

Blood glucose and diabetes

Revision notes · How insulin and glucagon control blood glucose, the two types of diabetes, and how BMI and waist:hip ratio are used.

For Edexcel GCSE Biology 1BI0 and Combined Science 1SC0. **Triple only** is not in Combined Science. **Higher tier** is only on the Higher paper.

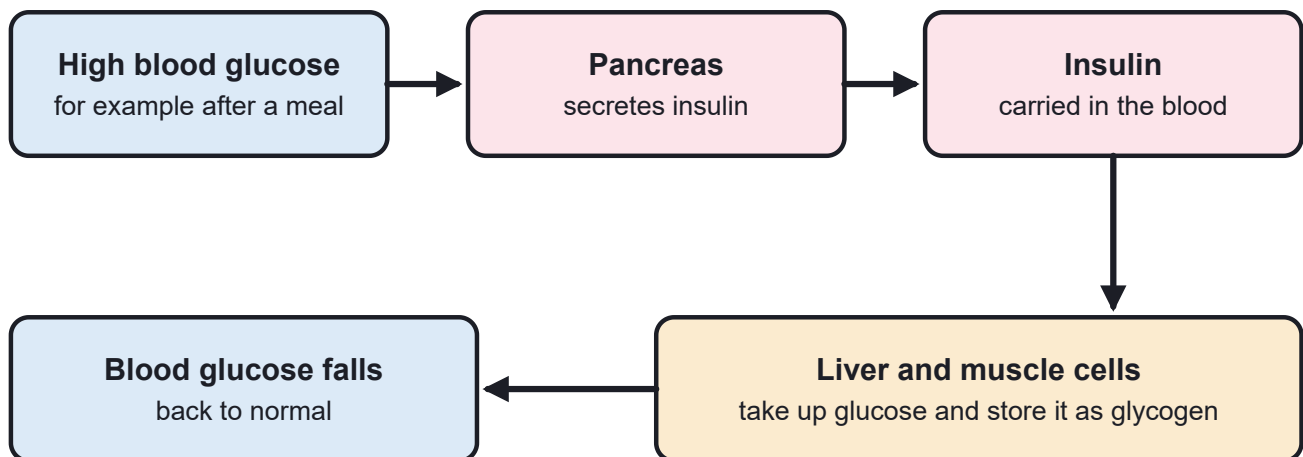
Blood glucose and diabetes Spec 7.13-7.17

Insulin and blood glucose Spec 7.13

Blood glucose concentration must stay steady. It rises after a meal. The **pancreas** detects this and secretes the hormone **insulin** into the blood.

1. Blood glucose concentration rises after a meal.
2. The pancreas secretes insulin into the blood.
3. Insulin makes cells take up glucose from the blood. In the liver and muscles, glucose is converted into **glycogen** for storage.
4. Blood glucose concentration falls back to normal.

Common mistake: The pancreas makes insulin. The liver stores glycogen. Do not write that the pancreas stores glucose.



How **insulin** brings a high blood glucose concentration back to normal.

Glucagon Spec 7.14 Higher tier

If blood glucose concentration falls too low, for example between meals or during exercise, the pancreas secretes **glucagon** instead.

1. Blood glucose concentration falls.
2. The pancreas secretes glucagon into the blood.
3. Glucagon acts on the liver. The liver changes **glycogen into glucose**.
4. Glucose is released into the blood, so blood glucose concentration rises back to normal.

Insulin and glucagon compared		
	Insulin	Glucagon
Released when	Blood glucose is too high	Blood glucose is too low
Acts on	Liver and other cells	Liver
Effect	Glucose into cells, glucose to glycogen	Glycogen to glucose
Result	Blood glucose falls	Blood glucose rises

Insulin and glucagon work against each other. This is negative feedback, and it keeps blood glucose concentration close to normal.

Type 1 diabetes Spec 7.15

In **type 1 diabetes**, the pancreas does not produce enough insulin. Without insulin, body cells do not take up enough glucose from the blood. After a meal, blood glucose concentration rises and stays too high.

It is controlled by:

- **injections of insulin**, usually around meals
- monitoring blood glucose concentration
- controlling the amount of carbohydrate in the diet

Exam tip: Type 1 cannot be controlled by diet alone, because the body is missing the insulin. Injections are needed.

Suggested practical: sugar in simulated urine

Urine from a healthy person contains no glucose. Glucose in urine suggests that blood glucose concentration is too high, as in untreated diabetes.

1. Put a sample of simulated urine in a test tube.
2. Add Benedict's solution.
3. Heat the tube in a hot water bath for a few minutes.
4. Record the colour. Blue means no sugar. Green, yellow, orange and brick red mean more and more sugar.

Exam tip: Wear eye protection and take care with the hot water bath. Benedict's solution must be heated, or there is no colour change.

Type 2 diabetes Spec 7.16

In **type 2 diabetes**, the body cells no longer respond properly to insulin. Blood glucose concentration stays too high. It is linked to being overweight or obese.

It is controlled by:

- a carefully controlled diet, for example less sugar and refined carbohydrate
- regular exercise
- losing weight if overweight
- some people also need medication or insulin

Type 1 and type 2 compared

	Type 1	Type 2
Cause	Pancreas does not produce enough insulin	Cells no longer respond to insulin
Control	Insulin injections, diet and monitoring	Diet, exercise and weight loss, sometimes medication

Body mass, BMI and type 2 diabetes Spec 7.17

There is a **correlation** between body mass and type 2 diabetes. In general, the higher the body mass, the greater the chance of developing it. You need to be able to calculate and interpret two measurements.

$$\text{BMI} = \text{mass (kg)} \div \text{height (m)}^2$$

$$\text{waist:hip ratio} = \text{waist circumference} \div \text{hip circumference}$$

A higher waist:hip ratio means more fat is stored around the waist, which is linked to a higher risk of type 2 diabetes.

Calculating BMI and waist:hip ratio

A man has a mass of 85 kg and a height of 1.70 m. His waist is 102 cm and his hips are 96 cm. Calculate his BMI to 1 decimal place and his waist:hip ratio to 2 decimal places.

1. Square the height: $1.70 \times 1.70 = 2.89$

2. $\text{BMI} = 85 \div 2.89 = 29.41$

3. $\text{Waist:hip ratio} = 102 \div 96 = 1.0625$

Answer: BMI = 29.4 and waist:hip ratio = 1.06

Maths skill: Square the height before you divide. Use metres for height and kilograms for mass. Waist and hip must be in the same units, and the ratio has no unit.

Evaluating the correlation

- A correlation shows that two things change together. It does **not prove one causes the other**.
- Other factors, such as diet, exercise and age, may also affect the risk.
- BMI does not show whether mass is fat or muscle, so a very muscular person can have a high BMI. The waist:hip ratio gives extra information about where fat is stored.

Quick check

1. Which organ makes insulin and which organ stores glycogen?
2. What does glucagon do? (Higher)
3. State the cause of type 1 diabetes.
4. State the cause of type 2 diabetes.
5. Write the BMI equation.

Quick check answers

Blood glucose and diabetes

1. The pancreas makes insulin. The liver stores glycogen.
2. It makes the liver change glycogen into glucose, so blood glucose concentration rises.
3. The pancreas does not produce enough insulin.
4. Body cells no longer respond to insulin.
5. $\text{BMI} = \text{mass (kg)} \div \text{height (m)}^2$.