

Metabolism explained

Metabolism refers to the countless chemical processes going on continuously inside the body that allow life and normal functioning. These processes require energy from food. The amount of kilojoules (kJ) your body burns at any given time is regulated by your metabolism. You can't control your metabolism, but you can make it work for you when you exercise.

Two processes of metabolism

Hormones (chemical 'messages' secreted by the glands of the endocrine system) and the nervous system control your body's metabolism. Your metabolism can be upset by a variety of events, including genetic disorders and hormonal problems.

There are two complementary parts to your metabolism, which are carefully monitored to make sure they remain in balance. They are:

- **Catabolism** - the breakdown of food components (such as carbohydrates, proteins and fats) into their simpler forms, which can then be used to create energy. This immediate form of energy can be converted into heat or burned by cells.
- **Anabolism** - energy is stored in fat cells or used to help build and repair structures of the body.

Metabolic rate (or total energy expenditure)

Your body's metabolic rate (or total energy expenditure) can be divided into three components:

- **Basal metabolic rate (BMR)** - is the amount of kilojoules burned at rest and contributes 50-80 per cent of your energy used.
- **Energy used during physical activity** - this is the amount of kilojoules burned during movement and physical activity; in a normally active person, this component contributes 20 per cent of daily energy use.
- **Thermic effect of food** - this is the energy you use to eat, digest and metabolise food. It contributes about 5-10 per cent of your energy use.

Basal metabolic rate (BMR)

The BMR refers to the amount of energy your body needs to maintain itself. This accounts for 50-80 per cent of your total energy use. Total lean mass, especially muscle mass, is largely responsible for the BMR. So, anything that reduces lean mass will reduce BMR. That's why it's important to preserve muscle mass when you try to lose weight, since the BMR accounts for so much of the energy we use.

An average male may have a BMR of around 7,100kJ per day, while an average female may have a BMR of around 5,900kJ per day. Energy expenditure is continuous, but the rate varies throughout the day. The lowest rate of energy expenditure is usually in the early morning.

Energy used during physical activity

During heavy physical exertion, the muscles may burn through as much as 3,000kJ per hour. Energy used during exercise is the only form of energy expenditure that you have any control over.

The energy expenditure of the muscles makes up only 20 per cent or so of the total energy expenditure at rest but, during strenuous exercise, the rate of energy expenditure of the muscles may go up 50-fold or more.

The following lists the amount of energy used during various activities.

Activity Energy (kJ/kg/h)

Sitting quietly 1.7
Writing 1.7
Standing relaxed 2.1
Driving a car 3.8
Vacuuming 11.3
Walking rapidly 14.2
Running 29.3
Swimming (4km/hour) 33
Rowing in a race 67

Thermic effect of food

Your BMR rises after you eat because you use energy to eat, digest and metabolise the food you've just eaten. The rise occurs soon after you start eating and peaks two to three hours later. This rise in the BMR can range between 2-3 per cent and up to 25-30 per cent, depending on the size of the meal and the types of foods eaten. For example:

- **Fats** - raise the BMR 4 per cent
- **Carbohydrates** - raise BMR 6 per cent
- **Proteins** - raise BMR 30 per cent
- **Hot spicy foods** - these can also have a significant thermic effect: for example foods containing chilli, horseradish and mustard.

Factors affecting the BMR

Your BMR is influenced by a number of factors working in combination, including:

- **Body size** - larger adult bodies have more metabolising tissue and a larger BMR.
- **Age** - metabolism slows with age, due to a loss in muscle tissue but also due to hormonal and neurological changes.
- **Growth** - infants and children have higher energy demand per unit of body weight due to the energy demands of growth and the energy needed to maintain their body temperature.
- **Gender** - generally, men have faster metabolisms than women because they tend to be larger and have less body fat.
- **Genetic predisposition** - your metabolic rate may be partly decided by your genes.
- **Amount of lean muscle tissue** - muscle burns kilojoules voraciously.
- **Amount of body fat** - fat cells are sluggish and burn far fewer kilojoules than most other tissues and organs of the body.
- **Hormonal and nervous controls** - BMR is controlled by the nervous and hormonal systems; hormonal imbalances can influence how quickly or slowly the body burns kilojoules.
- **Dietary deficiencies** - for example, a diet low in iodine reduces thyroid function, which slows the metabolism.
- **Environmental temperature** - if temperature is very low or very high, the body has to work harder to maintain its normal body temperature; this increases the BMR.
- **Infection or illness** - BMR increases because the body has to work harder to build new tissues and to create an immune response.
- **Crash dieting, starving or fasting** - eating too few kilojoules encourages the body to slow the metabolism to conserve energy; BMR can drop by up to 15 per cent. There is also loss of lean muscle tissue, which further contributes to the drop in BMR.
- **Amount of physical activity** - hard-working muscles need plenty of energy to burn. Regular exercise increases muscle mass and 'teaches' the body to burn kilojoules at a faster rate, even when at rest.
- **Drugs** - some drugs, like caffeine or nicotine, can increase the BMR.

Age-related weight gain

Muscle tissue has a voracious appetite for kilojoules. The more muscle mass you have, the more kilojoules you will burn. People tend to put on fat as they age - this is because the body slowly loses muscle.

It's not clear whether this muscle loss is a result of the ageing process or because many people are less active as they age. However, it probably has more to do with becoming less active, as research has shown that strength and resistance training can reduce or prevent this muscle loss.

If you are over 40 years, have a pre-existing medical condition or haven't exercised in some time, see your doctor before embarking on any new fitness program.

Hormonal disorders

Hormones help to regulate the metabolism. Some of the more common hormonal disorders are concerned with the thyroid. This gland secretes hormones to regulate many metabolic processes, including energy expenditure (the rate at which kilojoules are burned). Disorders include:

- **Hypothyroidism** - or underactive thyroid. The metabolism slows because the thyroid gland doesn't release enough hormones. A common cause is the autoimmune condition Hashimoto's disease. Some of the symptoms of hypothyroidism include unusual weight gain, lethargy, depression and constipation.
- **Hyperthyroidism** - or overactive thyroid. The gland releases greater quantities of hormones than necessary and speeds the metabolism. The most common cause of this condition is Graves' disease. Some of the symptoms of hyperthyroidism include increased appetite, weight loss, nervousness and diarrhoea.

Genetic disorders of metabolism

Sometimes a faulty gene affects part of the metabolic process and stops the body from using food components, such as carbohydrates, in the normal way. In most cases, these disorders can be managed under medical supervision, with strict attention to diet. Some genetic disorders of the metabolism include:

- **Fructose intolerance** - the inability to break down fructose, which is a type of simple sugar found in fruits, fruit juices, sugar (for example, cane sugar) and certain vegetables.
- **Galactosaemia** - the inability to convert the carbohydrate galactose into glucose. Galactose is not found in nature; it is produced when lactose is broken down by the digestive system into glucose and galactose. Sources of lactose include milk and milk products, such as yoghurt and cheese.
- **Phenylketonuria (PKU)** - the inability to convert the amino acid phenylalanine into tyrosine. High levels of phenylalanine in the blood can cause brain damage. High protein foods must be avoided.

Where to get help

- Your doctor
- An accredited practising dietitian, contact the Dietitians Association of Australia

Things to remember

- Metabolism refers to the countless chemical processes going on continuously inside the body that allow life and normal functioning.
- The amount of kilojoules your body burns at any given time is regulated by your metabolism.
- The metabolic rate is influenced by many factors, including age, gender, muscle-to-fat ratio, amount of physical activity and hormone function.

This page has been produced in consultation with, and approved by:

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