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Metabolism

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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.

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 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**

- 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.

**References**

- Metabolic disorders, MedlinePlus, National Library of Medicine, National Institutes of Health, USA. [More information here.]
- Dietary Energy, National Health and Medical Research Council (NHMRC), Australian Government. [More information here.]
- Healthy Weight, 2013, Cancer Council NSW. [More information here.]

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More information

Digestive system

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- Digestive system explained
- Oesophagus
- Stomach
- Small intestine
- Large intestine
- Rectum
- Liver and gallbladder
- Pancreas

Digestive system explained

- Barium tests
  Barium tests are used to examine conditions of the digestive tract such as reflux, narrowing or ulceration...

- Digestive system explained
  The digestive tract can be thought of as a long muscular tube with digestive organs attached along the way...

- Fibre in food
  A diet high in fibre keeps the digestive system healthy...

Oesophagus

- Barrett's oesophagus
Symptoms of Barrett's oesophagus are similar to regular heartburn, which means many people don't seek treatment until their condition is quite advanced...

- Digestive tract birth defects
  Too much amniotic fluid surrounding the baby during pregnancy (polyhydramnios) may indicate the presence of defects of the digestive tract...

- Hiccups
  Hiccups that last for days, weeks or even years may be symptomatic of underlying disease...

- Indigestion
  Food inside the stomach is only kept there by the force of gravity so to avoid heartburn, don't lie down after a big meal...

- Throat cancer
  Risk factors for throat cancer include smoking and heavy alcohol consumption...

Stomach

- Abdominal pain in children
  Children may feel stomach pain for a range of reasons and may need treatment...

- Gastritis
  Gastritis may be caused by many factors including infection, alcohol, particular medications and some allergic and immune conditions...

- Hernias
  Both reducible and non-reducible hernias need to be surgically repaired - this is a common operation...

- Peritonitis
  Peritonitis is a life-threatening emergency that needs prompt medical treatment...

- Stomach cancer
  The symptoms of stomach cancer are usually vague and can be common to other medical conditions...

- Stomach ulcer
  Most stomach ulcers are caused by infection or medication, not stress or poor diet...

Small intestine

- Coeliac disease and gluten sensitivity
  Coeliac disease is an immune disease caused by gluten...

- Crohn's disease and ulcerative colitis
  When people with inflammatory bowel disease are not experiencing a flare-up of their illness, they feel quite well and are often free of symptoms...

- Gastroenteritis
  It is important to establish the cause of gastro, as different types of gastroenteritis respond to different treatments...

- Gastroenteritis - amoebiasis
  Amoebiasis can cause diarrhoea among travellers to developing countries...

- Gastroenteritis - campylobacteriosis
  Campylobacteriosis is a type of gastroenteritis and is more common in children under five years of age and young adults...

- Gastroenteritis - cryptosporidiosis
  Outbreaks of cryptosporidiosis have been associated with child care centres, public swimming pools and contaminated water supplies...

- Gastroenteritis - giardiasis
  Most people infected with Giardia parasites do not develop symptoms but can still spread the infection to others...

- Gastroenteritis in children
  Gastroenteritis or Gastro can be dangerous for very young babies. Gastro is common in young children and spreads easily. Gastro is a bowel infection which causes diarrhoea (runny or watery poo) and...

- Gastroenteritis - salmonellosis

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You may be more prone to salmonellosis if you are elderly, have another medical condition (such as a weakened immune system) or are malnourished.

- **Gastroenteritis - shigella**
  Outbreaks of shigella gastroenteritis can occur in institutional settings, particularly where children are still in nappies or adults are incontinent.

- **Irritable bowel syndrome (IBS)**
  Irritable bowel syndrome can't be cured with medications or special diets but avoiding individual triggers can help prevent it.

- **Pets – safe handling of reptiles and tropical fish**
  People in contact with tropical fish and reptiles such as turtles, lizards and snakes may be at risk of infections and illness due to germs (such as bacteria, viruses and parasites) carried on the...

- **Rotavirus**
  Rotavirus is a common cause of viral gastroenteritis for Australian babies and preschool children.

- **Traveller's diarrhoea**
  The risk of traveller's diarrhoea is higher where sanitation and hygiene standards are poor.

**Large intestine**

- **Appendicitis**
  Anyone of any age can be struck by appendicitis, but it seems to be more common during childhood and adolescence.

- **Botulism**
  Botulism is considered a medical emergency. If untreated, it may cause death.

- **Bowel cancer**
  Bowel cancer is highly curable if found at an early stage.

- **Bowel motions**
  Many illnesses and events can affect the colour and texture of faeces.

- **Collagenous colitis and lymphocytic colitis**
  Collagenous colitis and lymphocytic colitis are types of inflammatory bowel disease (IBD).

- **Constipation**
  Most cases of constipation are treated by eating a diet high in fibre, drinking more fluids, and exercising daily.

- **Constipation and children**
  A healthy diet, plenty of fluids, exercise and regular toilet habits can help relieve constipation in children.

- **Diarrhoea**
  Acute diarrhoea in babies and young children can be life threatening.

- **Diverticulosis and diverticulitis**
  Diverticulosis and diverticulitis relate to the formation or infection of abnormal pouches in the bowel wall.

- **Flatulence**
  Foods that tend to trigger flatulence also contain essential nutrients and shouldn't be eliminated.

- **Incontinence and continence problems**
  Many things can be done to manage, treat and sometimes cure incontinence and continence problems.

- **Incontinence - prevention tips**
  Incontinence can be prevented in most cases.

- **Irritable bowel syndrome (IBS)**
  Irritable bowel syndrome can't be cured with medications or special diets but avoiding individual triggers can help prevent it.

- **Pinworms**
  Despite the unsavoury reputation, a pinworms infection (worms) is relatively harmless and easily treated.

- **Polyps**
Nasal polyps can sometimes interfere with breathing.

- **Short bowel syndrome**
  A person with short bowel syndrome is likely to be deficient in a range of important nutrients.

- **Slow transit constipation**
  A newborn with slow transit constipation may not pass meconium until 24 hours or more after being born.

- **Stoma after ileostomy or colostomy**
  A stoma is an artificially created hole (stoma) in the abdomen so that faeces can still leave the body.

- **Tapeworms and hydatid disease**
  It's important for your own health to control tapeworm infection in your dog.

**Rectum**

- **Anal fissure**
  Around half of cases of anal fissures heal by themselves with proper self-care and avoidance of constipation.

- **Haemorrhoids**
  A diet high in fibre can both treat and prevent haemorrhoids.

- **Rectal cancer**
  If treated in its earliest stages, rectal cancer is highly curable.

- **Rectal prolapse**
  Rectal prolapse occurs when the rectum turns itself inside out and comes out through the anus.

- **Rectocele**
  A rectocele is when the rectum protrudes into the vagina.

**Liver and gallbladder**

- **Cirrhosis of the liver**
  Cirrhosis is a type of liver damage where healthy cells are replaced by scar tissue.

- **Gallbladder - gallstones and surgery**
  Medical treatment for gallstones may not be necessary unless the gallstones cause symptoms.

- **Gilbert's syndrome**
  Gilbert's syndrome and hepatitis both cause jaundice but are not related.

- **Hepatitis**
  Hepatitis is an umbrella term for several diseases that affect the liver.

- **Hepatitis A**
  Immunisation is the best protection against hepatitis A infection and it is recommended for people in high-risk groups.

- **Hepatitis B**
  Hepatitis B is a viral infection that affects the liver and can lead to serious illness or death.

- **Hepatitis B – immunisation**
  Immunisation against hepatitis B reduces the risk of infection in babies.

- **Hepatitis C**
  In Australia, hepatitis C is most often spread through the sharing of unsterile drug injecting equipment. New all oral combination treatment has greatly improved health outcomes for people with.

- **Hepatitis C Care - what it means for Victorians (video)**
  Hepatitis C Care - what it means for Victorians.

- **Jaundice in babies**

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If your baby is full-term and healthy, mild jaundice is nothing to worry about and will resolve by itself within a week or so.

- **Liver**
  - Some forms of liver disease are inherited, while others are caused by lifestyle factors.
- **Liver cancer**
  - Liver cancer can be a primary cancer that starts in the liver, or a secondary cancer that starts in another part of the body and spreads to the liver.
- **Liver - fatty liver disease**
  - The damage caused by fatty liver disease can often be halted or reversed through simple lifestyle changes.
- **New drugs for the treatment of hepatitis C – Frequently Asked Questions for patients**
  - In Australia, hepatitis C is most often spread through the sharing of unsterile drug injecting equipment. New oral combination treatment has greatly improved health outcomes for people with.
- **Primary biliary cirrhosis**
  - Primary biliary cirrhosis is an autoimmune condition characterised by inflammation and scarring of the bile ducts within the liver.

**Pancreas**

- **Diabetes**
  - Diabetes and the build-up of glucose (sugar) in the blood can cause serious complications if left untreated.
- **Diabetes type 1**
  - Type 1 diabetes can affect anyone of any age, but is more common in people under 30 years.
- **Diabetes type 2**
  - Type 2 diabetes may be prevented, but it cannot be cured.
- **Pancreas**
  - The pancreas helps to digest food, particularly protein.
- **Pancreatic cancer**
  - The causes of pancreatic cancer are unknown, but smokers are at greater risk.
- **Pancreatitis**
  - Pancreatitis is inflammation of the pancreas, which can be either acute or chronic.

**Related Information**

- **Body mass index calculator for children and teenagers**
  - This calculator measures body mass index (BMI), which is a measure of body fat. It is only an approximate measure of the best weight for your health. The calculator can be used for anyone from two to...
- **Obesity and hormones**
  - The hormones leptin, insulin, oestrogens, androgens and growth hormone are factors in obesity.
- **Balancing energy in and energy out**
  - A kilojoule is a unit of measure of energy, in the same way that kilometres measure distance.
- **Kids and energy needs**
  - It’s important for kids to eat a wide variety of foods for a healthy, well-balanced diet and to be physically active. Creating healthy habits during childhood helps to ensure lifelong healthy.
- **Energy in food (kilojoules and calories)**
  - A kilojoule is a unit of measure of energy, in the same way that kilometres measure distance.

**Home**

**Related information on other websites**

- Australian dietary guidelines (2013)
- Dietary Energy
- Dietitians Association of Australia
- Metabolic Dietary Disorder Association.

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Support Groups

- Metabolic Dietary Disorder Association

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