a man with diabetes drank a glucose solution. The concentration of glucose in his blood was measured at regular intervals. The results are shown in the graph.



(a) Suggest **two** reasons why the concentration of glucose decreased after 1 hour even though this man's blood contained no insulin.

1 being used up by cells for respiration

2 glucose converted to glycogen in cells

(2)

(b) The investigation was repeated on a man who did not have diabetes. The concentration of glucose in his blood before drinking the glucose solution was 80 mg per 100 cm3.

drop in the blood sugar level after the drink to 80 should be shown in graph

Sketch a curve on the graph to show the results you would expect. (1)

(c) The diabetic man adopted a daily routine to stabilize his blood glucose concentration within narrow limits. He ate three meals a day: breakfast, a midday meal and an evening meal. He injected insulin once before breakfast and once before the evening meal.

The injection he used before breakfast was a mixture of two types of insulin. The mixture contained slow-acting insulin and fast-acting insulin.

(i) Explain the advantage of injecting both types of insulin before breakfast.

Fast acting insulin reduces blood glucose from breakfast;
Slow acting insulin reduces blood glucose from other meals before the evening meal

(2)

(ii) One day, the man did not eat a midday meal. Suggest **one** reason why his blood glucose concentration did not fall dangerously low even though he had injected himself with the mixture of insulin before breakfast.

ref to glycogen storage in body;
conversion to glucose;
glucagon;
balance/ provide glucose

(1)

3 Plants also respond to stimuli such as light.

(i) State the name of the response of plants to light.

phototropism ; (ignore refs. to positive or negative) [1]

Ahmed was provided with several young plant shoots and a sample of auxin.

(ii) Describe an experiment he could carry out to show that auxin causes bending of a shoot.

paint auxin on one side of shoot (or description of other suitable treatment) ;
place shoot in a dark place AW ;
leave + for stated period of time (e.g. 1 to 3 days) / until the shoot to grows vertically / changes direction AW ;
ref. to control without auxin ;
ref. to repeats used ;

[4]

(iii) Explain the mechanism that results in a shoot bending towards light.

auxin accumulates on or moves to + shaded side of shoot / auxin is broken down by light ;
difference in concentrations on shaded side and light side ;
cells with higher concentration of auxin absorb more water ;
causes unequal growth ; [max. 3]

[3]

Synthetic plant hormones behave in a similar way to auxins. Describe how synthetic plant hormones are effective as weedkillers.

i. ref. to large concentrations used ;
ii. plants / leaves / stems + are stimulated to grow rapidly ;
iii. growth gets out of control ;
iv. root growth inhibited by high concentrations of auxin ;
v. so plants die ; (linked to ii, iii or iv) ;
vi. ref. to only broad leaved plants affected AW ;

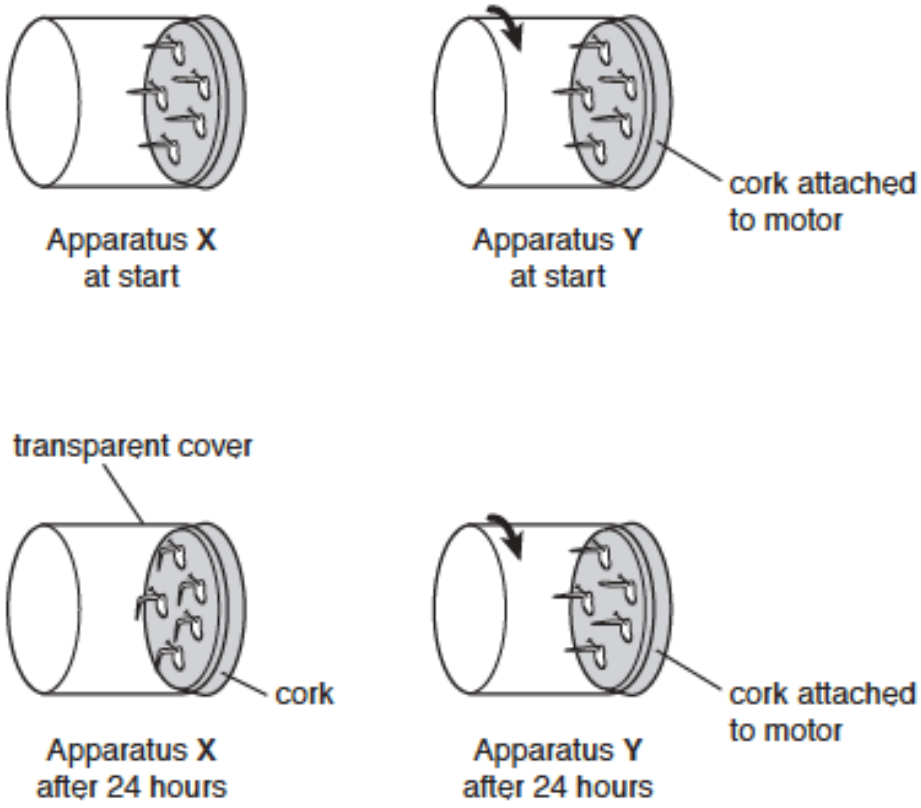
[2]

4 In an experiment, pea seeds were germinated on moist cotton wool.

Ten seedlings with straight radicles were selected.

Five of these seedlings were pinned to a vertical piece of cork and enclosed in a transparent cover (apparatus **X**). The other five were treated in the same way, but the cork was attached to a motor that turned the seedlings four times an hour (apparatus **Y**).

Both sets were left in the dark for 24 hours. The results are shown in Fig. 5.1.



(a) (i) Name the response shown by the seedlings in apparatus **X**.

NO MARKS FOR REFS. TO PHOTOTROPISM

positive; (only award if linked to geotropism) .....[2]

geotropism; (can award, even if linked to 'negative') **[2]**

(ii) Explain the mechanism that caused the roots in apparatus **X** to grow downwards.

i. ref. to auxin;
ii. produced (near) tip of root AW; ....
iii. ref. to diffusion to other parts of root;
iv. collects on/moves to + lower side of root AW; Ⓐ ref. to effect of gravity ....
v. slows down cell growth on lower side;
vi. resulting in differential growth rate AW; **max. [3]** ....

.....[3]

(iii) State two advantages to a plant of this response.

1. to obtain water; / to obtain minerals/named minerals/salts/nutrients/® food .....
2. ref. to anchorage/stability AW; .....[2]

(b) (i) Explain the purpose of apparatus **Y** in this experiment.

ref. to <u>control</u>;
ref. to acting as a comparison;
ref. to no effect of gravity AW/gravity is constantly changing AW;

(ii) Explain why the experiment was carried out in the dark.

ref. to light will be another variable;
root will respond to light as well as gravity AW; to keep conditions uniform AW;

max. [1]

(c) After obtaining the results, another sample of germinating pea seeds was left in the dark for several days. A further sample was kept in the light. Describe how the plumules of the seedlings kept in the dark would differ from those of the seedlings kept in the light.

i. plumules/leaves in dark will lack chlorophyll/be more yellow/pale/white/etiolated;
ii. plumules/stem in dark + will be longer/thinner/weaker/have longer internodes/grow faster; Ⓐ etiolated if not already given
iii. leaves in dark will be undeveloped/smaller;
iv. plumules in light will bend towards light;

max. [2]

[Total: 11]