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## Metabolism

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### Summary

- 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 affected by your metabolism.
  - Your metabolic rate is influenced by many factors, including age, gender, muscle-to-fat ratio, amount of physical activity and hormone function.
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Metabolism refers to all the chemical processes going on continuously inside your body that allow life and normal functioning (maintaining normal functioning in the body is called homeostasis). These processes include those that break down nutrients from our food, and those that build and repair our body.

Building and repairing the body requires energy that ultimately comes from your food. The amount of energy, measured in kilojoules (kJ), that your body burns at any given time is affected by your metabolism.

If we eat and drink more kilojoules than we need for our metabolism and exercise, we store it mostly as fat. Most of the energy you expend each day is used to keep all the systems in your body functioning properly. This is out of your control. However, you can make metabolism work for you when you exercise.

### Two processes of metabolism

Your metabolism has two parts, which are carefully regulated by the body 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 and provide the basic building blocks needed for growth and repair
- anabolism – the part of metabolism in which our body is built or repaired. Anabolism requires energy that ultimately comes from our food. When we eat more than we need for daily anabolism, the excess nutrients are typically stored in our body as fat.

### Metabolic rate

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

- Basal metabolic rate (BMR) – is the amount of kilojoules (kJ) burned at rest. BMR includes the energy the body uses to keep all its systems functioning correctly. It accounts for the largest amount of energy expended daily (50-80 per cent of your daily energy use).
- Energy used during physical activity – in a moderately active person (30–45 minutes of moderate-intensity physical activity per day), this component contributes 20 per cent of daily energy use.
- Thermic effect of food – 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 homeostasis.

Your BMR is largely determined by your total lean mass, especially muscle mass, because lean mass requires a

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lot of energy to maintain. Anything that reduces lean mass will reduce your BMR.

As your BMR accounts for so much of your total energy consumption, it is important to preserve or even increase your lean muscle mass through exercise when trying to lose weight. Maintaining lean muscle mass also helps reduce the chance of injury when training, and exercise increases your daily energy expenditure.

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

### **Energy used during physical activity**

During heavy physical exertion, the muscles may burn through as much as 3,000 kJ 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 total energy expenditure at rest, but during strenuous exercise, it may increase 50-fold or more. Estimating the energy spent during exercise is difficult, as the true value for each person will vary based on factors such as their weight, age, health and the intensity with which each activity is performed.

Various activities and the approximate amounts of energy (in kJ per kilogram per hour) typically used during them are:

- 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 (at 4 km/hour) – 33
- rowing in a race – 67.

### **Influences on BMR**

Your BMR is influenced by multiple factors working in combination, including:

- body size – larger adult bodies have more metabolising tissue and a larger BMR
- amount of lean muscle tissue – muscle burns kilojoules rapidly
- amount of body fat – fat cells are 'sluggish' and burn far fewer kilojoules than most other tissues and organs of the body
- 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. Loss of lean muscle tissue further reduces BMR
- age – metabolism slows with age due to loss of muscle tissue, but also due to hormonal and neurological changes
- growth – infants and children have higher energy demands per unit of body weight due to the energy demands of growth and the extra energy needed to maintain their body temperature
- gender – generally, men have faster metabolisms than women because they tend to be larger
- genetic predisposition – your metabolic rate may be partly decided by your genes
- 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
- environmental temperature – if temperature is very low or very high, the body has to work harder to maintain its normal body temperature, which 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
- 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
- dietary deficiencies – for example, a diet low in iodine reduces thyroid function and slows the metabolism.

### **Thermic effect of food**

Your BMR rises after you eat because you use energy to eat, digest and metabolise the food you have 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 two per cent and 30 per cent, depending on the size of the meal and the types of foods eaten.

Different foods raise BMR by differing amounts. For example:

- fats raise the BMR 0–5 per cent
- carbohydrates raise the BMR 5–10 per cent
- proteins raise the BMR 20–30 per cent
- hot spicy foods, for example, foods containing chilli, horseradish and mustard can have a significant thermic effect.

### **Metabolism and age-related weight gain**

Muscle tissue has a large appetite for kilojoules. The more muscle mass you have, the more kilojoules you will burn.

People tend to put on fat as they age, partly because the body slowly loses muscle. It is not clear whether 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 of age, have a pre-existing medical condition or have not exercised in some time, see your doctor before embarking on any new fitness program.

### **Hormonal disorders of metabolism**

Hormones help 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).

Thyroid disorders include:

- Hypothyroidism (underactive thyroid) – the metabolism slows because the thyroid gland does not 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 (overactive thyroid) – the gland releases larger 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**

Our genes are the blueprints for the proteins in our body, and our proteins are responsible for the digestion and metabolism of our food. Sometimes, a faulty gene means we produce a protein that is ineffective in dealing with

our food, resulting in a metabolic disorder. In most cases, genetic metabolic disorders can be managed under medical supervision, with close attention to diet.

The symptoms of genetic metabolic disorders can be very similar to those of other disorders and diseases, making it difficult to pinpoint the exact cause. See your doctor if you suspect you have a metabolic disorder.

Some genetic disorders of metabolism include:

- fructose intolerance – the inability to break down fructose, which is a type of sugar found in fruit, fruit juices, sugar (for example, cane sugar) and certain vegetables
- galactosaemia – the inability to convert the carbohydrate galactose into glucose. Galactose is not found by itself 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 and foods containing the artificial sweetener aspartame must be avoided.

### Where to get help

- Your doctor
- Dietitians Association of Australia Tel. 1800 812 942

### Things to remember

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- Your 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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