Homeostasis and response

Model answers and marking points

GCSE science 6-mark questions

This topic online

1 Mei is cooking at home in Manchester. She accidentally touches a hot pan and pulls her hand away before she feels any pain.

Describe how this reflex action happens. (6 marks)

Model answer

The stimulus is the heat from the pan. Receptors in the skin of Mei's fingers detect the heat and produce electrical impulses.

The impulses travel along a sensory neurone to the spinal cord, which is part of the central nervous system.

Where the sensory neurone meets a relay neurone there is a small gap called a synapse. When the impulse reaches the end of the sensory neurone, a chemical is released. It diffuses across the gap and starts a new impulse in the relay neurone.

The relay neurone, in the spinal cord, passes the impulse across another synapse to a motor neurone.

The motor neurone carries the impulse to the effector, which is a muscle in her arm. The muscle contracts and pulls her hand away from the pan.

This is a reflex arc. The impulse does not need to go to the conscious part of her brain first, so the response is automatic and very fast. This is why she moves her hand before she feels any pain, which reduces the damage to her skin.

Marking points (credit any 6 relevant points, linked in a sensible order)

- the stimulus is the heat from the pan
- receptors in the skin detect the heat
- electrical impulses travel along a sensory neurone to the spinal cord
- at a synapse, a chemical diffuses across the gap and starts an impulse in a relay neurone
- the relay neurone passes the impulse to a motor neurone, again across a synapse
- the motor neurone carries the impulse to the effector, a muscle in the arm
- the muscle contracts and pulls the hand away
- the pathway does not involve the conscious part of the brain, so it is automatic and fast
- the fast response reduces damage to the skin

How it is marked

- 5-6 marks: describes the full pathway from stimulus to response in the correct order, naming all three neurones and the synapses, and explains why it is fast.
- 3-4 marks: describes most of the pathway in order, with one stage missing or wrong.
- 1-2 marks: names one or two parts, such as a nerve or a muscle, with no clear sequence.

What loses marks

- saying the impulse goes to the brain first
- saying the receptor or the nerve is the effector
- describing electrical impulses jumping across the synapse

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2 **Higher tier**

Daniel eats a large bowl of pasta at lunchtime. In the evening he plays football for two hours without eating anything else.

Explain how Daniel's body keeps his blood glucose concentration within a normal range during the afternoon and the evening. (6 marks)

Model answer

Daniel's pancreas monitors the concentration of glucose in his blood.

After lunch, the starch in the pasta is digested into glucose, which is absorbed into the blood, so his blood glucose concentration rises. The pancreas detects this and releases the hormone insulin into the blood. Insulin causes glucose to move from the blood into his body cells. In the liver and muscles, insulin causes excess glucose to be converted into glycogen, which is stored. This brings his blood glucose back down to normal.

During football, his muscles are respiring much faster and use up a lot of glucose, so his blood glucose concentration falls. The pancreas detects the fall and releases a different hormone, glucagon. Glucagon travels to the liver and causes stored glycogen to be converted back into glucose. This glucose is released into the blood, raising the concentration back to normal even though he has not eaten.

Insulin and glucagon work against each other in a negative feedback cycle. Whenever the level moves too far one way, a hormone is released that brings it back.

Marking points (credit any 6 relevant points, linked in a sensible order)

- the pancreas monitors the blood glucose concentration
- after the meal, starch is digested and glucose is absorbed, so blood glucose rises
- the pancreas releases insulin into the blood
- insulin causes glucose to move from the blood into cells
- in liver and muscle cells, insulin causes excess glucose to be converted into glycogen for storage
- during football, muscles use glucose for respiration, so blood glucose falls
- the pancreas releases glucagon into the blood
- glucagon causes glycogen in the liver to be converted back into glucose, which is released into the blood
- insulin and glucagon act in a negative feedback cycle, reversing the change

How it is marked

- 5-6 marks: explains the role of insulin after the meal and glucagon during exercise, including glycogen storage and breakdown, and describes this as negative feedback.
- 3-4 marks: explains the role of insulin clearly but glucagon only briefly, or both hormones without the role of glycogen.
- 1-2 marks: states that insulin lowers blood glucose, with little explanation.

What loses marks

- mixing up glucagon and glycogen
- saying the liver produces insulin
- saying insulin turns glucose into glucagon

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3 A GP surgery in Cardiff has information about two patients with diabetes.

	Patient A	Patient B
Age when diagnosed	9	54
Body mass index	18 (healthy)	34 (obese)
Insulin made by pancreas	almost none	normal amount
Response of body cells to insulin	normal	reduced

Use the data to identify the type of diabetes each patient has. Explain how each type should be treated.

(6 marks)

Model answer

Patient A has type 1 diabetes. The data shows the pancreas makes almost no insulin, and this patient was diagnosed young, at age 9. The body cells respond normally to insulin, so the problem is that there is no insulin to respond to. Without insulin, glucose cannot be moved out of the blood into cells, so the blood glucose can rise to dangerously high levels.

Type 1 diabetes is treated with insulin injections, which replace the missing hormone. The injections are usually given at mealtimes, and the patient also needs to think about how much carbohydrate they eat and how active they are.

Patient B has type 2 diabetes. This patient makes a normal amount of insulin, but their body cells have a reduced response to it. They were diagnosed much later, at 54, and their BMI of 34 shows they are obese, which is a risk factor for type 2 diabetes.

Type 2 diabetes is usually first treated with a carbohydrate-controlled diet and regular exercise, which can help the patient lose weight. If this is not enough, the doctor may also prescribe drugs.

Marking points (credit any 6 relevant points, linked in a sensible order)

- Patient A has type 1 diabetes
- evidence: diagnosed young and the pancreas makes almost no insulin
- in type 1 diabetes blood glucose can rise to dangerously high levels
- type 1 is treated with insulin injections
- injections are timed with meals, and diet and exercise are managed alongside
- Patient B has type 2 diabetes
- evidence: diagnosed later, obese, and the body cells no longer respond properly to the insulin made
- obesity is a risk factor for type 2 diabetes
- type 2 is first treated with a carbohydrate-controlled diet and an exercise regime
- drugs may be used if diet and exercise are not enough

How it is marked

- 5-6 marks: identifies both types using at least two pieces of data each, and explains the correct treatment for each, linked to the cause.
- 3-4 marks: identifies both types with some evidence and gives at least one correct treatment.
- 1-2 marks: identifies one type correctly, or gives a treatment with no link to the data.

What loses marks

- saying type 2 means no insulin is made
- giving insulin injections as the first treatment for type 2
- identifying the type without using the data

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4 Mr Adeyemi's kidneys have failed. His doctors tell him about two treatments.

Dialysis	Kidney transplant
Three sessions a week, each about 4 hours, in hospital	One major operation
Strict diet: limits on salt, protein and fluids	Normal diet once recovered
Available straight away	Waiting list of 2 to 3 years for a donor kidney
Costs the NHS about £30 000 a year	About £17 000 for the operation, then about £6000 a year for drugs

Evaluate the two treatments. Give a justified conclusion.

Separate science only

(6 marks)

Model answer

Healthy kidneys filter the blood and remove urea and excess water and ions. When they fail, these build up and can be fatal.

In dialysis, the patient's blood flows past a partially permeable membrane with dialysis fluid on the other side. The fluid has the same concentration of glucose and useful ions as normal blood, so these are not lost, but urea diffuses out of the blood into the fluid. The big advantage is that dialysis is available straight away. However, Mr Adeyemi would spend about 12 hours a week in hospital and would have to follow a strict diet. It also costs the NHS about £30 000 every year.

A transplant would let him eat normally and live a much more normal life. After the first year it is also far cheaper, about £6000 a year compared with £30 000. But there is a 2 to 3 year wait for a donor kidney, and the kidney could be rejected because his immune system may recognise its antigens as foreign. He would need to take immunosuppressant drugs for life, which make infections more likely.

I think the best plan is to start dialysis now to keep him alive, then have a transplant when a matching kidney is available, because it gives a better quality of life at a lower long-term cost.

Marking points (credit any 6 relevant points, linked in a sensible order)

- the kidneys normally remove urea and excess water and ions from the blood
- in dialysis blood flows past a partially permeable membrane, with dialysis fluid on the other side
- dialysis fluid has the same concentration of useful substances as normal blood, so glucose and useful ions are not lost, while urea diffuses out
- dialysis is available at once but takes many hours a week and needs a strict diet
- dialysis costs more each year than a transplant
- a transplant lets the patient live a normal life with a normal diet
- the donor kidney may be rejected because its antigens are recognised as foreign
- immunosuppressant drugs are needed for life, increasing the risk of infections
- donor kidneys are in short supply, so there is a long wait
- a justified conclusion, for example dialysis while waiting, then a transplant

How it is marked

- 5-6 marks: explains how dialysis works, weighs advantages and disadvantages of both treatments using the table, and gives a reasoned conclusion.
- 3-4 marks: gives advantages and disadvantages of both treatments with some use of the table, conclusion weak.
- 1-2 marks: lists points from the table with no evaluation.

What loses marks

- saying urea moves by osmosis or active transport in dialysis
- saying the dialysis fluid contains no glucose
- a conclusion that ignores the waiting list

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5 A sexual health clinic gives information on two methods of contraception: the contraceptive pill and condoms.

Compare these two methods, including how each one works and its advantages and disadvantages. (6 marks)

Model answer

The contraceptive pill is a hormonal method, whereas a condom is a barrier method.

The pill contains hormones, such as oestrogen and progesterone. These inhibit the production of FSH by the pituitary gland, so eggs do not mature and are not released from the ovaries. A condom works in a different way: it is worn over the penis and physically stops sperm from reaching an egg.

If taken correctly the pill is more effective than condoms, which can tear or be put on wrongly. However, the pill has to be taken every day, and missing pills reduces how well it works. Being hormonal, it can also cause side effects such as headaches or mood changes, but condoms have no hormonal side effects.

The biggest advantage of condoms is that they protect against sexually transmitted infections, such as HIV, because they stop body fluids being exchanged. The pill gives no protection against these infections.

Condoms are easy to buy in shops without seeing anyone, while the pill needs a consultation with a doctor, nurse or pharmacist first. Some couples use both methods together for the greatest protection.

Marking points (credit any 6 relevant points, linked in a sensible order)

- the pill is a hormonal method; a condom is a barrier method
- the pill contains hormones, such as oestrogen and progesterone or progesterone only
- the pill inhibits FSH production, so eggs do not mature and are not released
- a condom stops sperm reaching the egg
- the pill is more effective than condoms if taken correctly
- the pill must be taken every day and can have side effects such as mood changes
- condoms protect against sexually transmitted infections such as HIV; the pill does not
- condoms have no hormonal side effects and are easy to get without seeing a doctor, while the pill needs a consultation with a doctor, nurse or pharmacist
- using both methods together gives the greatest protection
- condoms can tear or be used incorrectly

How it is marked

- 5-6 marks: explains how each method works, including the hormonal effect of the pill, and compares advantages and disadvantages directly.
- 3-4 marks: explains how both work in simple terms with some advantages or disadvantages, comparison mostly implied.
- 1-2 marks: gives one fact about one method.

What loses marks

- saying the pill kills sperm
- saying the pill protects against sexually transmitted infections
- describing the methods separately without comparing them

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