Metabolism

4.4.2.3 · Bioenergetics · revision notes

Metabolism is the sum of all the reactions in a cell or the body. You need the examples of metabolic reactions in the specification and the small molecules that carbohydrates, proteins and lipids are built from and broken down into. Expect short recall and explain questions, often linked to enzymes, digestion or photosynthesis.

Key facts

- Metabolism = the sum of all the reactions in a cell or the body
- Energy for building new molecules comes from respiration
- Lipid = 1 glycerol + 3 fatty acids
- Excess proteins → urea → excreted
- Metabolic reactions are controlled by enzymes
- Glucose → starch (plant store), glycogen (animal store), cellulose (plant cell walls)
- Glucose + nitrate ions → amino acids → proteins
- Carbohydrates ← sugars; proteins ← amino acids; lipids ← fatty acids and glycerol

Notes

What metabolism is

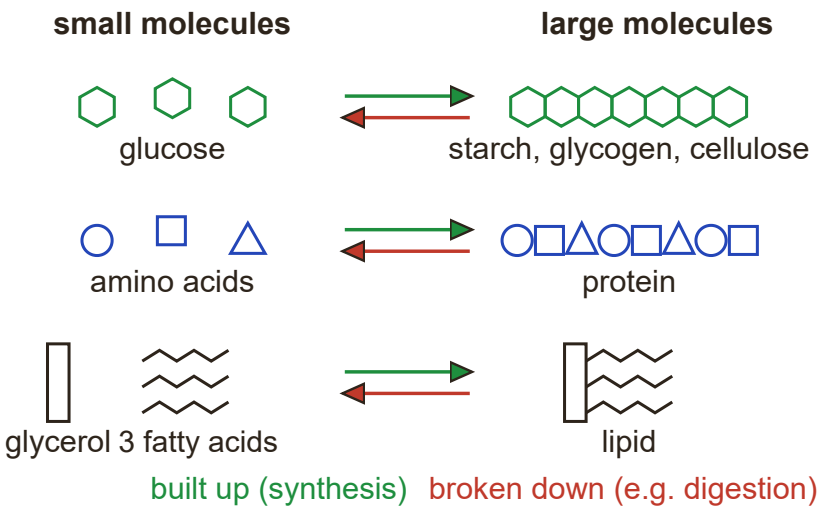
- **Metabolism** is the sum of all the reactions in a cell or the body.
- Metabolic reactions are controlled by **enzymes**.
- The energy transferred by **respiration** is used for the metabolic reactions that build (synthesise) new molecules.
- Some metabolic reactions build large molecules from small ones; others break large molecules down.

Examples you need to know

- Glucose is converted into **starch** (storage in plants), **glycogen** (storage in animals) and **cellulose** (plant cell walls).
- A **lipid** molecule is formed from one molecule of **glycerol** and three molecules of **fatty acids**.
- Glucose and nitrate ions are used to make **amino acids**, which are then used to make **proteins**.
- **Respiration** is itself a metabolic reaction.
- Excess proteins are broken down to form **urea**, which is excreted in urine.

Building blocks: made from and broken down into

- Carbohydrates (starch, glycogen, cellulose) are built from sugars such as glucose.
- Proteins are built from amino acids.
- Lipids are built from fatty acids and glycerol.



Building up needs energy from respiration; digestion breaks large molecules back down.

- Digestive enzymes break large food molecules down into these small units: carbohydrases give sugars, proteases give amino acids, and lipases give fatty acids and glycerol. Grade 6+ only
- The small units are absorbed and used to build the body's own carbohydrates, proteins and lipids, and glucose is also used in respiration. So these small molecules link the breakdown of food to the synthesis of new molecules. Grade 7+ only

How to answer each type of question

Define metabolism and give examples 1 to 3 marks Grade 3

1. Learn the definition exactly: the sum of all the reactions in a cell or the body.
2. For examples, choose from the specification list and make sure they fit the organism in the question (starch and cellulose in plants, glycogen in animals).

Example. (a) What is meant by metabolism?
(b) Give **two** examples of metabolic reactions that take place in plant cells.

Model answer.

(a) The sum of all the reactions in a cell or the body (1)

(b) Any two from: respiration; converting glucose into starch; converting glucose into cellulose; making amino acids / proteins; making lipids (1 each)

Complete sentences on building blocks

3 marks | Grade 5

1. Match each large molecule to its small units: proteins to amino acids, lipids to glycerol and fatty acids, carbohydrates to sugars.
2. Remember the numbers for a lipid: one glycerol, three fatty acids.

Example. Complete the sentences.
Proteins are made from molecules of ..... .
A lipid molecule is made from one molecule of ..... and three molecules of ..... .

Model answer. amino acids (1); glycerol (1); fatty acids (1)

Explain why a metabolic reaction needs respiration

2 marks | Grade 6

1. Say that building large molecules needs energy.
2. Say that this energy is transferred by respiration.

Example. A poison stops respiration in a cell.
Explain why the cell can no longer make proteins.

Model answer. Joining amino acids to make proteins (building large molecules) needs energy (1). This energy is transferred by respiration, so without respiration there is no energy for protein synthesis (1).

Explain how a nutrient is used in metabolism

3 to 4 marks | Grade 7

1. Start with breakdown: the large molecule is digested into its small units.
2. Then synthesis: the small units are used to build the body's own molecules, using enzymes and energy from respiration.
3. Finish with any excess and what happens to it.

Example. A person eats a meal that contains protein.
Explain how the protein is used in the person's metabolism. [4 marks]

Model answer. The protein is broken down (digested) into amino acids (1). The amino acids are absorbed and used to build (synthesise) the person's own proteins, for example enzymes (1). These reactions are controlled by enzymes and use energy transferred by respiration (1). Any excess protein is broken down to form urea, which is excreted (1).

Don’t lose marks

- Defining metabolism as 'digestion' or 'how fast you use food'. It is the sum of all the reactions in a cell or the body.
- Saying lipids are made of glucose and fatty acids. They are made of glycerol and fatty acids (one glycerol and three fatty acids).

- Saying plants store glycogen or animals store starch. Plants store starch; animals store glycogen.
- Saying urea comes from the breakdown of glucose or fat. It comes from the breakdown of excess proteins.
- Forgetting that respiration is itself one of the metabolic reactions.

More tips

Memory tricks

- Metabolism = every reaction: all the building up and all the breaking down.
- Three carbohydrates from glucose: starch stores (plants), glycogen stores (animals), cellulose supports (cell walls).
- Lipid 1 + 3: picture one glycerol backbone with three fatty acid tails, like a capital E.
- Pair each large molecule with its units and its enzyme: carbohydrate–sugars–carbohydrase, protein–amino acids–protease, lipid–fatty acids and glycerol–lipase.

Exam technique

- Learn the specification's examples of metabolic reactions; they are often asked as 'give two examples'.
- When a question asks about the importance of sugars, amino acids, fatty acids and glycerol, say they are the units large molecules are built from and broken down into.
- Use the words 'synthesise' (build) and 'break down' accurately, and mention enzymes and energy from respiration where they fit.
- Expect links to other topics: digestive enzymes, photosynthesis (glucose) and blood glucose control (glycogen).

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Define metabolism

Metabolism is the sum of all the reactions in a cell or the body.

Grade 4

Give examples of metabolic reactions

For example respiration, making starch, glycogen or cellulose from glucose, making lipids and proteins, and making urea.

Grade 5

Name the building blocks of large molecules

Carbohydrates are made from sugars, proteins from amino acids, and lipids from glycerol and fatty acids.

Grade 5

State how a lipid molecule forms

One molecule of glycerol joins with three molecules of fatty acids.

Grade 6

Explain why metabolism needs respiration and enzymes

Building new molecules uses energy transferred by respiration, and each reaction is controlled by enzymes.

Grade 6

Describe what happens to excess protein

Excess proteins are broken down to form urea, which is excreted.

Grade 7

Explain the importance of the small building blocks

Sugars, amino acids, fatty acids and glycerol are what large molecules are built from and broken down into, so they can be reused.

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