ORIGYM

# *Level 2 Certificate In Fitness Instructing Online*

## *MODULE 2: THE VERTEBRAE, CONNECTIVE TISSUES, MACROS AND MICRONUTRIENTS*

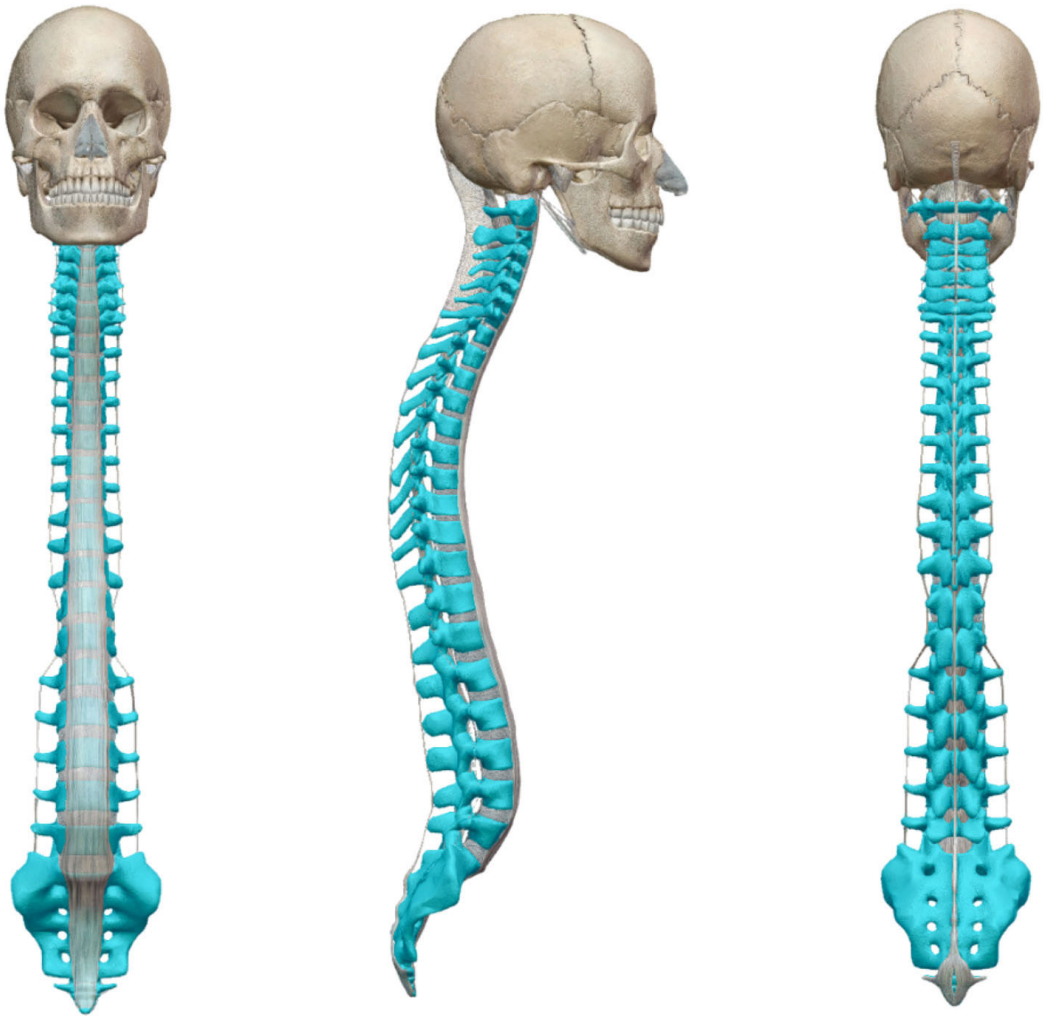
# CONTENTS

# The Vertebrae

## *MODULE 2:*
## *THE VERTEBRAE, CONNECTIVE TISSUES, MACROS AND MICRONUTRIENTS*

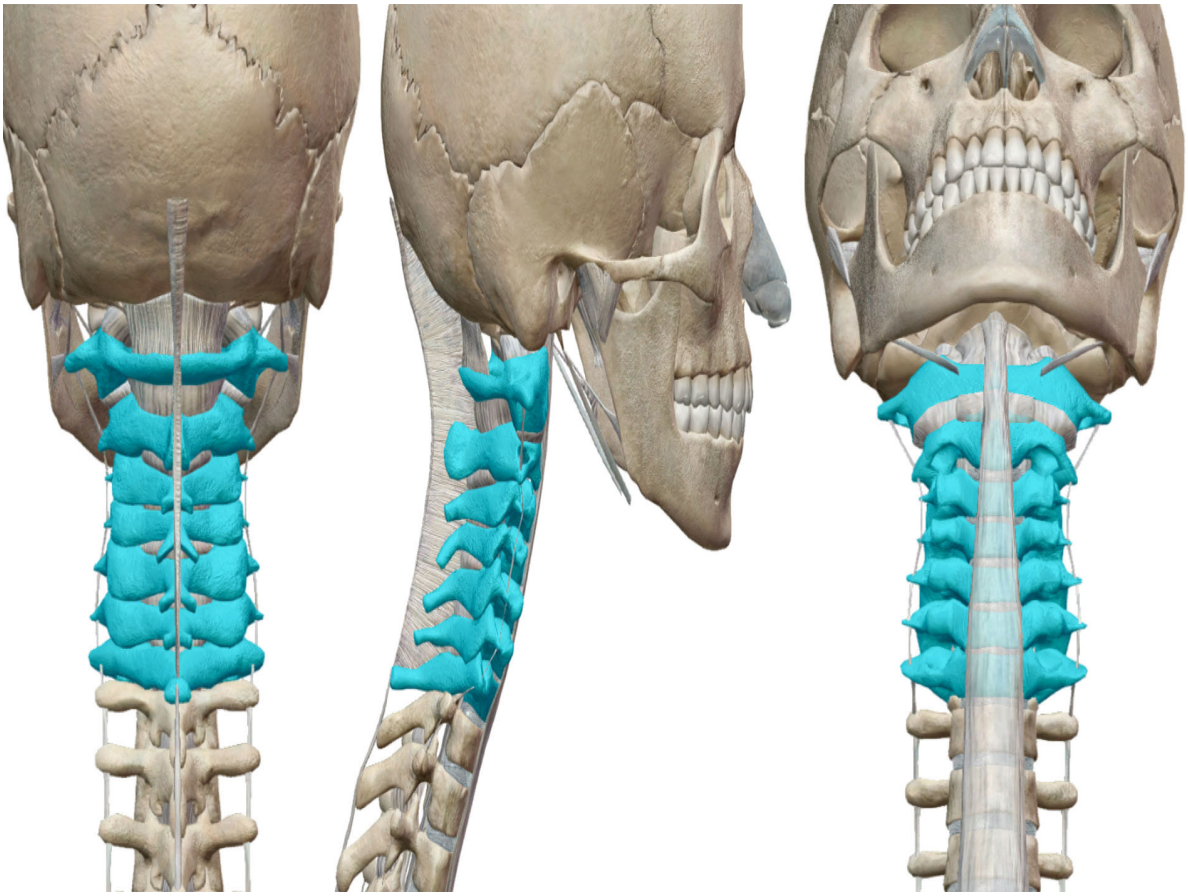
### The Vertebral Column

The vertebral column consists of the 24 vertebrae, the sacrum, and the coccyx. A total of 33 vertebrae are within the vertebral column including the sacrum and coccyx. The spinal cord passes from the foramen magnum of the skull through the vertebral canal within the spinal vertebral column.



## The Sections of the Vertebral Column

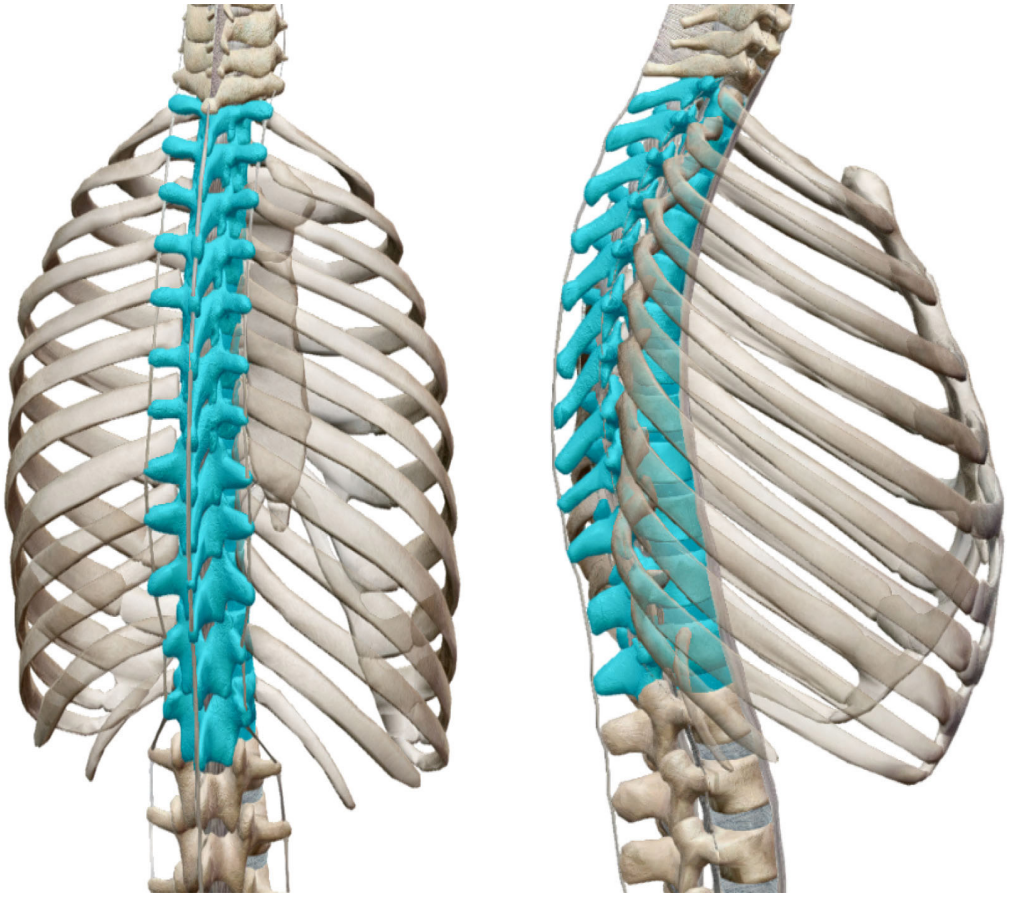
## Cervical Vertebrae



The cervical vertebrae are the first seven (C1-C7). C1 is known as the atlas. C2 is known as the axis. C7 is known as the vertebra prominent or vertebra prominens. Each vertebra of the vertebral column consists of an anterior body (except C1) and a posterior vertebral arch. The disc-like body of the vertebrae is weight bearing, and its upper and lower surfaces give attachment to the inter-vertebral discs.

The space between the body and the arch is the vertebral foramen, an opening that provides a passage for the spinal cord. Where the body and arch of two vertebra articulate (meet), a foramen is formed. This inter-vertebral foramen is an aperture for the transmission of the spinal nerves. The cervical vertebrae are the smallest of the true vertebrae and are unique in that there is a foramen in the transverse processes of C1-C7 that give passage to the vertebral artery and the vertebral vein.

## Thoracic Vertebrae

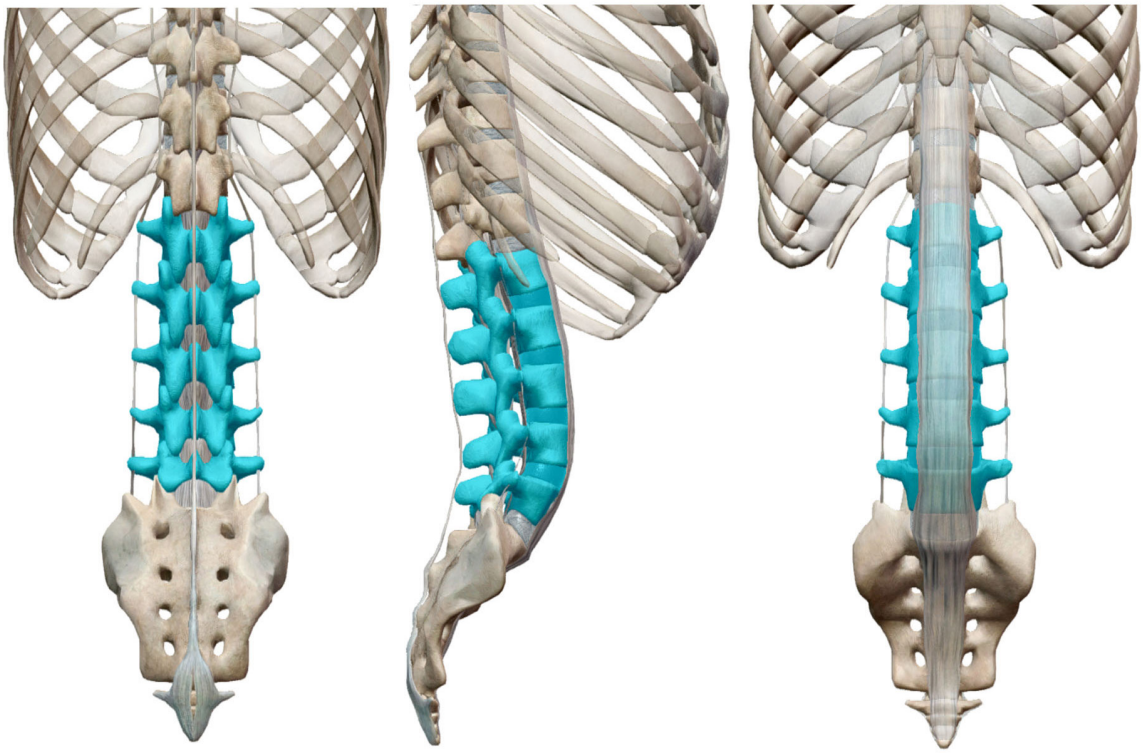


The thoracic vertebrae are the 8th through to 19th vertebrae (T1 - T12). Each thoracic vertebra of the vertebral column consists of an anterior body and a posterior vertebral arch. The disc-like body of the vertebrae is weight-bearing, and its upper and lower surfaces give attachment to the inter-vertebral discs.

Facets on the lateral side of the body articulate with the heads of the vertebrosternal ribs and false ribs. The vertebral arch is a composite structure; it consists of a pair of pedicles and a pair of laminae and supports 7 processes. The space between the body and the arch is the vertebral foramen, an opening that provides a passage for the spinal cord.

Where the body and arch of two vertebra articulate, a foramen is formed for the transmission of the spinal nerves. The transverse processes articulate with the tubercles of the vertebrosternal ribs and false ribs (except T11 and T12).

## Lumbar Vertebrae

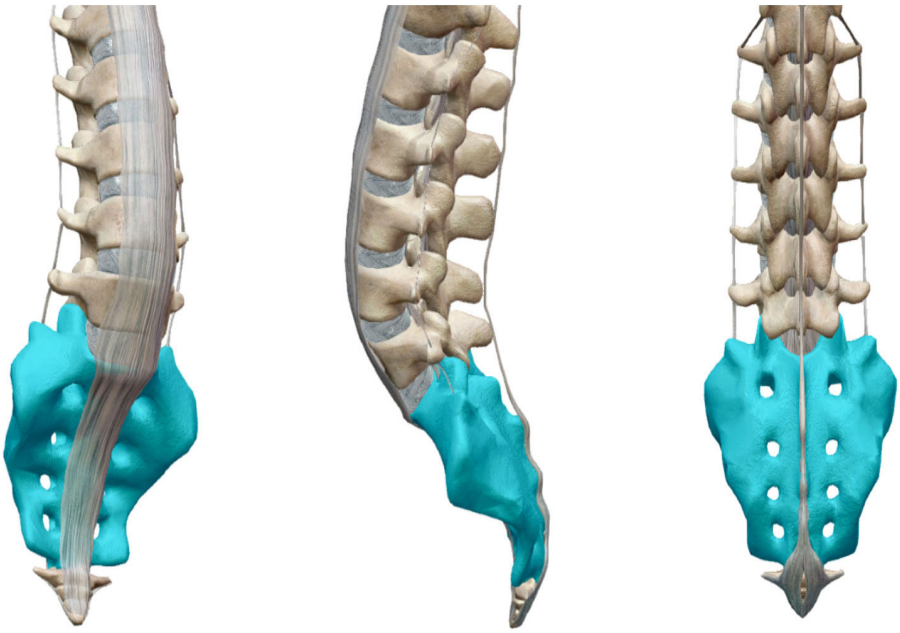


The lumbar vertebrae are the 20th through to 24th vertebrae (L1 - L5). Each lumbar vertebra consists of a heavy anterior body and a posterior vertebral arch. The disc-like body of the vertebrae is weight-bearing, and its upper and lower surfaces give attachment to the inter-vertebral discs. The long, slender transverse processes are situated in front of the articular processes instead of behind them, as in the thoracic vertebrae.

The superior tubercle of the transverse process is connected with the superior articular process to form the mammillary process; the inferior tubercle at the base of the transverse process is called the accessory process.

The spinal cord ends and the cauda equina begins, at or near L3. Because of this lumbar punctures are most often done between L4 and L5, where potential damage to the spinal cord is minimised.

## Sacral Vertebrae (Sacrum)

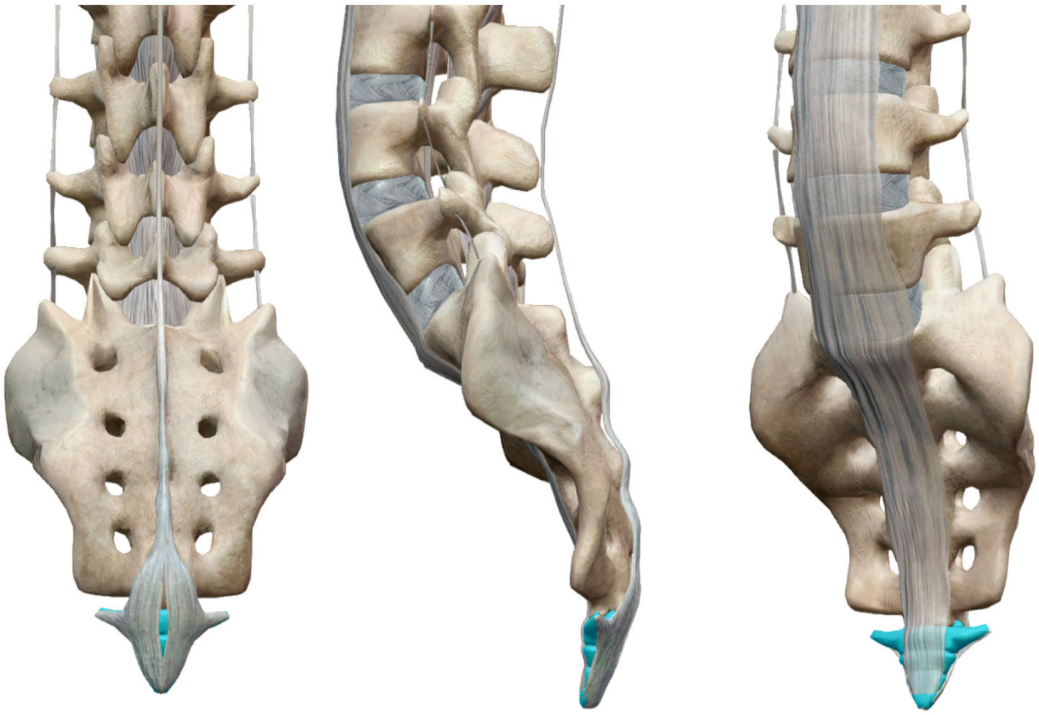


The Sacrum includes the sacral vertebrae, and are the 25th through to 29th (S1 - S5). These 5 vertebrae fuse in early adulthood to for the sacrum, a large triangular bone located between the hip bones.

Its upper part (base) articulates with the last lumbar vertebra (L5) by an inter-vertebral disc and its lower part (apex) articulates with the coccyx. The body of the first segment is large, resembling that of a lumbar vertebra, but each succeeding segment is smaller, flatter and more curved. The upper half of the lateral surface is a cartilage-covered articulation for the ilium.

The vertebral canal runs throughout the greater part of the bone, forming a passage for the sacral nerves and its walls are perforated by the anterior and posterior sacral foramina, through which these nerves exit. The female sacrum is shorter and wider than the male and directed more obliquely backwards, increasing the size of the pelvic cavity.

## Coccygeal Vertebrae (Coccyx)

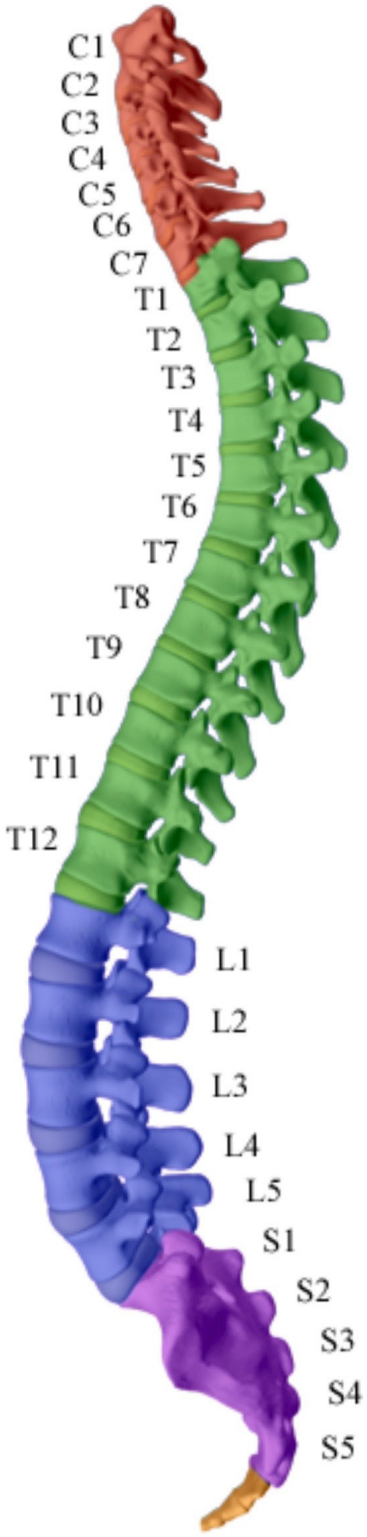


The coccyx (tail-bone) is the terminal portion, 30th through to 33rd vertebra of the vertebral column and forms part of the posterior wall of the pelvic cavity. It is formed by the fusion of the 4 vertebrae.

The first is the largest and resembles the lumbar vertebrae. The last 3 diminish in size; the last piece is often simply a nodule of bone. The anterior surface of the coccyx provides attachment for the anterior sacrococcygeal ligament and the levator ani and supports part of the rectum.

The posterior surface, at the base, articulates with the sacrum by a fibrocartilage joint. The borders of the coccyx are narrow and provide attachment on either side to several ligaments. The terminus, or apex, is rounded, and is attached to the tendon of the external sphincter.

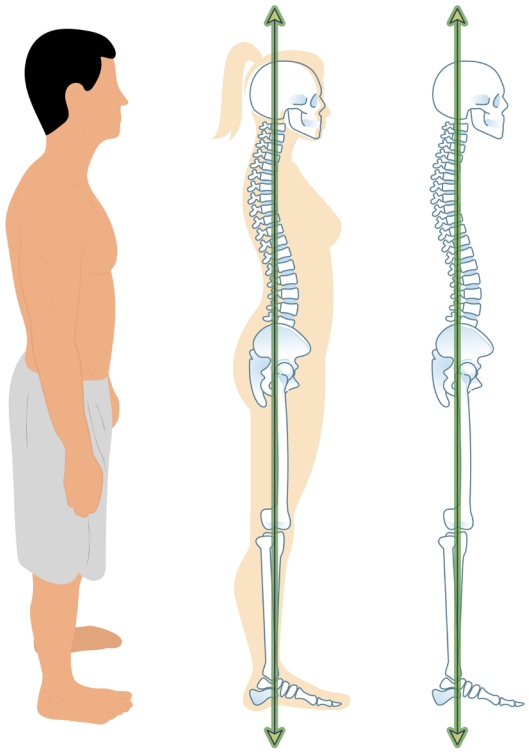
## Vertebral Positions C1 - S5



## Posture

The spine develops from a single curve during foetal development into four curves, two concave, and two convex. The cervical and lumbar regions with concave curves give the greatest range of movement.

# Neutral Balanced

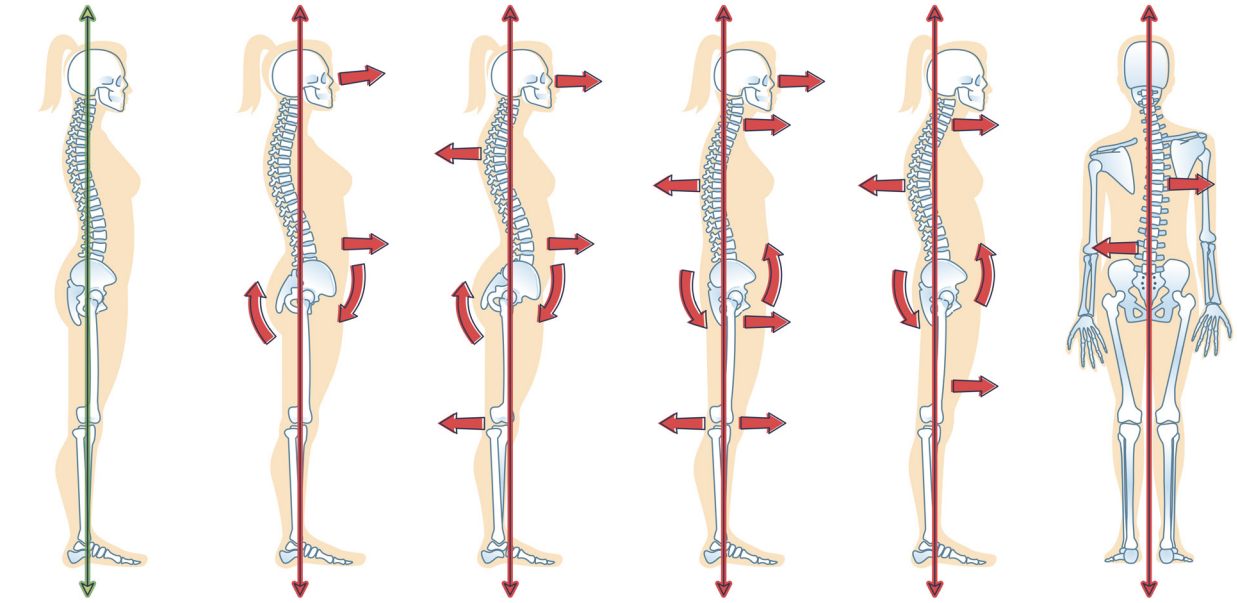


### *NEUTRAL SPINE*

A neutral spine describes the ideal position to minimise stress on the vertebrae and its ligaments.

In turn, achieving this posture during physical activity will help to reduce the risks of back pain.
It will also allow musculature to perform in a balanced way and maintain this optimal spinal curvature.

## *POSTURAL ABNORMALITY (DEVIATION)*




Deviation from optimal spinal posture can be common. Pregnancy can enhance the curvature of the lower spine to shift the centre of gravity backwards and compensate for the extra weight at the front.

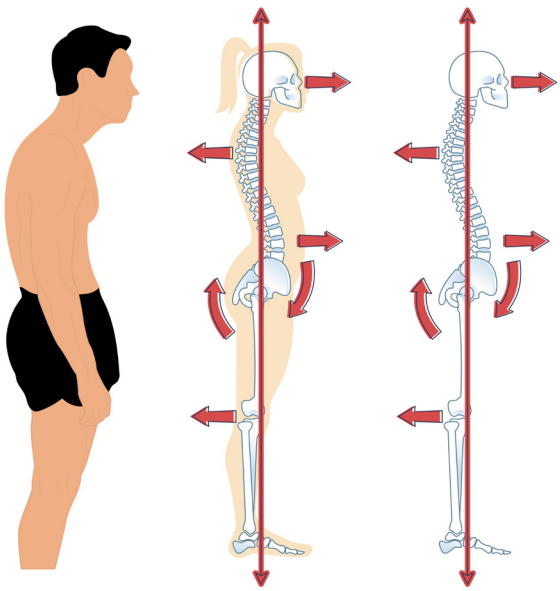
Postural abnormality can be present at birth, or can occur at any stage of life, and can be temporary or permanent.

Some of the major postural deviations are below:

# Kyphosis

An abnormally excessive convex curvature of the spine as it occurs in the thoracic and sacral regions.

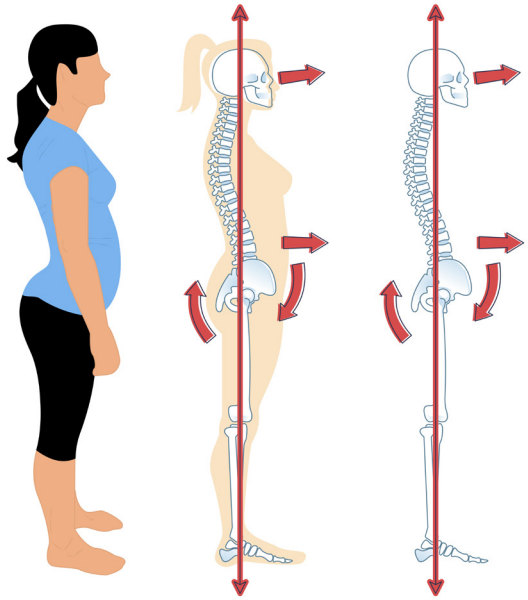
NB: Characterised by an abnormally rounded upper back.



# Lordosis

Defined as an excessive inward curve of the lower back.

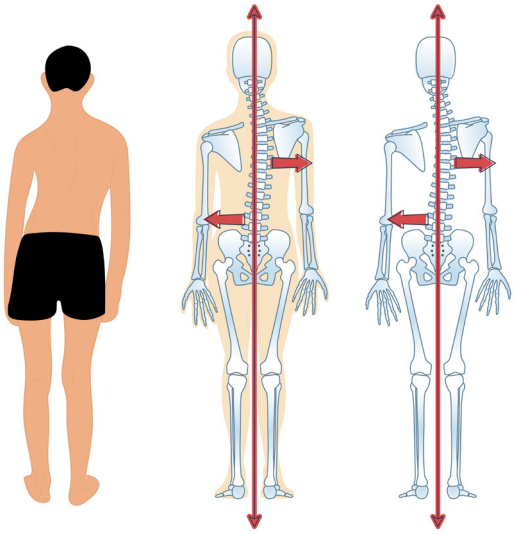
NB: Lordosis can occur at the cervical spine also.



# Scoliosis

Defined as the abnormal lateral curvature of the spine.

NB: A sideways curve which is often s-shaped or c-shaped.

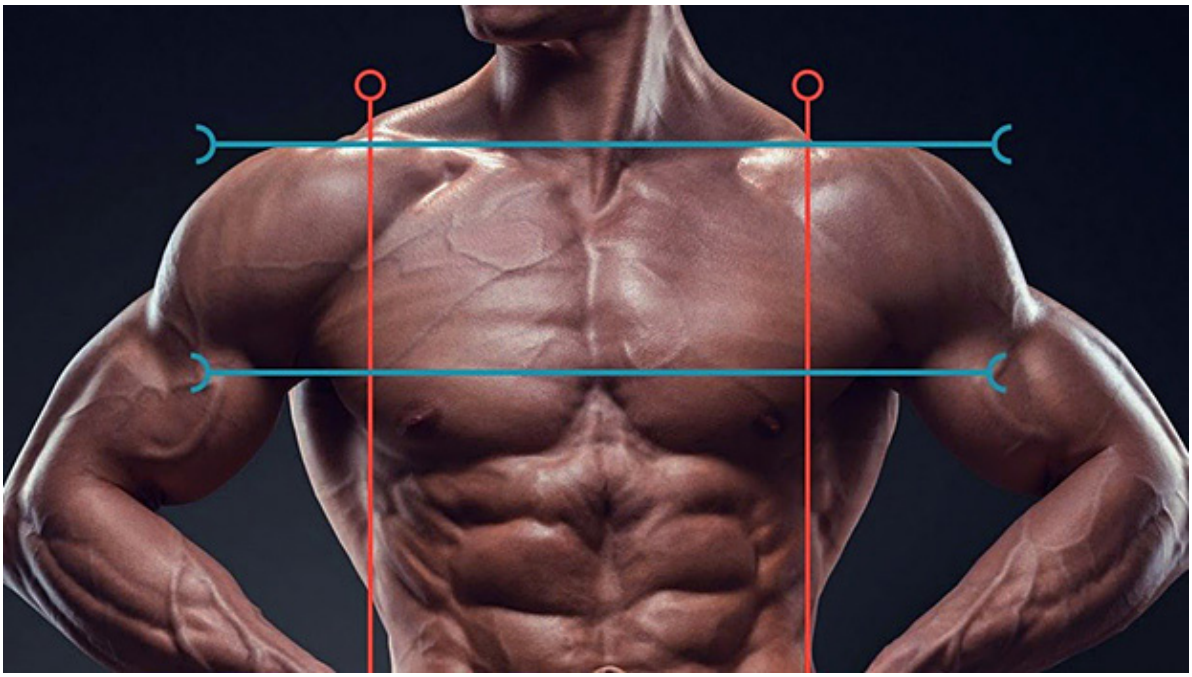


## Muscle Imbalance

The term “muscle imbalance” refers to a condition in the body that is present when opposing muscles are out of balance with one another in terms of strength, length and/or tension. Opposing muscles are those that perform opposite functions. They may oppose one another spatially left-to-right or front-to-back. For example, quadriceps are responsible for extending the knee and the hamstring is responsible for flexing it. One is on the front of the thigh, and the other, the back.

When opposing muscle groups are imbalanced, one group is tighter and shorter than the other, which is elongated and lax. Imbalances can cause pain both directly and indirectly. The muscle that is shorter and tighter is chronically tense; muscle memory has trained it to stay in its shortened position. Tense muscles can develop knots called trigger points that cause localized and referred pain. The weaker muscle is prone to strain.

Muscle imbalances can interfere with posture. Tight muscles exert a pulling force on nearby strictures. If a muscle connected to the lumbar spine is tight, for example, it can pull the spine forward and create what is called anterior pelvic tilt. If an imbalance causes postural distortion, pain and dysfunction may be felt throughout the body.



## What Causes Muscle Imbalance?

Generally, repetitive activity is to blame. This could occur from poor exercise habits or from repetitive movements required by your work. When you engage a muscle, the brain sends a signal to its opposing muscle to relax; this allows the engaging muscle to tense up without resistance. The process is called reciprocal inhibition. Once muscle memory sets in, the tension and laxity can become chronic.

# Flexibility

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### Introduction

Flexibility is best defined as the range of movement at a joint or joints and is influenced by joint structure, the shape of the bones and cartilage involved and the length and elasticity of the muscles that cross the joint.

Flexibility varies significantly from person to person and is specific to individuals. Poor flexibility can have an adverse effect on posture and function but so too can excessive flexibility or hypermobility.

While flexibility is, in many ways, genetic, some sports and activities are responsible for a reduction in flexibility. For example, long periods of sitting can shorten several important muscles including the hamstrings and hip flexors whereas jogging and cycling, activities that utilise a small range of movement, can also cause muscles to shorten. This phenomenon is called adaptive shortening.

Some activities are linked to or require a high degree of flexibility; the most obvious examples being dance, gymnastics and most martial arts. Flexibility is developed by stretching which involves moving the muscle origin and insertion further apart.

### THERE ARE SEVERAL NOTABLE BENEFITS TO STRETCHING:

- Increased range of movement.
- Reduced muscle tension.
- Increased physical and mental relaxation.
- Reduced risk of non-specific back pain.
- Possible reduced risk of DOMS (delayed onset muscle soreness).
- Decreased muscle viscosity resulting in smoother movements.
- Improved coordination.
- Improved proprioception.
- Improved circulation.
- Improved posture.
- Possible reduced risk of injury.

## Range Of Motion

The range of motion (R.O.M) is the amount of motion available at a specific joint.

**THE TABLE PROVIDES EXAMPLES OF JOINTS AND THE RANGES OF MOTION AVAILABLE AT THOSE JOINTS.**

| Joint | Action | Degrees of motion |
|---|---|---|
| **Shoulder** | Flexion | 160 degrees |
| | Extension | 50 degrees |
| | Abduction | 180 degrees |
| | Internal rotation | 45 degrees |
| | External rotation | 90 degrees |
| **Elbow** | Flexion | 160 degrees |
| | Extension | 0 degrees |
| **Hip** | Flexion | 120 degrees |
| | Extension | 0-10 degrees |
| | Abduction | 45 degrees |
| | Adduction | 15 degrees |
| | Internal rotation | 45 degrees |
| | External rotation | 45 degrees |
| **Knee** | Flexion | 140 degrees |
| | Extension | 0 degrees |
| **Ankle** | Plantarflexion | 45 degrees |
| | Dorsiflexion | 20 degrees |

Instructors should also ensure that there is an equal volume of pushing and pulling exercises and that dynamic and static stretches are utilised. Care should also be taken to ensure that all prescribed exercises are performed using good form.

## Factors Affecting Flexibility

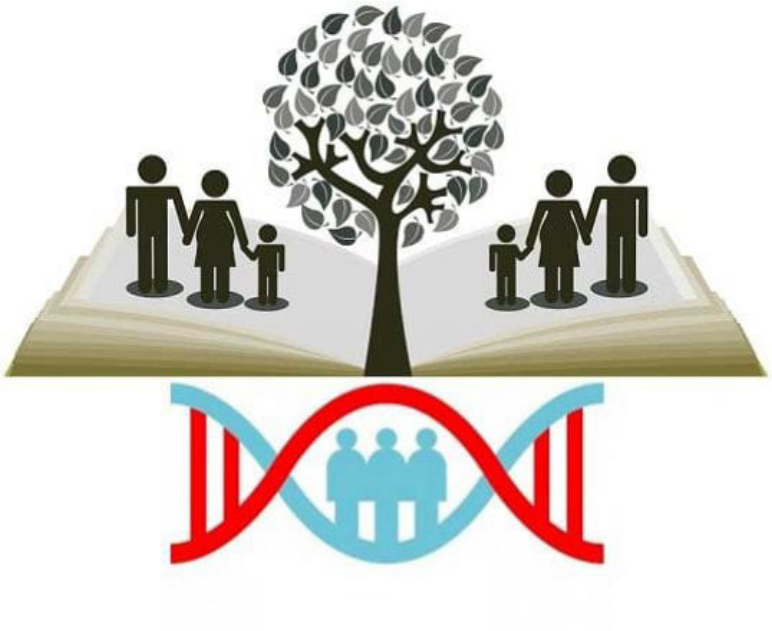
Flexibility can vary significantly from one individual to another and the potential for developing flexibility is, in part, limited by several factors:

### *Heredity*

Hypermobility is a hereditary trait; some people are born with a tendency toward hypermobility or, what is incorrectly referred to as “double joints”. Hypermobility increases the risk of injury and joint dislocation and it essential that muscles are strengthened to protect at-risk joints.

### *Age*

Babies are very flexible but, as they start to walk and more joint stability is required, muscles begin to tighten up. Younger people tend to be naturally more flexible than older people and muscle elasticity tends to decline with age unless regular stretching is performed.



### *Exercise history*

Years of running or cycling can adversely affect flexibility while performing full-range movements such as deep squats, high kicks and other dynamic activities will enhance it. A well-designed resistance training program utilising full ranges of movement will positively influence flexibility whereas the same program performed using a shortened range of movement will reduce flexibility.

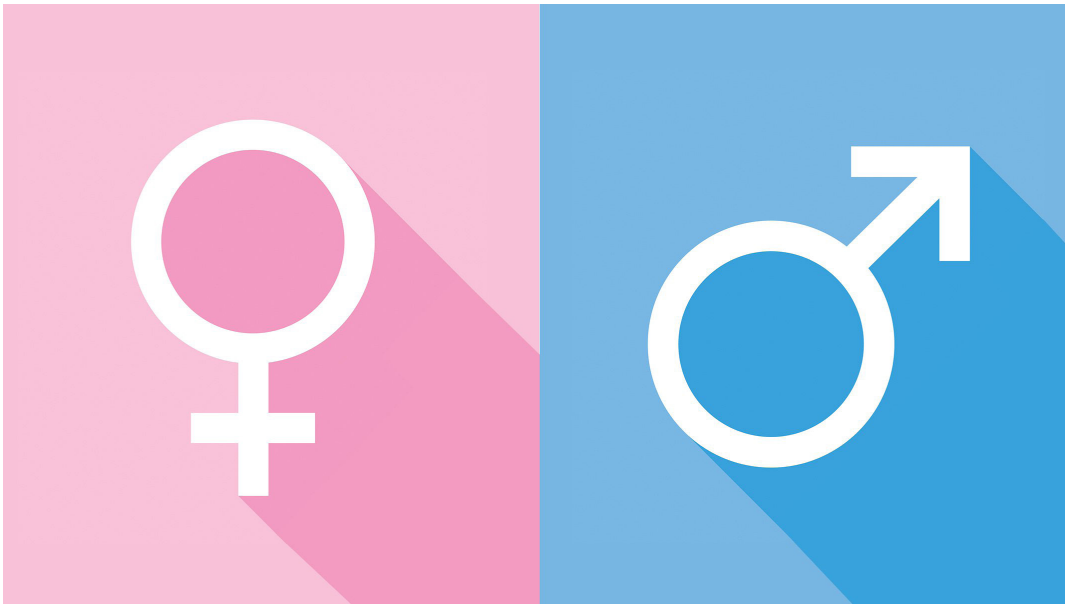
### *Temperature*

Direct or indirect heat make muscles and tendons more elastic. Conversely, a decrease in temperature can significantly reduce flexibility.

## Gender

Women tend to be naturally more flexible than men. The reasons are two-fold. Women have a higher amount of the hormone relaxin which does exactly what its name suggests – it relaxes soft tissue and muscle.

This facilitates greater flexibility. Relaxin levels increase significantly during pregnancy so that the women's body can stretch to accommodate the growing foetus and for the birth itself. Additionally, women are statistically more likely to participate in activities such as dancing or gymnastics where flexibility is important and therefore developed.



## Fashion

High heels and tight skirts can adversely affect flexibility because they place muscles in a shortened position or restrict the range of movement.

## Methods Of Stretching

There are several methods and types of stretching that an instructor should be familiar with so that they can choose the right one for their client:

### *ACTIVE STRETCHING*

Active stretching involves effort from the individual doing the stretching. This may be because they adopt and hold a stretch themselves or use the antagonist of the target muscle to stretch the opposing muscle.

Examples include using the middle trapezius, rhomboids and posterior deltoids to horizontally extend the shoulders and retract the shoulder girdle to stretch the pectoralis major and anterior deltoids.

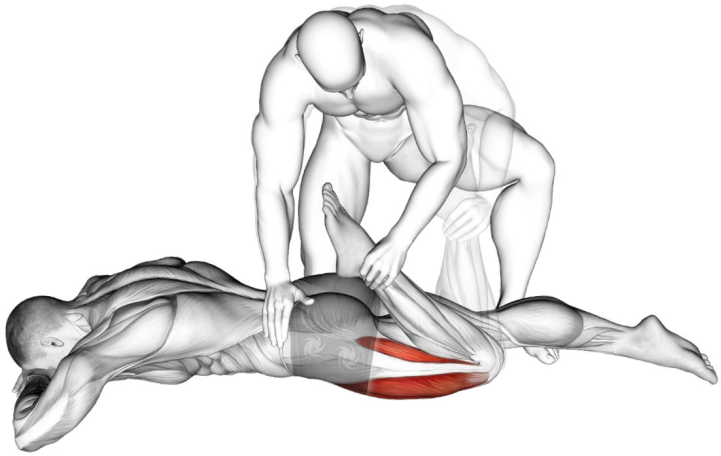
### *PASSIVE STRETCHING*

Passive stretching uses an external force or a prop to stretch the target muscle. For example, a length of rope to stretch the hamstrings of one leg while lying on your back or the use of a partner. Passive stretches are usually better when a longer than usual stretch is required as they are comfortable and require little or no input from the client.

### *FACILITATED STRETCHING*

Facilitated Stretching uses an isometric contraction of the target muscle to prepare it to stretch. This method encourages active stretching on the part of the client, avoiding additional passive stretching when possible. Facilitated stretching can be done with a partner or by yourself e.g. using a towel

NB: If a training partner or instructor is providing stretching assistance, it is essential that the force of the stretch is applied gradually and carefully and is accompanied by good communication between both parties as it's all too easy to overstretch and cause injury.

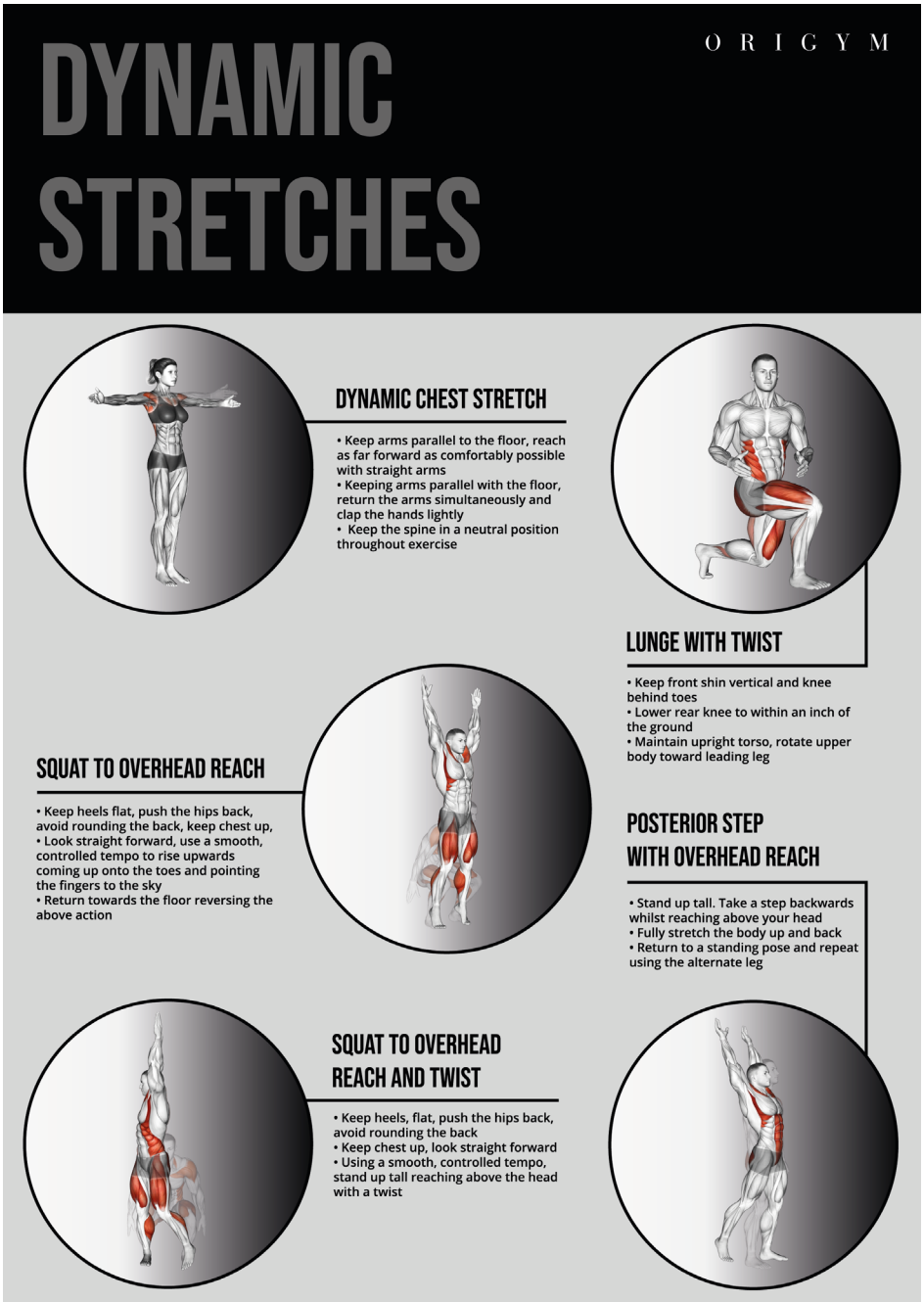


## Dynamic (Warm-Up Stretches)

Dynamic stretches involve taking a muscle or group of muscles through a wide range of movement without stopping in the fully extended position. For example, to stretch the hamstrings, you could swing your legs forward from your hips in an alternating high kick.

Dynamic stretches are always performed smoothly and in a controlled manner to minimise the risk of injury and should mimic the movements or activities of the following workout or sport. Other examples of dynamic stretches include forward lunges with a waist twist, wide-foot squats and repeatedly reaching your arms up above your head.

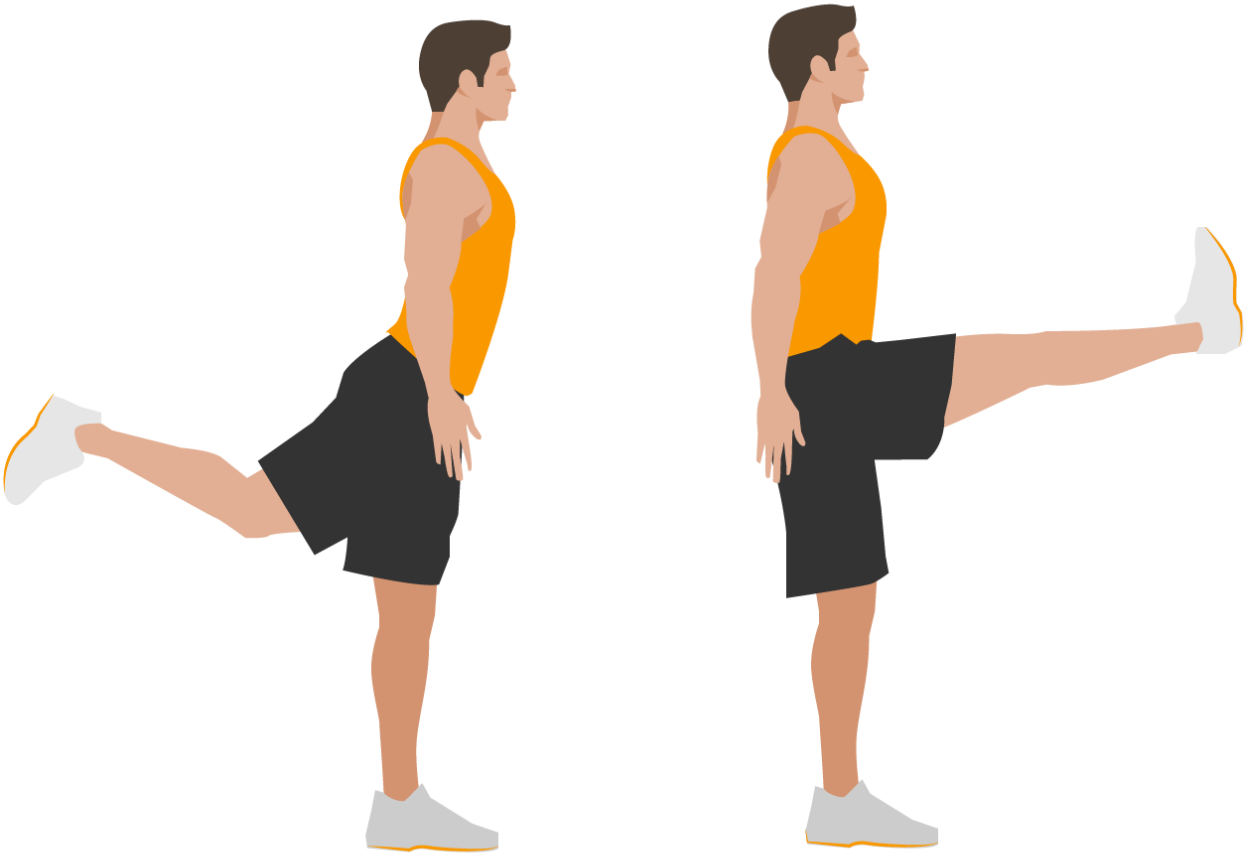
Dynamic stretches are normally best performed in sets of 10 - 15 repetitions and usually; 3 - 5 dynamic stretches; 1 - 2 sets each, are all that is required.



## Ballistic

This form of stretching involves using momentum and bodyweight to stretch a muscle beyond its normal point of bind. This is done using repetitive bouncing movements. For the vast majority of exercisers, this method is not recommended as rapidly and forcefully exceeding the point of bind may cause injury.

However, for certain sports people and for stretching adhesions and stubborn fibrous tissue in physiotherapy and rehabilitation, it may be necessary to use ballistic stretching.



## Static (Cool Down Stretches)

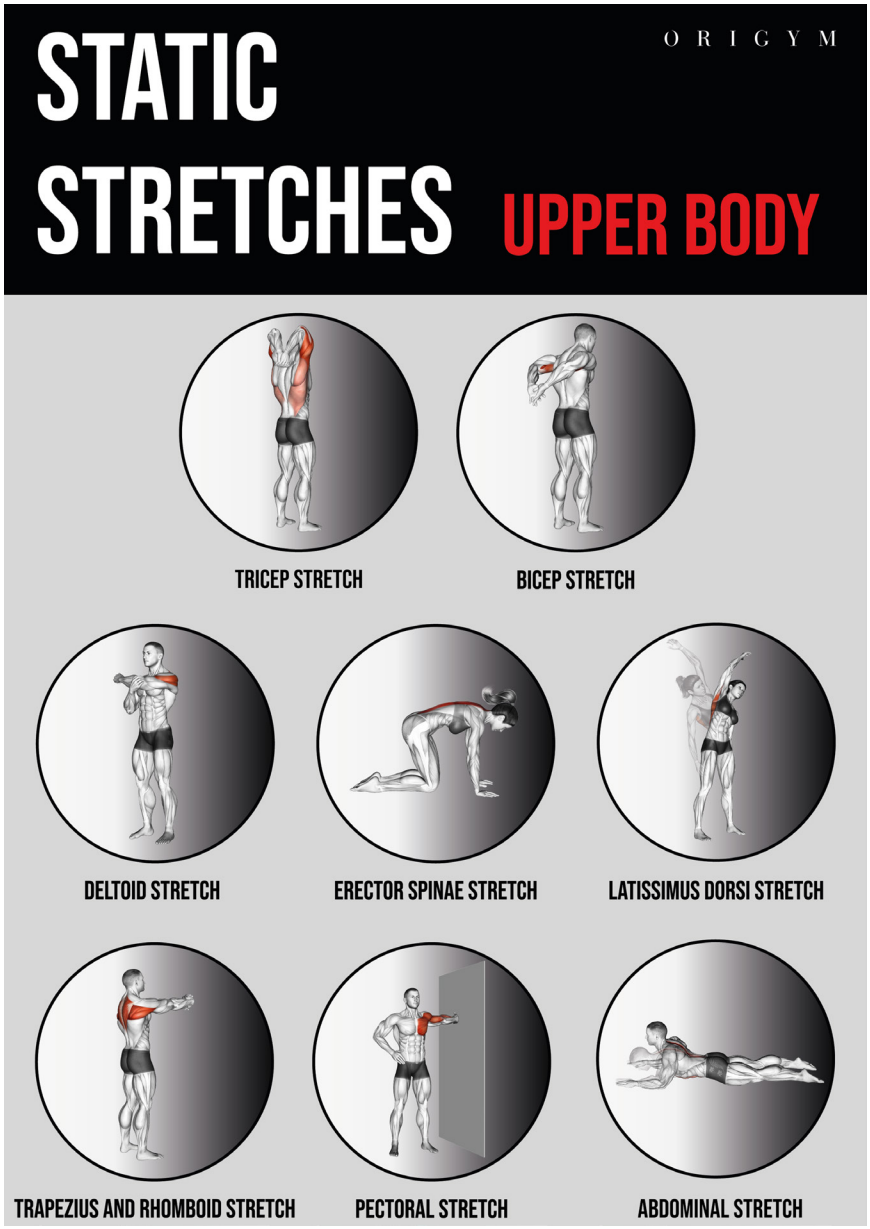
As the name suggests, static stretches involve little or no movement. The muscle in question is stretched until the point of bind (end of the range) is reached and that position is then held with no bouncing.

This should result in a mild stretching sensation but no actual pain in the target muscle or joints. Static stretches can be used to maintain the current level of flexibility (maintenance stretching) or increase flexibility (developmental stretching).

**Maintenance stretches are held for 10 to 15 seconds and then released**

**Developmental stretches are held for 30-seconds and then released**

Developmental stretches are usually increased incrementally as muscles gradually relax. In general, the longer a stretch is held, the greater the increase in flexibility will be. Care should be taken not to force a stretch or stretch a cold muscle as injury can result. It is also important to ensure that increases in the depth of a stretch come from elongation of the target muscle and not nearby joints e.g rounding the lower back in a hamstring stretch.



# Proprioceptive Neuromuscular Facilitation (PNF)

Proprioceptive neuromuscular facilitation (PNF) was first developed by Margaret Knott PT and Herman Kabat MD in the 1940s as a method of treating neurological dysfunctions. The treatment involved re-education of developmental movements and postures. This approach helped patients become more efficient in their movements and activities of daily living (ADLs). Muscle recruitment is enhanced through the use of the appropriate reflex and proprioceptive stimuli.

The efficient recruitment of motor patterns involves the use of the following PNF techniques:

- Resistance: Resistance applied to a muscle contraction will facilitate a smooth motor response through optimal muscle contraction and relearning. The type and degree of resistance vary to achieve the appropriate motor response.
- Irradiation: Irradiation is the overflow of neuronal excitation from stronger motor units to weaker ones, or units that may be inhibited by injury. This is done by applying graded resistance to larger muscle groups to enhance contraction in the weaker groups.
- Traction: The application of traction perpendicular to the arc of motion is used to facilitate an enhanced motor response.
- Manual pressure: Neuromuscular responses are influenced by contact with the skin and deeper pressure receptors.
- The stretch reflex: The stretch reflex is a stimulus that increases the state of responsiveness of a motor unit to cortical stimulation. This reflex is stimulated by the quick elongation of muscle. The stretch stimulates muscle spindles to create a contraction. The muscle spindle and its reflex work as a feedback device that operates to maintain optimal muscle length. The reflex produces a brief isolated contraction.
- Approximation: A compressive force to approximate joint surfaces can facilitate a motor response and promote stability.

# The 3 Types of PNF Methods

## *Contract-Relax*

This is also known as "active assisted" stretching in some of the literature. The Golgi tendon organs lie in the tendon of a muscle that mediates the stimulation of inhibitory interneurons in the spinal cord that causes relaxation of that muscle's motor neuron. They also make excitatory connections with the motor neurons that supply the antagonists of that muscle. Since the Golgi tendon organs are in series with the muscle fibres they are stimulated by both passive stretch and active contraction of the muscle.

The Golgi tendon organ, therefore, acts as a transducer in a feedback circuit that helps to regulate muscle force through inhibition and relaxation of the muscle. The contract-relax technique uses the development of tension in a muscle by isotonic contraction to facilitate the relaxation and therefore stretch a muscle.

By facilitating the relaxation of muscles we can improve circulation and improve extensibility of myofascial tissues. To accomplish this the muscle is placed in a maximally stretched position and resistance is applied to a muscle contraction of the muscle that is being stretched (direct contraction) or that muscles antagonist (reciprocal relaxation).

Movement occurs during this contraction. Following this contraction the limb is relaxed and upon relaxation is actively or passively stretched further.

- **Direct Contraction:** For example, when stretching the hamstring, the hip is placed in 90 degrees with the patient lying on his back. The knee is flexed against moving resistance isotonically and then relaxed. The hip held at 90 degrees, the knee is moved into its fully extended position so as to apply a stretch to the hamstring.
- **Reciprocal Relaxation:** For example, when stretching the hamstring, the hip is placed in 90 degrees with the patient lying on his back. The knee is then extended against resistance, contracting the quadriceps. The activity in the quadriceps causes reciprocal inhibition of the hamstrings allowing for a greater stretch.

## *Hold-Relax*

The hold-relax PNF stretching technique is used to facilitate the relaxation of muscles to gain range of motion. This method uses an isometric contraction rather than an isotonic one. To achieve this the limb is placed in pain-free range and an isometric contraction is sustained. The limb is then moved into the new range. The hold-relax method of PNF stretching is facilitated by the Golgi tendon organ to allow a reflexive relaxation of the muscle. It can be done individually or with assistance from a trainer or physical therapist. The danger of the hold-relax PNF stretching technique is that with this inhibition of muscle activity, it may predispose an athlete to injury if done prior to an athletic event.

## *Contract-Relax-Antagonist-Contract*

The first part of this stretch is similar to the hold-relax whereby the muscle being stretched is isometrically contracted for 3 to 6 seconds, then the antagonist muscle will immediately contract for 3 to 6 seconds. The joint is then pushed into its new range.

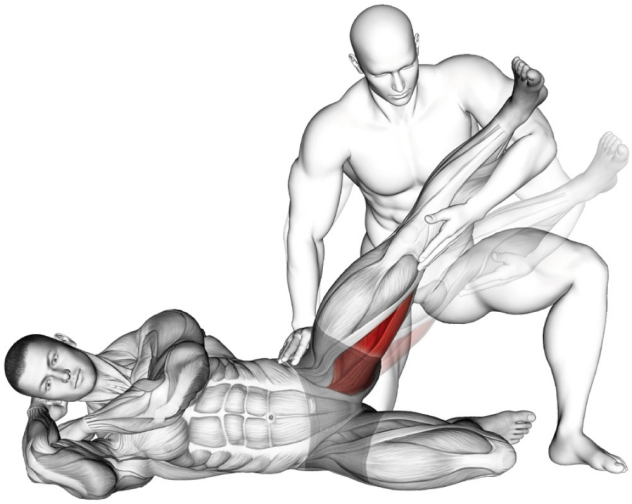
An example of a PNF stretching exercise to increase range of motion in the hamstrings is lying on your back with one leg pointing upwards. A partner carefully pushes the extended leg in the direction of the head of the one lying down. When the hamstrings are activated the partner prevents movement by keeping the leg in place. After the hamstrings relax again, the partner carefully pushes the leg even further towards the head. This process is repeated until the maximum point of bind it achieved.

A more advanced form of flexibility training that involves both the stretching and contraction of the muscle group being targeted. PNF stretching was originally developed as a form of rehabilitation, and to that effect, it is very effective.

## Methodology

1. The person who is to be stretched assumes the position.

The PT the places the person into a stitched position. This is called their point of bind.



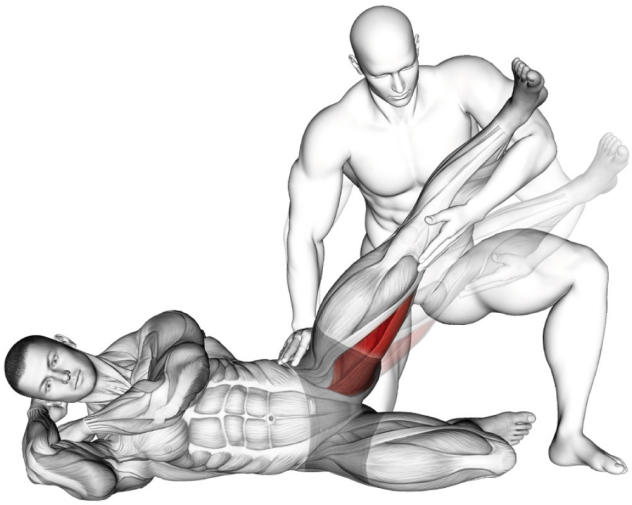
2. The person then contracts the stretched muscle (60-80% effort) for 3 - 6 seconds while the PT inhibits the movement.

NB: The force of the contraction should be relevant to the condition of the muscle. Ensure the person does not apply a maximum effort!

3. The person then relaxes the muscle, immediately the PT cautiously pushes passed the persons current "point of bind" and normal range of movement approximately for a further 5-20 degrees.

Allow 30 seconds of recovery (whilst in the new bind).

Repeat the procedure 2 - 4 times.

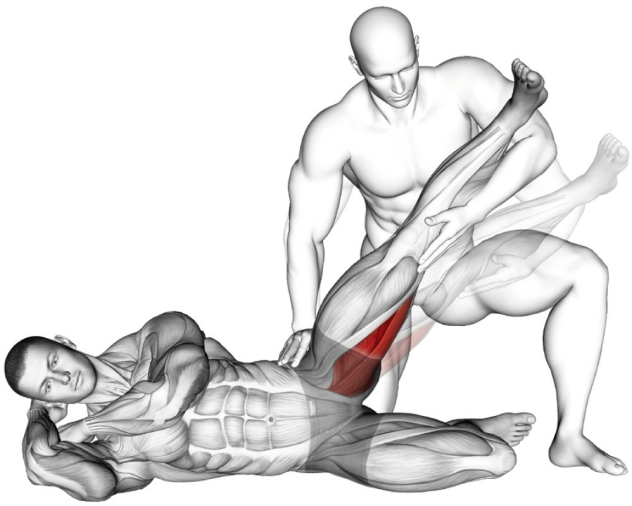


### ADVANTAGES

- Large increases in the range of motion.

### DISADVANTAGES

- For most exercises a partner is necessary.
- Decreases in maximum strength after performing PNF.



NB: When your client's range of motion has to be increased, PNF is a very useful method.

Because of the large amount of stress on the muscles, it is best to perform it on a separate day instead of a training day. Just like static stretching a proper warm-up beforehand is necessary.

## Neuromuscular Mechanisms

### *PNF STRETCHING: THE ROLE OF THE STRETCH REFLEX*

The muscle spindle is a long thin nerve receptor found within the muscle. Information from this receptor transmits information to the spinal cord regarding muscle length and the speed of lengthening. When a muscle is stretched quickly this muscle spindle fires and causes a reflexive contraction within that muscle that is undergoing the stretch. The greater the speed of stretch, the stronger the reflex contraction in the muscle being stretched.

### *PNF STRETCHING: AUTOGENIC INHIBITION:*

Inhibition of the antagonist muscle group is mediated by the muscle spindle. If the agonist muscle contracts, then the spindle fires, sending messages to the spinal cord causing the antagonist muscle to relax.

### *PNF STRETCHING: RECIPROCAL INHIBITION*

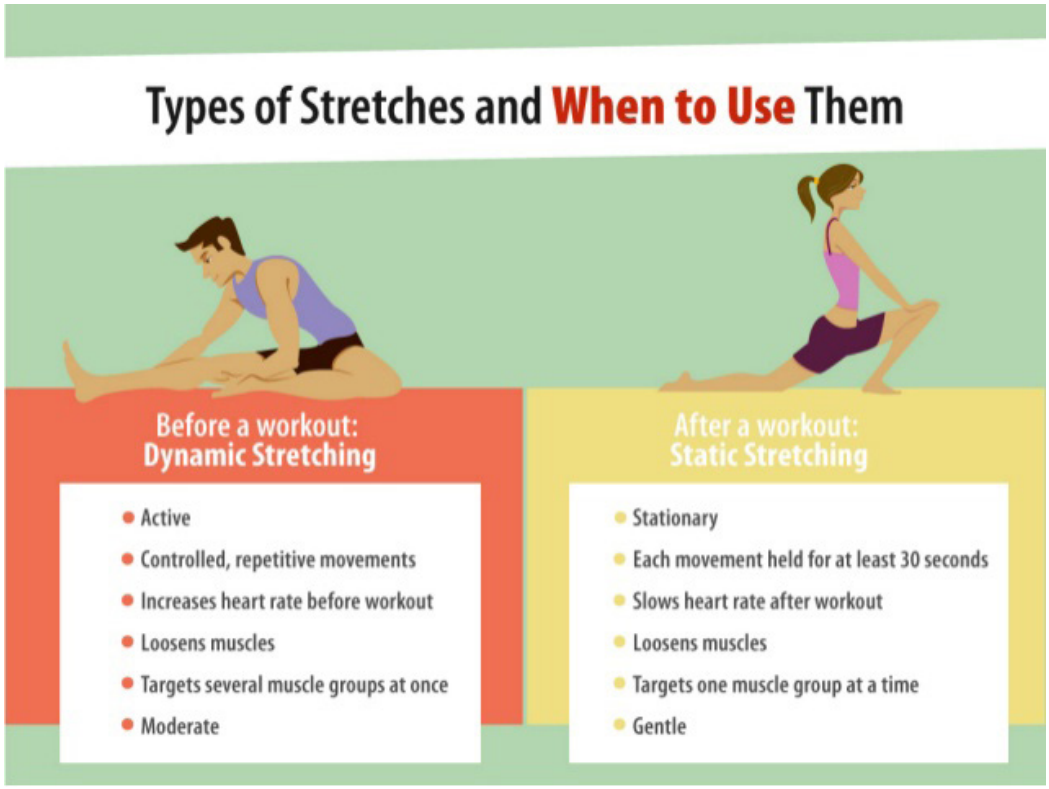
The Golgi tendon organ is a nerve receptor found in tendons. This receptor fires when tension increases within the tendon. This tension can be due to stretch or contracting muscle.

When the Golgi tendon organ fires a signal is sent to the spinal cord causing the agonist muscle to relax. During PNF stretching, these three mechanisms all work together to allow normal smooth movements and can be manipulated through PNF techniques to increase our ability to stretch.

## When To Stretch?

Stretching should be part of virtually every workout but is important that the right stretches are used at the right time. For example, static developmental stretches cause muscle relaxation and can inhibit force production so they are not really suited to the warm-up.

However, if a client has very bad flexibility in one or several muscles which makes the performance of a particular exercise more difficult than normal, statically stretching hypertonic muscles may be beneficial e.g. statically stretching the calves prior to squats. In contrast, the active nature of dynamic stretches means they are not really suitable for cool downs.




In the majority of cases, stretching is a safe and very beneficial activity however some population groups could suffer injury or health concerns as a result of stretching. An instructor should know who is and isn't a suitable candidate for flexibility training.

Considerations when flexibility training include:

- Avoid any developmental or ballistic stretches during pregnancy because of the softening effects of relaxin.
- Do not force a stretch if the movement is inhibited by a bony block.
- Avoid stretching the muscles surrounding a fracture site for 8-12 weeks post-injury.
- Stop stretching if any sharp muscle or joint pain occurs.
- Stop stretching if any muscle cramps occur.
- Do not stretch joints or tissue that is infected.
- Avoid stretching any muscle or joint that is acutely inflamed.
- Do not stretch any bruised or sore muscles if the cause was over-stretching.

Flexibility training is all too easily left out of exercise programs because of lack of time, not seeing the value or lack of knowledge. However not stretching can increase acute and chronic injury risks and regaining lost flexibility takes much longer than developing and maintaining it in the first place.

# The Nervous System

## *MODULE 2:*
## *THE VERTEBRAE, CONNECTIVE TISSUES, MACROS AND MICRONUTRIENTS*

The nervous system controls every major function that occurs in your body. In fact, without your nervous system, your muscles and other organs would be all but inert. Without your nervous system, your heart wouldn't beat, your blood wouldn't circulate and your muscles wouldn't contract. It's fair to say that your nervous system is your body's governor.

Because the nervous system and muscular system are so closely linked, symbiotic even, they are collectively called the neuromuscular system; 'neuro' pertaining to the nerves and muscular, obviously, pertaining to your muscles.

## Roles of the Nervous System

Input: There are a huge array of sensory nerves spread all throughout your body that are constantly gathering information such as the temperature, level of CO2 in your blood, degree of stomach distension, weight of the object you are trying to lift or the angle of the hill you are running up.

Analysis: The information gathered by the myriad of sensors around your body has to be interpreted and analysed so that the appropriate response can be generated. While some responses are voluntary, many more are automatic or involuntary and are known as reflexes.

Output: Finally, having gathered and analysed the incoming information, response or output is initiated e.g. increasing breathing rate because of elevated CO2 levels or sweating to reduce body temperature.

### THERE ARE TWO MAIN PARTS OF THE NERVOUS SYSTEM

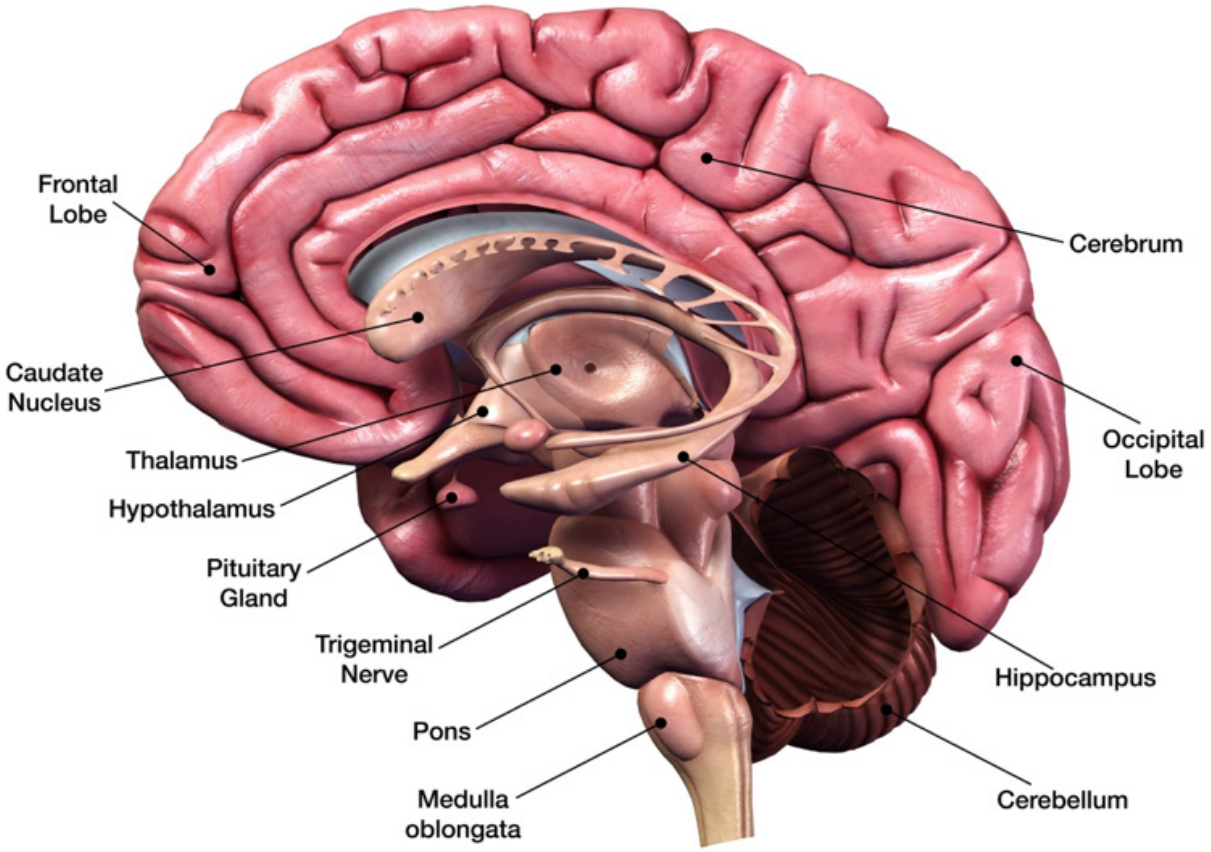
- **The central nervous system or CNS.**
- **The peripheral nervous system or PNS.**

# The Brain

## THE BRAIN IS MADE UP OF TWO HEMISPHERES:

The left side of the brain: It is responsible for controlling the right side of the body. It also performs tasks that have to do with logic, such as in science and mathematics.

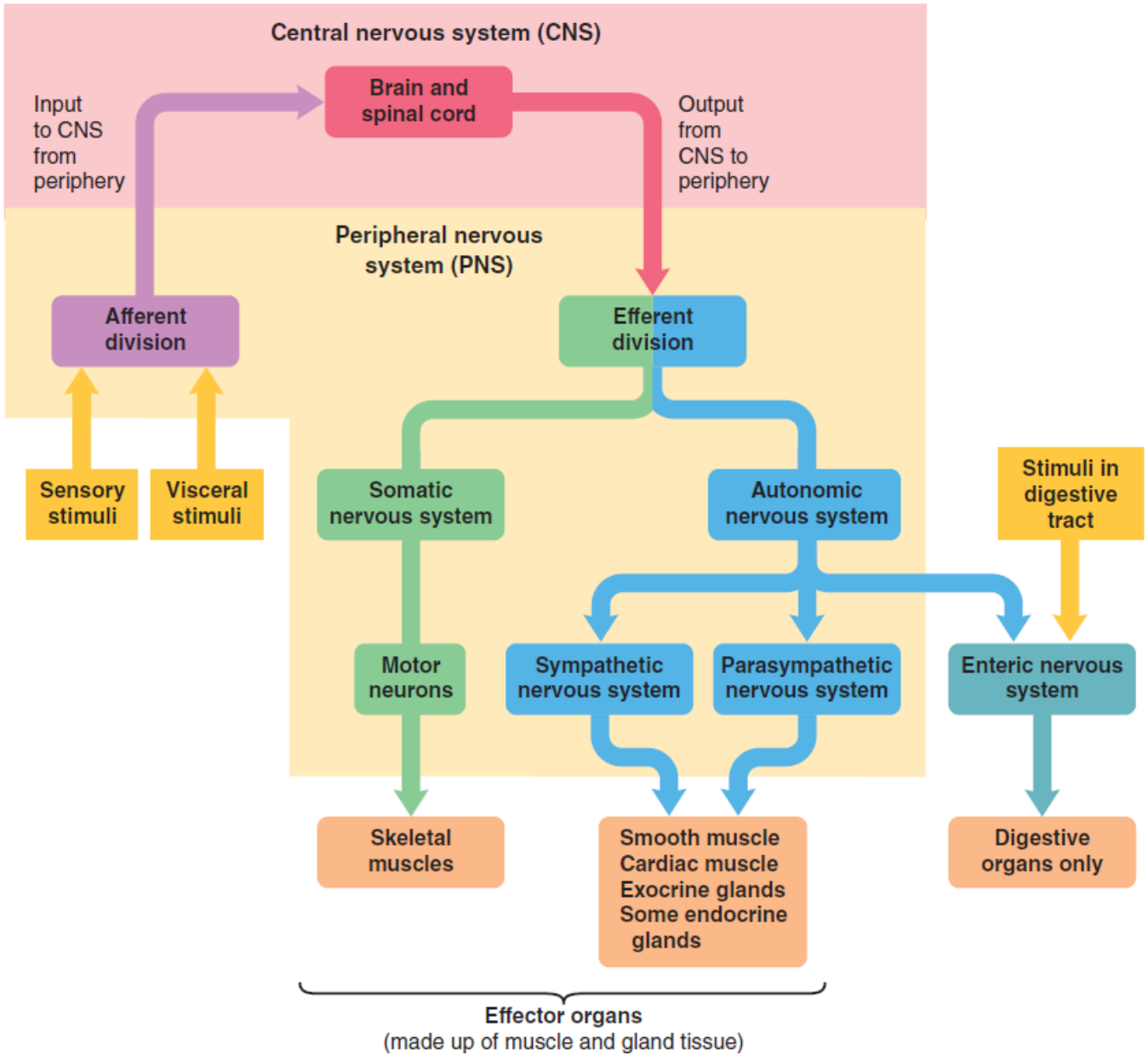
The right side of the brain: It is responsible for controlling the left side of the body. It also performs tasks that have to do with creativity and the arts.




## THE BRAIN HAS 3 MAIN PARTS:

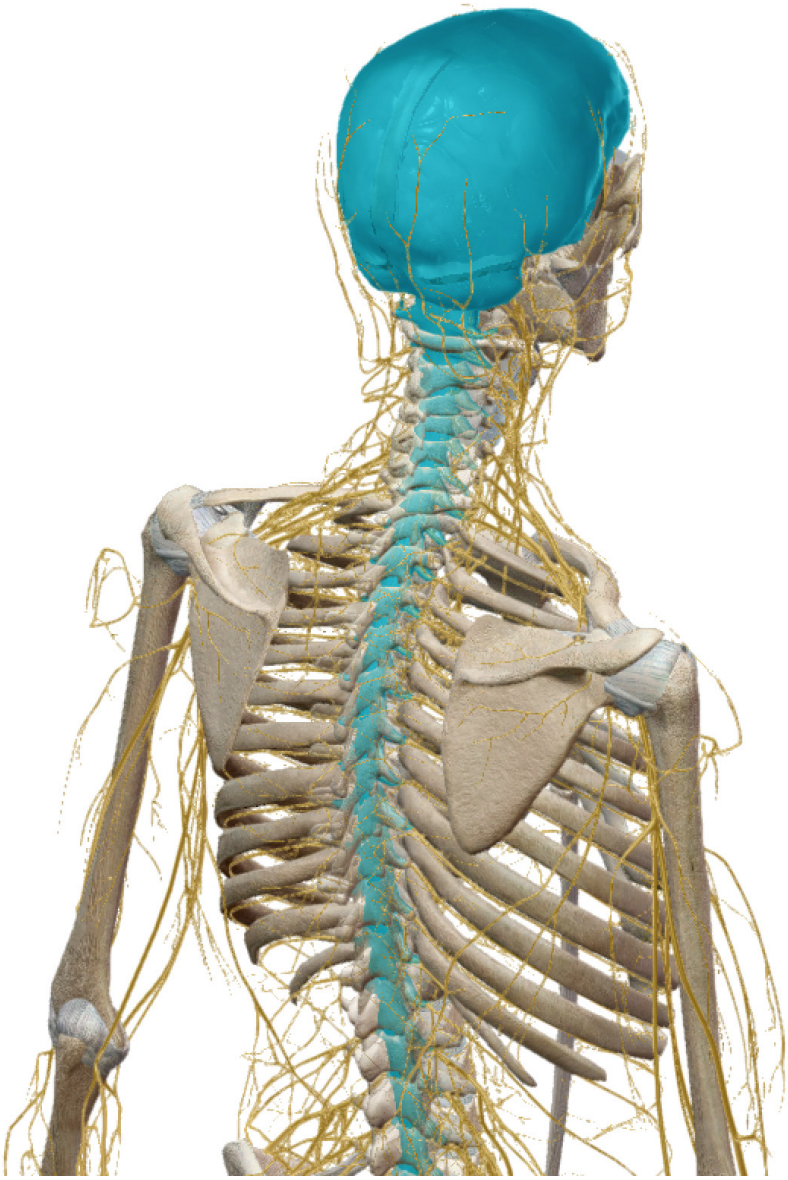
- Cerebrum: is the largest part of the brain and is composed of the right and left hemispheres.
- Cerebellum: is located under the cerebrum.
- Brainstem: acts as a relay centre connecting the cerebrum and cerebellum to the spinal cord.

## The Organisational Structure of the Nervous System



## Subdivisions of the Nervous System

## The Central Nervous System



The central nervous system consists of the brain and spinal cord and is responsible for all conscious and unconscious decision making. The brain has a huge capacity – far greater than any computer – and controls dozens if not hundreds of bodily functions simultaneously.

The brain is made up of two hemispheres, the cerebrum, the cerebellum and several other parts, all of which have very specialist functions. For example, the cerebellum's main job is controlling the actions of your muscles and storing memories. The brain is safely contained within your skull or cranium and is surrounded by a layer of fluid and fat, which protects it from impact.

The spinal cord is responsible for controlling reflex reactions and also provides the means for connecting the brain to the nerves that supply the rest of the body. It comprises of cervical, thoracic, lumbar and sacral segments which are all named after the section of the vertebral column through which they pass.

## The Peripheral Nervous System

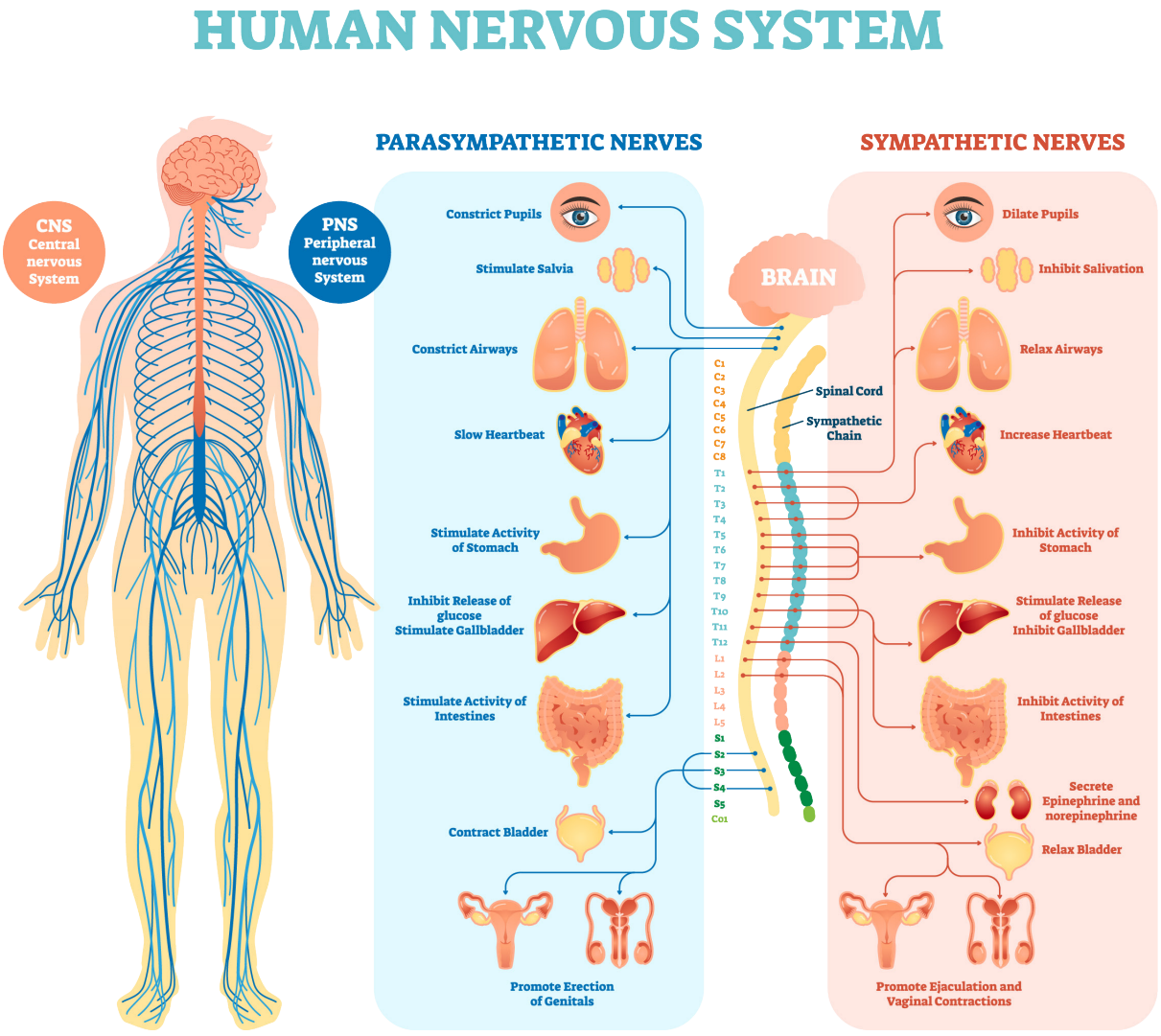
The peripheral nervous system is the name used to describe all of the branches of nerves outside of the central nervous system.

The PNS transmits information to and from the CNS and is divided into motor nerves and sensory nerves – also called neurons.

Motor neurons transmit impulses from the CNS to organs, glands and muscles. These impulses will cause the muscles to contract and organs and glands to do their specialist jobs. Motor nerves exit the anterior or front of the spinal cord and essentially "flow away" from the CNS.

In contrast, sensory neurons, which attach to the posterior aspect of the spinal cord, flow toward the CNS and relay information such as the position of the limbs, core temperature, texture, taste and smell.

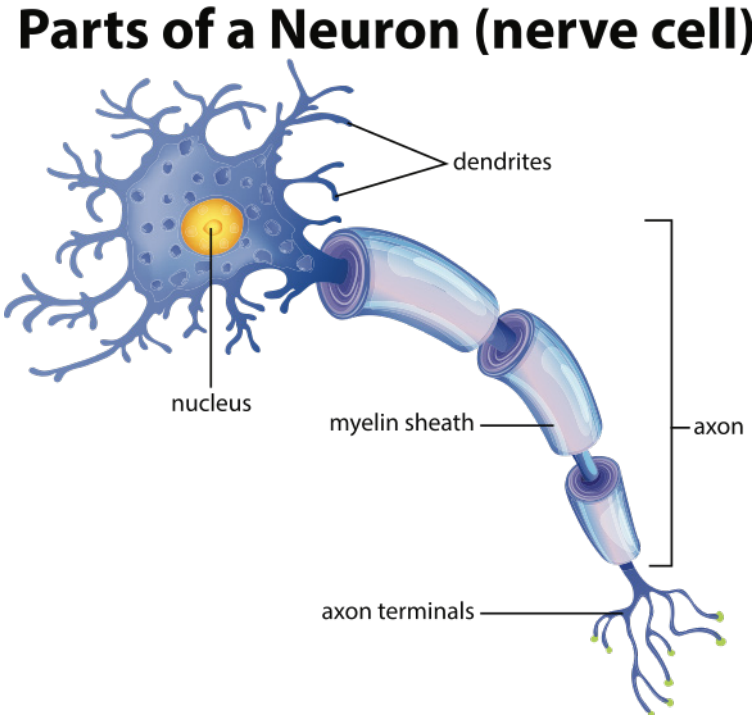
Information is constantly flowing to and from the CNS via the sensory and motor neurons. Both motor and sensory neurons play an important role in muscle contractions.



## Structure of the Neuron

The basic cellular unit of the nervous system is the nerve cell or neurons. Neurons are designed to transmit information rapidly in response to changes inside and outside the body. They differ in size and shape according to their function and location within the nervous system, but all neurons have different characteristic components:

- A cell body which sustains the metabolic activities of the cell and contains the nucleus.
- The Axon that transmits information away from the cell body and is coated with a myelin sheath for protection. Nodes along with the myelin sheath help to speed up the impulses. The sheath and nodes are covered in a protective outer membrane. The Axon terminals are specialised to release the neurotransmitters.
- Dendrites are located on the cell body to receive information, or, at the end of the axon to pass information to the next neuron. The pre-synaptic membranes of the dendrites hold chemical (neurotransmitters), that will be released in the synaptic cleft. Once these chemicals come into contact with the post-synaptic membranes of the next neuron, that neuron will be stimulated.
- The Myelin Sheath is a protective covering that surrounds fibres called axons, the long thin projections that extend from the main body of a nerve cell or neuron. The main function of myelin is to protect and insulate these axons and enhance their transmission of electrical impulses.
- Neurotransmitters are packaged into synaptic vesicles that cluster beneath the Axon terminal membrane on the presynaptic side of a synapse.




Individual neurons convey information by conducting electrical impulses; however, electrical information does not pass from one neuron to another. Communication between separate neurons occurs chemically in the synaptic cleft between neurons. An impulse will be picked up by the cell body and passed down the axon into the dendrites.

When a neuron is at rest, the outside of its membrane will be positively charged, and the inside is negatively charged. This is known as 'membrane potential'. The high concentration of excess sodium ions outside the neuron membrane cannot enter the cell. Potassium ions line the inside of the cell membrane.

Stimulation of the neuron will result in a brief change in a segment of the neuron, known as depolarisation. As the cell membrane depolarises it becomes very permeable allowing sodium ions to rush into the neuron creating a positive charge on the inside in that segment, while the outside becomes negatively charged. This is called the action potential and as they pass along the nerve, segments will return to their original priority.

## Neurotransmitters

The membranes of the dendrites have small sacs containing chemicals called neurotransmitters. Once these membranes are stimulated by the action potential the chemicals are released into the synaptic cleft where they will bind with or be absorbed by the post-synaptic membrane.

Neurotransmitters can work in two ways;

- **Transmitting the action potential across the synaptic cleft and therefore having a stimulatory effect or slowing.**
- **Or preventing the transmission of the action potential, having an inhibitory effect. The neurotransmitters, like the accelerator and brakes in a car, maintain balance within the nervous system.**

## Motor Units

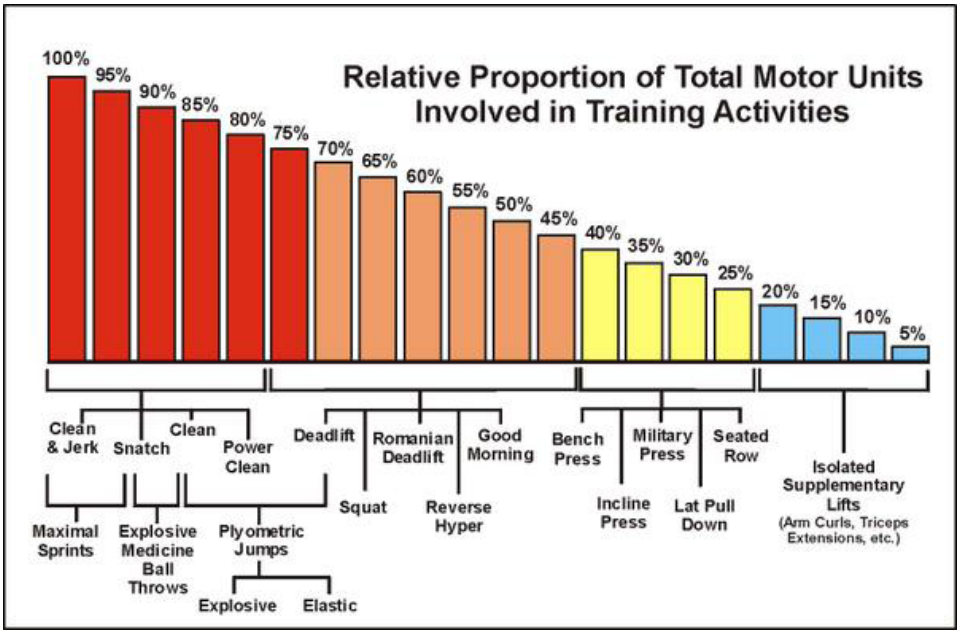
Muscles are made up of bundles of muscle fibres and these fibres are arranged into groups called motor units. A motor unit consists of anywhere between 10 and 1000 muscle fibres and the motor neuron that innervates or supplies it. The number of fibres present in a motor unit depends on its location and function but, irrespective of where it is located, all muscle fibres within the motor unit are activated by the same, single motor neuron.

All the muscle fibres innervated by the motor neuron will either work together at the same time or not at all. This is commonly referred to as the "all or nothing" law. Once sufficient stimulus is received from the motor neuron, all the muscle fibres within the motor unit will contract with 100% of their contractile ability or not at all.

Muscles contain many motor units; the bigger the muscle, the more motor units are likely to be present. The more motor units that are innervated at the same time, the more force will be produced.

If a lot of force is required, i.e. lifting a heavy weight, a large number of motor units will work together. If, however, a smaller amount of force is needed, fewer motor units will be innervated. At no point do motor units work at anything less than 100% of their contractile ability; force variation is the result of more or fewer motor units being recruited.

If a muscular task takes an extended period of time, motor units are recruited sequentially or, in other words, one after another. That way, as one motor unit fatigues, another one will take over. In examples of very low intensity activity, e.g. walking, this sequential recruitment can be almost never-ending but in more intense activities, e.g. a set of press-ups, work finishes when all motor units are exhausted.

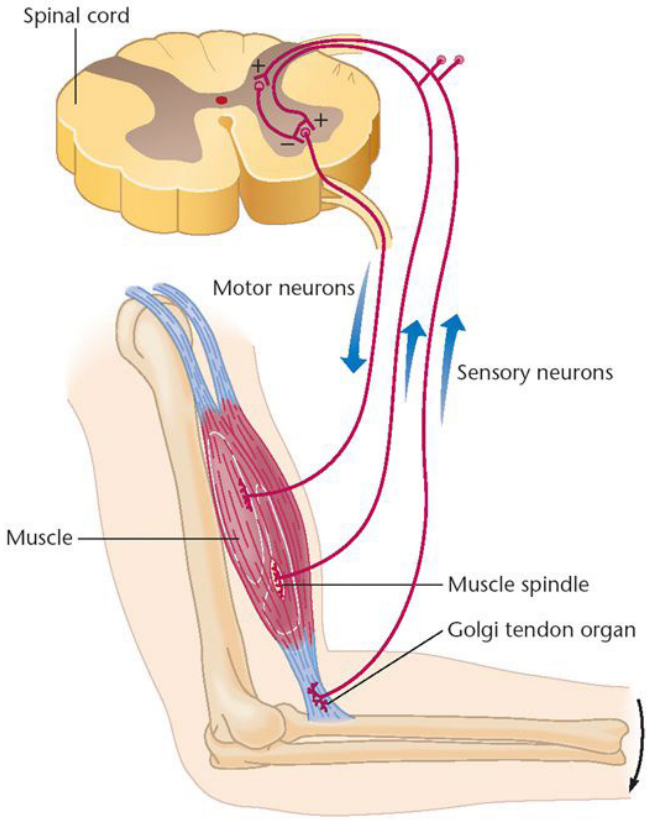



The number of motor units that can be innervated or switched on at the same time varies from person to person and is a trainable characteristic. A beginner might only be able to innervate 50% of his or her total motor units whereas a more advanced exerciser might be able to innervate 70% or more. This helps to explain why two people who have the same amount of muscle can have such different levels of strength.

Beginner exercisers often experience rapid increases in strength not because their muscles get bigger but simply because their nervous systems become more adept at innervating a larger number of motor units simultaneously.

While exercise "teaches" the nervous system to work more efficiently so that more motor units can be innervated simultaneously, in order to protect bones, muscles and connective tissue from injury, it is not possible to recruit all motor units at the same time. This limitation is controlled by the Golgi tendon organ.

## Responses Of The Neuromuscular System To Exercise




Exercise has a profound effect on all the systems of the body, not least the neuromuscular system. Changes can be acute or short term (i.e. during the training session) or chronic or long term (i.e. as a result of several weeks or months of training).

### ACUTE CHANGES

During a workout, the following may occur:

- Vasodilation of blood vessels and capillaries to facilitate increased blood flow.
- Blood diverted away from non-essential organs to working muscles.
- Increased temperature.
- Reduced nervous inhibition.

### CHRONIC CHANGES

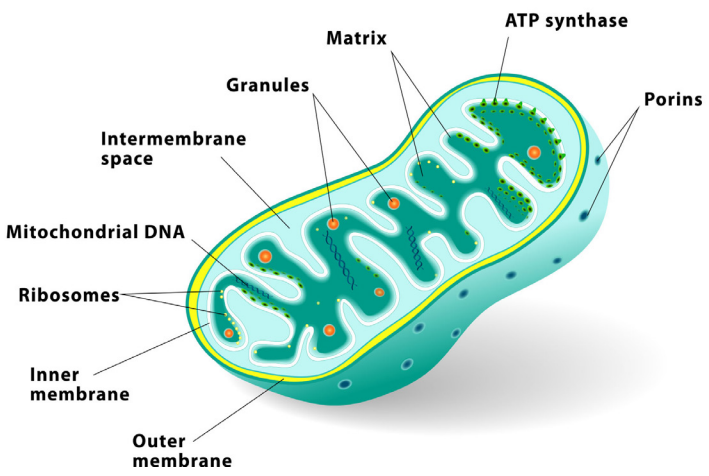
The changes experienced by the neuromuscular system depend on several factors including:

- Exercise frequency.
- Exercise duration.
- Exercise volume.
- Exercise intensity.
- Exercise modality.

## LONG TERM ADAPTATIONS TO RESISTANCE TRAINING INCLUDE:

- The increased cross-sectional size of muscles (hypertrophy).
- Improved balance and coordination.
- Increased strength due to hypertrophy.
- Increased strength due to decreased nervous inhibition.
- Increased glycolytic activity allowing more high-intensity work to be performed.
- Increased size of glycogen stores.

## MITOCHONDRION




## LONG TERM ADAPTATIONS TO AEROBIC EXERCISE INCLUDE:

- An increase in the size and number of energy-producing mitochondria.
- An increase in capillarisation surrounding muscle fibres and at the alveoli.
- An increase in aerobic enzyme activity stored glycogen and triglycerides in the muscle fibres.

# Connective Tissue

## MODULE 2:
## THE VERTEBRAE, CONNECTIVE TISSUES, MACROS AND MICRONUTRIENTS

### Introduction

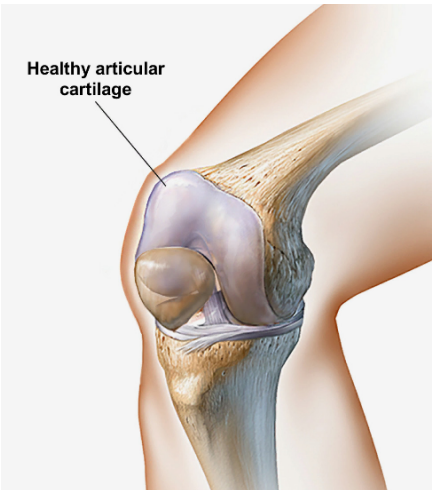
Connective tissue, supports, connects, surrounds, or separates different types of tissues and organs in the body. The bones of the human skeleton form the basic framework for the entire body but need a series of other structures to give the body its shape and functionality.

These structures are:

- Cartilage
- Ligaments
- Tendons

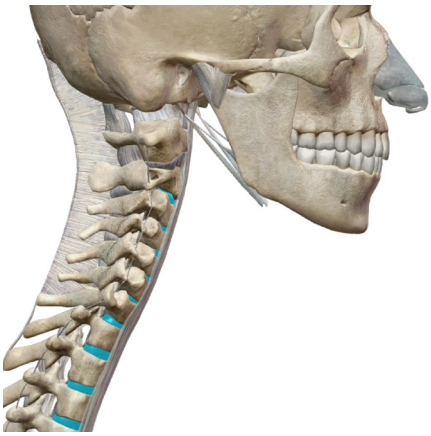
## *Cartilage*

Three types of cartilage found in the body perform separate functions. It is very tough, dense, and fibrous, and these characteristics allow it to withstand great forces of torsion and compression. Despite its strength, it can be worn over time or torn during trauma and has a limited ability to heal itself due to it having no blood vessels of its own therefore a lack of blood supply.



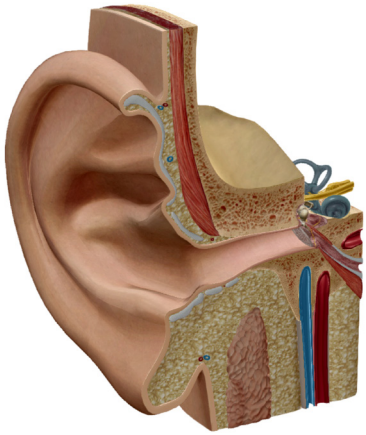

### *HYALINE (ARTICULAR) CARTILAGE*

- The most common type
- Covers the ends of bones
- Glossy blue-white in appearance
- Present in synovial and cartilaginous joints
- Very tough
- Smooth and becomes slippery
- Reduces friction during joint movement



### *FIBROCARTILAGE*

- Found in inter-vertebral discs, joint capsules, and ligaments
- The strongest type of cartilage
- Can act as a shock absorber in joints

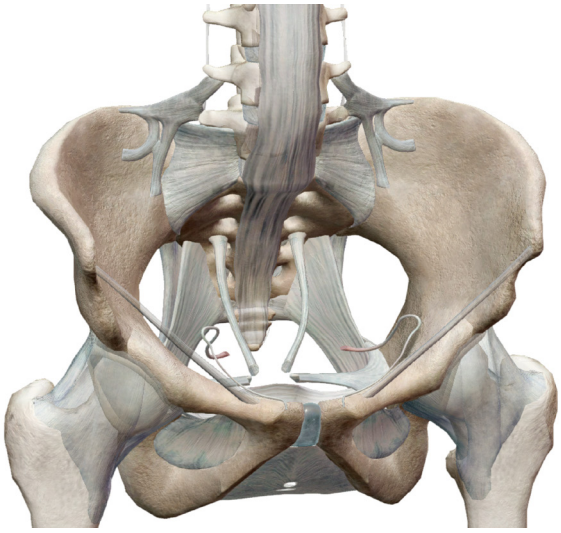


### *ELASTIC CARTILAGE*

- Found in the external Ear, Epiglottis and Larynx
- It has a threadlike network of fibres which contain Elastin
- Elastic properties allow it to return to its original shape
- Also has collagen fibres to give it strength

## *LIGAMENTS*

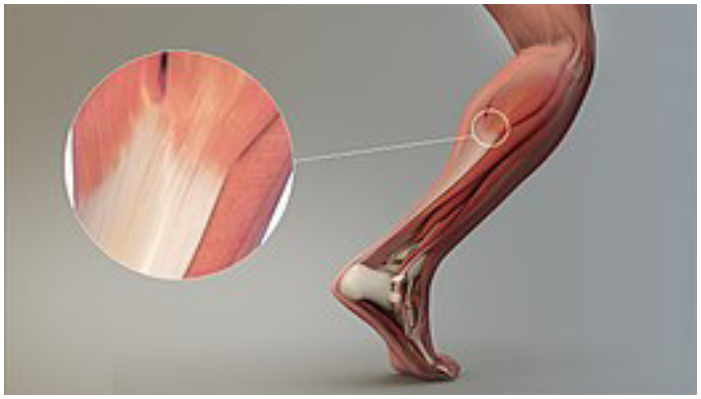
Ligaments are white in colour and extremely tough. Their non-elastic fibrous tissue can be either cord-like or strap-like in construction and provide stability to joints. Ligaments help to guide joints through normal movement patterns and also prevent unwanted movement. This means they can endure great tension being placed upon them, although excessive tension can cause damage which is referred to as a tear or sprain.



- **Connect bone to bone.**
- **Provide joint stability.**
- **Aid joint movement.**
- **Prevent unwanted movement.**

## *TENDONS*

Tendons are similar to ligaments in construction. They too can be cord-like or strap-like in construction. Their role is to transmit the forces produced by muscles to allow the bones to act as levers. One tendon can be responsible for the actions of multiple muscles. Tendons are extremely tough but can be placed under excessive tension which can cause damage, referred to as a tear or strain.



- **Connect muscle to bone.**
- **Enable transmission of force produced by muscles.**

## Blood Supply

Cartilage has a very limited blood supply which means that when damaged it is unlikely to repair. It is common for damaged cartilage to be removed as a surgical procedure. Ligaments have a limited to no blood supply provided from their attachment sites to bone.

Therefore the healing time is slow in comparison to tendons which have a far greater blood supply gained from the surrounding soft tissues to which they are attached.

# Macronutrients: Carbohydrates

## *MODULE 2:*
## *THE VERTEBRAE, CONNECTIVE TISSUES, MACROS AND MICRONUTRIENTS*

Carbohydrates, also known as carbs or simply CHO, are a controversial topic in popular nutrition with a clear divide between the high carb and the low carb camps. In truth, both low and high carb dietary approaches can work – it very much depends on your personal preferences, activity levels, fitness goals, bioindividuality and, of course, your likes and dislikes. Rather than dwell on the high or low carb argument, this section will focus on a general overview of carbohydrate and its role in your body.

## What Is A Carbohydrate?

Carbohydrates are plant foods that are made up of sugar molecules called saccharides. Saccharides are found singularly, in pairs and in complicated chains. The structure of a carbohydrate dictates how it is categorised.

Carbohydrates provide four calories of energy per gram or around 16.8 kilojoules and are the preferred source of energy for your brain and higher intensity activities such as weight lifting and sprinting. On consumption, all digestible carbohydrates are broken down into glucose.

### CARBOHYDRATES ARE FOUND IN THREE BASIC CATEGORIES:

- **Simple carbohydrates: also known as sugars.**
- **Complex carbohydrates: also known as starches.**
- **Non-Starch polysaccharides (NSP): also known as fibre.**

## Simple Carbohydrates

Simple carbohydrates can be found in two forms – **monosaccharides** or **disaccharides.**

**Monosaccharides consist of single saccharide molecules.**

**Disaccharides are pairs of molecules joined together.**

Simple carbohydrates are often referred to as sugars which carries a negative connotation and implies all simple carbohydrates are bad for you.

| Monosaccharides (1 - Sugar Unit) | Disaccharides (2 - Sugar Units) |
|---|---|
| Glucose (dextrose) | Sucrose |
| Fructose (fruit sugar) | Lactose |
| Galactose | Maltose |

| There are three primary monosaccharides | Which make up these three common disaccharides. |
|---|---|
| Glucose | Sucrose = (glucose and fructose) |
| Fructose | Lactose = (glucose and galactose) |
| Galactose | Maltose = (glucose double bonded to glucose). |

| Healthy: Fruit | Less healthy: sweets |
|---|---|
| Contains fructose and glucose in varying amounts | Contains more than 15g of sugar per 100g of food (FSA) |
| Contains vitamins, minerals and fibre | Contains low quality, processed fats |
| Contains anti-oxidants and phytochemicals | High energy/low nutrient ratio |
| Contains trace amino acids | Has an adverse effect on blood glucose and insulin levels |
| Much healthier than refined sugars | Contains no fibre |

## Complex Carbohydrate

Complex carbohydrates are made from multiple chains of saccharide molecules called polysaccharides – poly meaning many. Polysaccharides are also called starches. Starches make up the greatest percentage of most people's food intake and can be found in bread, rice, pasta, vegetables and grain-based foods. Like simple carbohydrates, complex carbohydrates can be refined or unrefined.

| Sources of refined complex carbohydrate | Sources of unrefined complex carbohydrate |
|---|---|
| White bread | Wholemeal/wholegrain bread |
| White pasta | Wholegrain/wild rice |
| White bread | Fresh and frozen vegetables |
| White rice | Pulses |
| **Properties** | |
| Contains more than 15g of sugar per 100g of food (FSA) | Contains fructose and glucose in varying amounts |
| Contains low quality, processed fats | Contains vitamins, minerals and fibre |
| High energy/low nutrient ratio | Contains anti-oxidants and |
| Has an adverse effect on blood glucose and insulin levels | phytochemicals |
| Contains little or no fibre | Contains trace amino acids |
| Likely to cause overeating | Much healthier than refined carbohydrates |

## Refined Versus Unrefined

Digestible carbohydrates can be further subdivided into two categories: unrefined and refined

**Refined carbohydrates** have been through more processing than unrefined carbs and, subsequently, are often stripped of much of their nutritional value. White bread, white rice, white pasta and sugary sweets are good examples of refined carbohydrates.

**Unrefined carbohydrates** have gone through very little in the way of processing and, subsequently, contain larger amounts of vitamins, minerals and fibre than refined carbohydrates. Examples of unrefined carbs include brown rice, brown pasta, wholemeal bread and fruit. Both simple and complex carbs can be unrefined or refined.

| There are three primary monosaccharides | Which make up these three common disaccharides. |
|---|---|
| Glucose | Sucrose = (glucose and fructose) |
| Fructose | Lactose = (glucose and galactose) |
| Galactose | Maltose = (glucose double bonded to glucose). |

| Healthy: Fruit | Less healthy: sweets |
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| Contains anti-oxidants and phytochemicals | High energy/low nutrient ratio |
| Contains trace amino acids | Has an adverse effect on blood glucose and insulin levels |
| Much healthier than refined sugars | Contains no fibre |

The energy contained in carbohydrates cannot be released without vitamins and minerals, the most important being the B vitamins. Eating lots of refined carbohydrates, which are devoid of many vitamins, can cause depletion of vitamin and mineral reserves which makes it hard for the body to utilise carbohydrate for fuel.

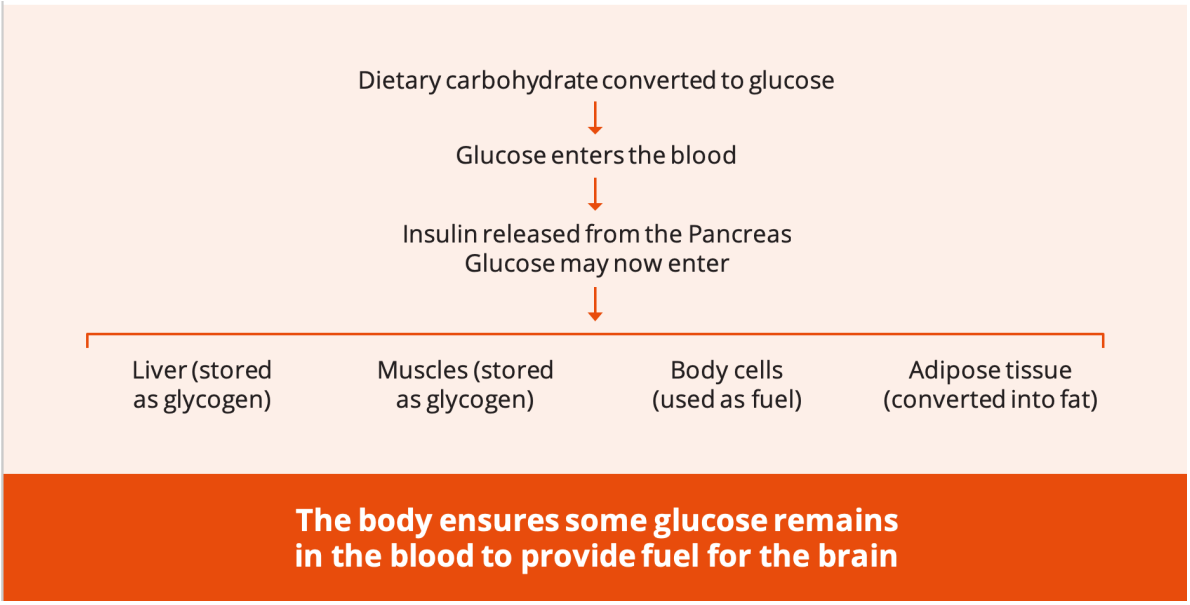
For this reason, heavily refined carbohydrates are often referred to as anti-nutrients or nutrient-robbers as they require vitamins but do not contain any.

## The Fate Of Dietary Carbohydrate

Whatever type of carbohydrate you consume; all carbohydrate is broken down by digestive enzymes called pancreatic and salivary amylase and turned into glucose. Your body has a number of different uses for glucose.

Once digested, glucose enters your bloodstream and stimulates your pancreas to release the hormone insulin. Insulin acts like a key to unlock your cells and allows the glucose to enter various tissues. Glucose is stored for later use in the form of glycogen, used for fuel or if there is an excess, converted to fat.

A small amount of glucose also remains in your blood and is the primary fuel for your brain. Glycogen is locked into your liver or muscles. Liver glycogen provides a reservoir of glucose for your brain whereas muscle glycogen provides energy for contractions by the muscles in which it is stored.




**The body ensures some glucose remains in the blood to provide fuel for the brain**

## The Glycemic Index

It's clear then, considering refined and unrefined, simple and complex carbohydrates, not all carbohydrates have been created equal and some sources of carbs are definitely healthier than others in terms of nutritional density. It's easy enough to select which carbohydrates contain the least amount of refined sugars and the greatest number of micronutrients but there is yet another way that carbohydrates are classified; **The Glycemic Index.**

The glycemic index is a scoring system that rates carbohydrates according to the speed at which they are digested and converted into blood glucose.

The glycemic index uses a 1 to 100 scale. Fast-acting carbohydrates score very high on the scale while slower acting carbohydrates get more moderate (medium) to low scores. The glycemic index gives you a good indication of what carbohydrates to eat and when. There are numerous interpretations of what constitutes a low, medium (moderate) or high glycemic index but the chart below is fairly representative of the norm.

# Glycemic Index

### Low GI (<55), Medium GI (56-69) and High GI (70>)

| Grains / Starchs | | Vegetables | | Fruits | | Dairy | | Proteins | |
|---|---|---|---|---|---|---|---|---|---|
| Rice Bran | 27 | Asparagus | 15 | Grapefruit | 25 | Low-Fat Yogurt | 14 | Peanuts | 21 |
| Bran Cereal | 42 | Broccoli | 15 | Apple | 38 | Plain Yogurt | 14 | Beans, Dried | 40 |
| Spaghetti | 42 | Celery | 15 | Peach | 42 | Whole Milk | 27 | Lentils | 41 |
| Corn, sweet | 54 | Cucumber | 15 | Orange | 44 | Soy Milk | 30 | Kidney Beans | 41 |
| Wild Rice | 57 | Lettuce | 15 | Grape | 46 | Fat-Free Milk | 32 | Split Peas | 45 |
| Sweet Potatoes | 61 | Peppers | 15 | Banana | 54 | Skim Milk | 32 | Lima Beans | 46 |
| White Rice | 64 | Spinach | 15 | Mango | 56 | Chocolate Milk | 35 | Chickpeas | 47 |
| Cous Cous | 65 | Tomatoes | 15 | Pineapple | 66 | Fruit Yogurt | 36 | Pinto Beans | 55 |
| Whole Wheat Bread | 71 | Chickpeas | 33 | Watermelon | 72 | Ice Cream | 61 | Black-Eyed Beans | 59 |
| Muesli | 80 | Cooked Carrots | 39 | | | | | | |
| Baked Potatoes | 85 | | | | | | | | |
| Oatmeal | 87 | | | | | | | | |
| Taco Shells | 97 | | | | | | | | |
| White Bread | 100 | | | | | | | | |
| Bagel, White | 103 | | | | | | | | |



High glycemic foods such as sugary cereals, refined grain products and confectionery are quickly digested and converted to usable glucose. This makes them ideal if you need a quick burst of energy during or just before a workout or want to refuel as fast as possible after a workout.

Low glycemic index foods such as beans, apples, most dairy and porridge oats take longer to digest and will release their energy slower. This means that you tend to feel fuller for longer after eating low glycemic index carbohydrates and experience more stable energy levels throughout the day as a result.

As with all of your food choices, try to select the most nutritionally dense form of carbohydrate that you can. Although all carbohydrates provide energy, they are by no means equal in terms of vitamin, mineral and fibre density. Given the choice between a fresh apple and a cookie, the apple should be your food of choice – most of the time anyway.

## Fibre


Fibre is part of the carbohydrate group and is present to one degree or another in all grains, fruits, vegetables, pulses, legumes and nuts. Technically a non-starch polysaccharide or NSP for short, the human digestive systems lacks the necessary enzymes to break fibre down and so, as far as we are concerned, fibre is a calorie-free food.

Animals that can extract energy from fibre have more than one stomach or have the ability to produce specialised enzymes so they can digest this tough plant-derived starch. For humans, although fibre does not contribute any energy to your daily diet, it provides numerous other health-related benefits.

## Types of Fibre

Fibre can be classified as soluble or insoluble. This refers to its interaction with water.

Soluble fibre forms a gel-like substance as it passes through your digestive tract. Like a dry sponge, it soaks up liquid as it passes through your intestines and absorbs small but significant amounts of bile acid, cholesterol and fat in your digestive system. Soluble fibre is found in the soft flesh of fruits, vegetables and grains.

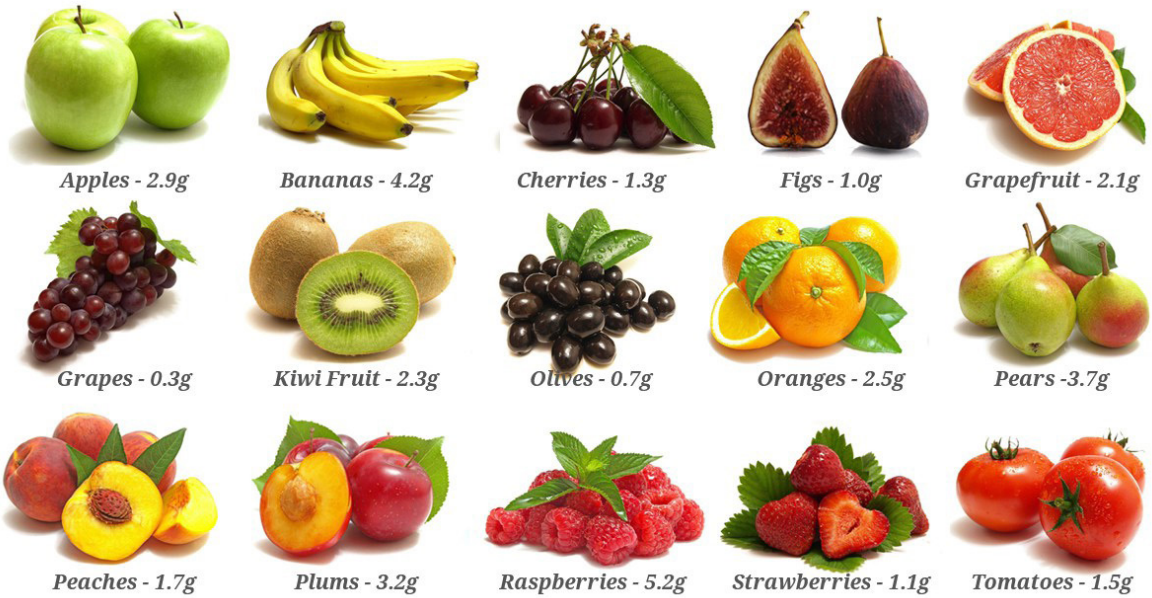
Insoluble fibre is sometimes called roughage and is found in the tough outer husk of grains as well as the skins of vegetables and fruit. Insoluble fibre passes through your digestive system like an old-fashioned bottle brush and gives it a good internal scrubbing

# Fibre Requirements

Despite being calorie and nutrient-free, fibre offers a wide range of health benefits. The RDA (recommended daily allowance) for fibre is around 35 grams per day, split evenly between soluble and insoluble varieties.

Your total daily fibre requirement varies according to your age, weight and the amount of food you are eating which is why you may often see a recommended range for fibre consumption of 24 to 35 grams.

As fibre is calorie-free, there is little harm in making sure you hit the upper ranges of this scale. If you are currently eating too little fibre and decide to eat more, increase your daily fibre intake gradually. Going from a low fibre diet to a high fibre diet overnight is like trying to run a marathon on the first day you take up jogging. Increase your fibre intake slowly and gradually over a few weeks to minimise your chances of suffering digestive discomfort.



## *Lowers cholesterol levels*

Soluble fibre found in beans, oats, flaxseed and oat bran may help lower total blood cholesterol levels by lowering low-density lipoprotein (LDLs), or "bad," cholesterol levels.

Studies also have shown that high-fibre foods may have other heart-health benefits, such as reducing blood pressure and inflammation.

## *Helps control blood sugar levels*

In people with diabetes, fibre; particularly soluble fibre, can slow the absorption of sugar and help improve blood sugar levels. A healthy diet that includes insoluble fibre may also reduce the risk of developing type 2 diabetes.

## *Normalizes bowel movements*

Dietary fibre increases the weight and size of your stool and softens it. A bulky stool is easier to pass, decreasing your chance of constipation.

If you have loose, watery stools, fibre may help to solidify the stool because it absorbs water and adds bulk to stool.

## *Helps maintain bowel health*

A high-fibre diet may lower your risk of developing haemorrhoids and small pouches in your colon (diverticular disease). Studies have also found that a high-fibre diet likely lowers the risk of colorectal cancer. Some fibre is fermented in the colon. Researchers are looking at how this may play a role in preventing diseases of the colon.

## *Aids in achieving a healthy weight*

High-fibre foods tend to be more filling than low fibre foods, so you're likely to eat less and stay satisfied longer. And high-fibre foods tend to take longer to eat and to be less "energy-dense," which means they have fewer calories for the same volume of food.

## *Helps you live longer*

Studies suggest that increasing your dietary fibre intake; especially cereal fibre, is associated with a reduced risk of dying from cardiovascular disease and all cancers.

As previously discussed, fibre is calorie-free. This means that foods that contain a lot of fibre such as whole grains, fruits and vegetables are generally lower in calories than less fibrously-dense foods. To put this in perspective, an apple and a typical biscuit both contain around 60 calories. Because much of the mass of the apple is made up from calorie-free fibre and water, compared to sugar and fat in the biscuit, the apple is bigger, far more filling and much more satisfying to eat. Most of us can eat a few biscuits in a single serving but it's pretty unlikely you'll eat the same number of apples! Filling up on fibre is a great way to prevent overeating.

Stretch receptors in your stomach send signals to your brain when it is full so you know when to stop eating. This message can take as long as 30 minutes to be sent and received. Fibrous foods cause greater gastric distension than non-fibrous foods. Simply put, this means you feel fuller quicker, which results in your brain getting the "stop eating" signal sooner than usual. This limits your potential for overeating.

In addition to being low in calories, fibrous foods generally take longer to chew and eat and keep you feeling fuller for longer. Fibre is a major gastric inhibitor. This simply means that fibre delays the emptying of your stomachs contents into your small intestine. The longer food stays in your stomach, the longer you feel full.

A real-world example of this phenomenon is Chinese food. It's an old truism that after eating a Chinese meal, 20 minutes later you are hungry again. Why? White rice! White rice is mostly devoid of fibre and subsequently passes out your stomach and into your small intestine very rapidly. This means you can go from feeling full to feeling empty very quickly.

By delaying gastric emptying, fibre also helps to control your blood glucose levels. Large fluctuations in blood glucose trigger corresponding fluctuations in insulin levels. Roller coasting blood glucose levels play havoc with your hunger. A rapid drop in blood glucose can often result in cravings for carbohydrate (one reason never to go grocery shopping on an empty stomach) so by ensuring that your stomach empties slowly, fibre helps ensure that your blood glucose levels remain relatively stable.

## Refined Sugars


In many cases, the list of ingredients in processed and refined foods includes refined sugars. Refined sugars are very sweet, mildly addictive, contain empty calories and help increase sales.

They are strongly linked to diabetes and obesity and are best avoided where possible.

## Common Refined Sugars and Sweeteners

- **Dextrose**
- **Glucose syrup**
- **High fructose corn syrup**
- **Glucose-fructose syrup**
- **Inverted sugar syrup**
- **Mannitol**
- **Xylitol**
- **Sorbitol**
- **Maltodextrin**

In addition to these caloric sweeteners, there are several low calorie and calorie-free sweeteners in current use including stevia, aspartame, saccharin and acesulfame K.

Low and no-calorie sweeteners are often used in "diet" products but are a very controversial subject as many are linked to things like high blood pressure, seizures, depression, numbness, aching muscles, diarrhoea, headaches, rashes, hyperactivity and even cancers. It is safe to say that switching from sugar to using artificial sweeteners instead is not an automatically healthy option.

In addition to artificial sweeteners, another less-than-healthy but common food additive is the flavour enhancer monosodium glutamate or MSG for short. MSG has mildly addictive qualities and increases appetite so its inclusion is likely to increase the amount of food eaten; good for profit margins but not so good for your waistline.

### VARIANTS/INDICATORS OF THE PRESENCE OF MSG INCLUDE:

- Yeast extract
- Hydrolysed protein
- Whey protein isolate
- Soy protein isolate
- Carrageenan
- Some "natural" flavourings

## Digestive Health

The hollow tubes of your intestines are made of smooth muscle and like the muscles of your chest, arms and legs, benefit from a regular workout. Fibre provides the means to exercise your digestive system. A diet devoid of fibre will result in poor intestinal health in the same way that a lack of exercise will result in a flabby, weak body.

To push food through your digestive system, the smooth muscular tubes that make up your digestive tract must squeeze inward in an action called peristalsis. Picture a snake swallowing an egg and the wave-like undulations as the snake squeezes the egg down the length of its body – that's peristalsis.

Low fibre foods do not travel through your hollow digestive tubes very easily. A large amount of pressure is required to push food along.

Imagine trying to get the very last bit of toothpaste out of the tube – it's a real challenge! Fibre adds bulk to your food and, consequently, it passes through your digestive system much more easily and with far less pressure.

Easy food passage and reduced food transit time (the time it takes from ingestion to elimination) has a major impact on digestive health and is strongly linked to a lower incidence of diverticular disease, also known as diverticulitis. This is a painful and serious medical condition where bacteria-filled bulges develop in the walls of your intestines. By consuming adequate fibre, intestinal pressure is kept to a minimum and there is much less likelihood of developing this unpleasant disease.

## Getting Enough

While getting enough fibre is very important, supplementation is seldom the best way. Fibre supplements such as bran and psyllium husks do indeed provide fibre but they do not provide any of the other nutritious benefits associated with eating fibrous fruits, vegetables and whole grains; specifically vitamins and minerals.

An over-reliance on fibre supplements may actually result in a vitamin and mineral deficiency. The best way to get enough fibre in your diet is to eat a wide variety of fruit, vegetables, grains and other natural food.

Refined foods such as white bread, white rice, white pasta and processed meals contain very little fibre so, wherever possible, search for foods in their most natural and unprocessed state. Simply following the old advice of eating an apple a day is one way to make sure you are on your way to getting enough essential fibre in your diet.

## Whole sources of carbohydrate

| Whole Sources of Carbohydrates | Amount per 100g | Additional Information |
|---|---|---|
| Carrots (Baby) | 6g | N/A |
| Carrots (Tinned) | 4.4g | Tinned in water |
| Banana | 20.3g | N/A |
| Strawberries (Fresh) | 6g | N/A |
| Strawberries (Frozen) | 6g | N/A |
| Mango (Fresh) | 13.6g | N/A |
| Mango (Dried) | 74.7g | N/A |
| Flour (Plain) | 73.5g | N/A |
| Flour (Wholemeal) | 59.4g | N/A |
| Bread (White) | 46.4g | Warburtons 'Toastie' |
| Bread (Wholemeal) | 37.8g | Hovis "Wholemeal' |
| Potatoes (Maris Piper) | 17.5g | N/A |
| Potatoes (New/Baby) | 14.9g | N/A |
| Rice (Basmati) | 32.3g | N/A |
| Rice (Brown) | 36.9g | N/A |
| Pasta (White) | 35.7g | Fusili |
| Pasta (Brown) | 32.9g | Fusili |
| Baked Beans | 12.5g | Heinz |
| Lentils | 9.4g | Red Split |
| Milk ** | 4.8g per 100ml | Semi-Skimmed/2%/Green |
| Natural Yoghurt (Plain) ** | 6.8g | N/A |
| Digestive Biscuit | 63.6g | N/A |

* Colours are representative of their location within the eat-well plate.
** Whilst the highlighted dairy products do not contain starch, they do contain fast acting sugars in greater amounts than the other macronutrients.

ORIGYM

# Macronutrients: Proteins

## *MODULE 2:*
## *THE VERTEBRAE, CONNECTIVE TISSUES, MACROS AND MICRONUTRIENTS*

Protein is an organic compound that serves many functions in the body. Protein contains four-calories or 16.8 kilojoules of energy per gram, protein is a vital nutrient that makes up a large amount of your body's tissues including your hair, skin, nails, and bones and, of course, your muscles. It is also an important factor in controlling homoeostasis and can, under certain circumstances, be used for fuel.

The word protein is derived from the Greek word for primary or first – proto and is made up of smaller units called amino acids. Amino acids can be thought of as the protein alphabet although, unlike the 26 letters in the English alphabet, there are only 20 amino acids. When digested, protein is broken down into these amino acids which are then re-ordered and re-built back into usable proteins for use in the body.

## Peptides

Animal and plant amino acids are joined together to make substances called peptides. This process results in chains of amino acids of varying length. When the chain of amino acids is long or complex enough, it forms a protein. To be considered a protein, the polypeptide chain must contain 100 or more amino acids.

| Peptides | | |
|---|---|---|
| **Two amino acids** | Dipeptide | Di meaning two |
| **Three amino acids** | Tripeptide | Tri meaning three |
| **4-9 amino acids** | Oligopeptide | Oligo meaning few |
| **10 or more amino acids** | Polypeptide | Poly meaning many |

# Amino Acids

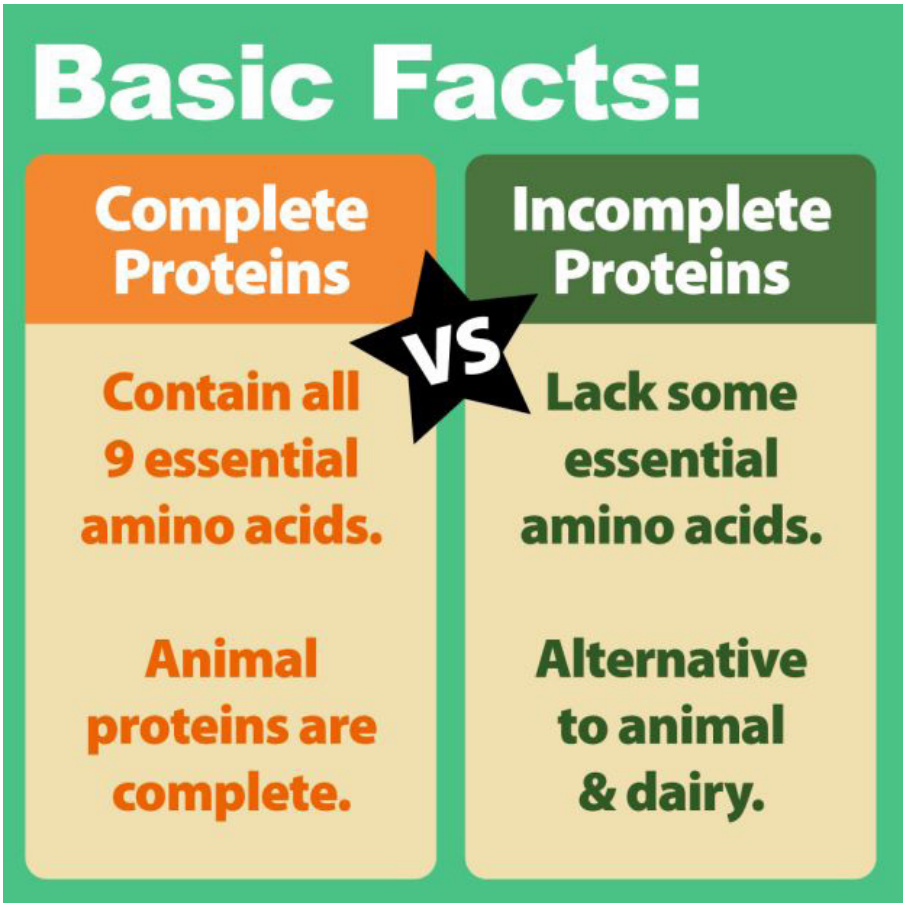
Of the 20 amino acids, nine are classified as essential while eleven are classified as non-essential or conditionally essential. The nine essential amino acids must be present in the food you eat while the remaining eleven non-essential amino acids are synthesised by your liver providing that the essential amino acids are present in your diet. Non-essential amino acids are also present in some foods and consumption of these foods will "spare" the essential amino acids.

- **Essential (9)**
- **Non-Essential (11)**

| Essential | Conditionally Non-Essential | Non-Essential |
|---|---|---|
| Histidine | Arginine | Alanine |
| Isoleucine | Cystine | Asparagine |
| Leucine | Glutamine | Aspartate |
| Lysine | Glycine | Glutamate |
| Methionine | Proline | Serine |
| Phenylalanine | Tyrosine | |
| Threonine | | |
| Tryptophan | | |
| Valine | | |

*Leucine, Isoleucine and Valine are collectively called the branch chain amino acids and make up approximately 35% of the amino acids found in muscle tissue. For this reason, BCAA supplements are very popular as it is hypothesised that consuming BCAAs can help repair muscle tissue from exercise-induced muscle damage and may reduce muscle soreness. Whether this is true or not, BCAA supplements are popular with many athletes.

## Complete And Incomplete Proteins




Foods that contain adequate amounts of all the essential amino acids are classed as complete.

Complete proteins include eggs, meat, fish, dairy produce, poultry, soy and quinoa. A diet rich in these foods means that you have all the amino acids necessary to synthesise the non-essential amino acids.

Many plants contain a variety of amino acids but are often deficient in some of the essentials and are therefore classed as incomplete proteins. Because they are lacking one or more of the essential amino acids most plant foods are considered to be carbohydrates rather than proteins. Examples include vegetables, seeds, nuts, beans and grains.

## Sources of Protein

| Complete proteins | Incomplete proteins |
|---|---|
| Eggs | Cereals |
| Dairy foods | Grains |
| Poultry | Nuts |
| Fish | Beans |
| Meat | Lentils |
| Soy foods | Seeds |
| Buckwheat | Vegetables |
| Quinoa | |

## Complementary Proteins

Like pieces of a jigsaw, you can slot incomplete proteins together to make a fully-fledged protein. This is important for vegetarians and for people who want to consume non-animal protein sources. It's simply a matter of making sure that, between them, the incomplete proteins supply all of the essential amino acids in sufficient amounts. A protein made up in this way is called a complementary protein and provides a convenient way to obtain adequate dietary protein without having to eat any animal-protein foods. There are a number of food combinations you can use to form a complementary protein.

- **Grains and pulses**
- **Vegetables and nuts**
- **Vegetables and seeds**
- **Grains and dairy**
- **Nuts and seeds**
- **Nuts and pulses**
- **Seeds and pulses**

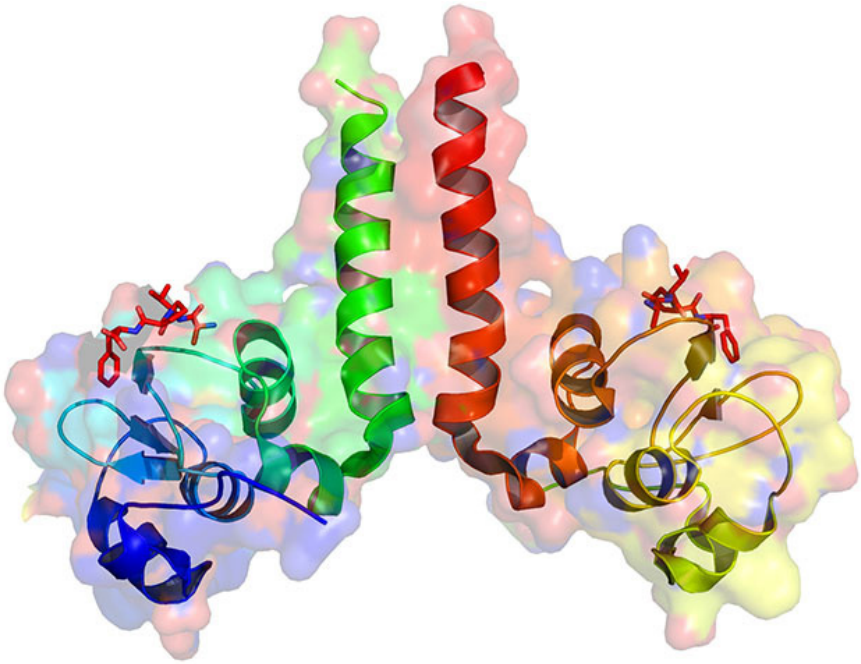
With a little culinary imagination it is possible to turn any of the incomplete proteins listed into a healthy source of complete protein, or, at the very least put some peanut butter on your toast or some nuts in your vegetable stir fry!

However, it's worth noting that complementary proteins do not need to be consumed in the same meal to be effective. In fact, recent research suggests that a viable complete protein can be created from two complementary proteins consumed in the same 24-hour period. Foods that are considered to be complementary proteins will also contain insignificant amounts of carbohydrate which must be considered when calculating energy intake.

## Whole Sources of Protein

## (Where protein is the main macronutrient)

| Whole Sources of Protein | |
|---|---|
| Pork | Fish (cod, kippers) |
| Egg | Poultry (chicken, turkey) |
| Beef | Wild Game (elk, deer, phesant) |
| Tofu | Cottage Cheese |



In addition to dietary protein, there are three other types of protein which are categorised according to their function in the body:

- **Structural proteins** form the framework of many-body components including collagen which is present in bone and connective tissue and keratin which is present in the skin. Muscle tissue, hair and nails are other examples of structural proteins.
- **Homoeostatic proteins** are an integral part of the synthesis of hormones, enzymes and blood cells. These substances regulate various bodily functions and include insulin and adrenalin and infection-fighting white blood cells (WBCs).
- **Fuel proteins** are not the body's preferred source of energy but are a viable source of energy when glycogen (stored glucose) levels start to run low and an alternative source of energy is required e.g. during periods of starvation or during long-duration endurance events. Amino acids can be converted to glucose, fatty acids or a substance called ketones to produce adenosine triphosphate (ATP).

## Necessary Terminology

### *Catabolism*

Catabolism describes the breaking down larger structures into smaller ones in the body; specifically protein.

Exercise, ageing and illness all cause catabolism and some degree of catabolism is happening all of the time inside your body. As cells are broken down, they are built back up using recycled and fresh amino acids. In the case of exercise-induced catabolism, tissue, muscle specifically, is built back bigger and stronger but in the case of age-related catabolism, the repair process is eventually outpaced by the breakdown process and the result is the ageing process.

### *Anabolism*

The process of building within the body, i.e. renewing skin cells or building muscle, is called anabolism. Anabolism primarily occurs during periods of rest and recovery. Characterised by tissue growth, repair and renewal, the process of anabolism requires adequate dietary protein otherwise both health and performance may suffer. Anabolism always follows catabolism – providing there are enough amino acids available to fuel the process.

## Rating Protein

Protein foods are rated in terms of quality using a number of different scales. The various scales evaluate the digestibility of a protein and the availability of essential amino acids.

The greater the amount of the consumed protein that can be utilised by your body, the higher the score will be. Most animal origin proteins such as eggs, meat, fish as well as soya score very highly whereas incomplete proteins score much lower.

The most well-known scale for protein quality is the Biological Value scale or BV for short however other scales include Net Protein Utilisation or NPU, Protein Efficiency Ratio or PER and the Protein Digestibility Corrected Amino Acid Score or PDCAAS. Each rating method is slightly different and uses a variety of criteria for scoring a protein, hence the variance in the chart below.

## Protein Quality Ratings

The chart below shows four different rating methods scientists use to evaluate the quality of several proteins. The higher the number shown in the columns, the better your body uses the protein.

**B.V. (Biological Value):** is the proportion of absorbed protein that is retained in the body for maintenance and/or growth. The highest score of 100 was given for the best protein at the time, egg. However, whey protein came along and proved even better than an egg.

**P.E.R. (Protein Efficiency Ratio):** is the gain in body weight divided by the weight of the protein consumed.

**N.P.U (Net Protein Utilisation):** is the proportion of protein intake that is retained (calculated as BV times Digestibility).

**P.D.C.A.A.S (Protein Digestibility Corrected Amino Acid Score):** is based on the amino acid requirements of humans. A protein scoring a 1.0 indicates it meets all the essential amino acid requirements of humans according to the Food Agriculture Organisation and World Health Organisation. However, it does not take into account surplus essential amino acids some proteins have that could compensate for lower levels in another protein like beans.

Whey protein tops the list as the best quality protein due to its specific amino acid array. Lower quality vegetable proteins are at the bottom of the list due to low levels of one or more essential amino acids.

However, one protein is not superior to others in all ways. Each has distinct advantages and disadvantages.

| SOURCE | B.V | N.P.U | P.E.R | P.D.C.A.A.S |
|---|---|---|---|---|
| Whey Protein | 104 | 92 | 3.6 | 1.0 |
| Whole Egg | 100 | 94 | 3.8 | 1.0 |
| Beef | 80 | 73 | 2.0 | 0.92 |
| Casein (Milk) | 77 | 76 | 2.9 | 1.0 |
| Soy | 74 | 61 | 2.1 | 0.99 |
| Rice | 59 | 57 | 2.0 | 0.26 |
| Beans | 49 | 39 | 1.4 | 0.68 |

## Protein Requirements

Protein requirements vary from one person to another; it depends how big you are and how active you are. Because the food pyramid and Eat Well Plate nutrition models place an emphasis on carbohydrate over protein, it's not unlikely that a significant percentage of the exercising population is actually consuming too little protein. This can adversely affect the potential benefits of exercise. By contrast, eating too much protein can result in increases in body fat.

Protein should feature as a major part of most meals and daily intake then fine-tuned to ensure protein needs are being met. The table below outlines the American College of Sports Medicine's (ACSM) recommendations for protein consumption which is widely accepted as being appropriate in the majority of cases.

| Activity Type | Ideal Dail Protein Intake (grams) per Kg of Body Weight |
|---|---|
| Sededary person / low intensity activity | 0.75 |
| Recreational adult exerciser | 0.8 - 1.5 |
| Endurance training (moderate or heavy) | 1.2 - 1.4 |
| Strength and Power training | 1.4 - 1.8 |
| Growing teenage athlete | 1.5 - 2 |
| Exerciser on a weight (fat) loss programme | 1.6 - 2 |
| Exerciser on a weight (muscle) gain programme | 1.8 - 2 |

## Protein Recommendations

It's clear then that all proteins were not created equal. However, it's not just the quality of the protein you should consider but also the actual food quality as well.

As the old adage goes; "If you put junk in you'll get junk out" so it pays to try and consume the best quality protein foods you can. Lean organic meats and poultry, free-range eggs, organic milk and raw nuts are all good sources of protein that will provide amino acids and other essential nutrients.

Not-so-good protein choices include burgers, sausages, meat pies, UHT dairy, roasted nuts, non-organic pulses, reformed meats such as luncheon meat and battery farmed eggs.

Reformed and processed meats often contain as little as 6% actual meat, a figure allowable by law, and much of their weight consists of water, fillers such as wheat, sugar and bone meal.

More information will be discussed during the "Calculating Protein Requirements" section.

# Macronutrients: Fats

## MODULE 2:
## THE VERTEBRAE, CONNECTIVE TISSUES, MACROS AND MICRONUTRIENTS

Weighing in at 9 calories or 37.8 kilojoules per gram, dietary fats are much maligned and often misunderstood. The media frequently vilifies them and food marketers take advantage of our "fat-phobia" by actively promoting low-fat products.

While dieticians usually suggest cutting reducing your fat intake, proponents of Palaeolithic and low carbohydrate diets insist that fat is good and should be well represented in your daily diet. Who is right and who is wrong is a book in the making so the intention of this section is to discuss how your body uses fat and the different types of fat you will find in your diet.

### FAT PLAYS AN IMPORTANT ROLE IN MANY PHYSIOLOGICAL FUNCTIONS:

- **The formation of virtually all cell membranes**
- **The formation of myelin sheaths within the nervous system**
- **Constitutes the majority of the CNS and spinal cord**
- **Provides a means for storing energy–i.e. adipose tissue**
- **The synthesis of steroid hormones**
- **Assists in the regulation of enzymes**
- **Provides insulation through subcutaneous adipose tissue**
- **Provides protection to the internal organs and brain**
- **Facilitates the transportation, storage and usage of vitamins A, D, E and K**
- **Provides primary fuel source at low levels of intensity**

## Types Of Dietary Fats

Fats, also known as lipids, come in four main types – saturated, monounsaturated, polyunsaturated and trans fats. They are broken down into fatty acids when digested and each fat has a very specific chemical structure which dictates its role in your body.

### *TRIGLYCERIDES*

In nature, fatty acids usually occur in threes. These three-fatty acid units are called triglycerides because the three fatty acids are attached to a carbohydrate "backbone" called glycerol.

### *SATURATED FATS*

Often considered the "bad boy" of dietary fats, saturated fats are comprised of chains of carbon atoms that are packed or saturated with hydrogen. This makes them, with the exception of palm oil and coconut oil, solid at room temperature and chemically inert.

Saturated fats do not react very much to heat, light or oxygen which makes them ideal for cooking. Foods such as butter, animal produce, eggs and dairy contain large amounts of saturated fat.

Your body likes to use saturated fats for energy during aerobic activity, as stored energy for later use within your adipose tissue, protection of vital organs, cell membrane integrity, transport and storage of fat-soluble vitamins and is also essential for protein utilisation.

| Common sources of saturated fat | |
|---|---|
| **Animal** | **Non-animal** |
| Meat | Coconut oil |
| Poultry | Palm oil |
| Dairy | |
| Eggs | |

Despite their negative reputation, research has revealed that saturated fat should be included in all healthy diets and is, in fact, a vital nutrient.

#### SATURATED FAT HAS SEVERAL IMPORTANT FUNCTIONS:

- **Enhancement of immune system function**
- **Provides energy and structural integrity to cells**
- **Enhances liver function and provides protection against alcohol**
- **It is anti-microbial and anti-viral**

The worst thing that can be said about saturated fats is they have a high propensity to being converted to body fat is consumed in large quantities and with high levels of carbohydrate. For this reason, many people reduce their saturated fat intake in an effort to create a calorific deficit and lose weight.

## *MONOUNSATURATED FAT*

Monounsaturated fat is missing some hydrogen and, as a result, a double bond is formed in the carbon chain. The double bond causes a bend in the carbon chain and, in chemistry, shape dictates function. This means that a monounsaturated fat behaves differently to saturated fat.

Monounsaturated fats are moderately reactive and more susceptible to changes caused by heat, light and oxygen. Liquid at room temperature, monounsaturated fats are linked to cardiovascular health and feature heavily in the olive oil-rich Mediterranean diet.

Other sources of monounsaturated fats include nuts and nut derived oils and butters, beef, avocados and numerous seeds. The relative chemical instability of monounsaturated fats means that, while they can be heated and used for cooking, overheating them can make them less healthful. To avoid turning your good monounsaturated into less healthy trans fats (discussed later) do not overheat olive oil or nut oil when cooking. You can tell when you have overheated an oil when it begins to smoke.

For cooking, choose oils that have a high "smoke point". Olive oil, for example, has a smoke point of around 200 degrees centigrade compared to flaxseed oil that will smoke at around 100 degrees centigrade.

| **Sources of monounsaturated fats** | |
|---|---|
| Olives and olive oil | Rapeseed oil |
| Lard | Avocados |
| Beef | Most nuts |
| Peanuts, peanut oil and butter | Most seeds |

## *POLYUNSATURATED FATS*

Polyunsaturated fats contain two or more double bonds in their carbon chains. This characteristic makes them highly reactive when exposed to heat, light or oxygen.

Examples of polyunsaturated fats include oily fish, sunflower seeds, sesame seeds, walnuts, soya beans and any oils subsequently extracted from these sources.

The inherent reactivity seen in polyunsaturated fats means that exposing an otherwise healthy polyunsaturated fat to high temperatures is likely to result in the formation of trans fats.

Polyunsaturated fats are not ideal oils for cooking and more stable saturated and monounsaturated fats are the better choice. Consume the majority of your polyunsaturated fats in a raw state to maximize their healthfulness.

Polyunsaturated fats, many of which are considered essential for health hence their common moniker "essential fatty acids" or EFAs for short, can be sub-categorised as omega-three or omega-six fatty acids.

Omega, the final letter in the Greek alphabet, refers to the position in the chain at which the last double bend is located i.e. three from the end or six from the end. These extremely healthful fats are responsible for a wide range of functions within your body including the formation of cellular hormone-like substances called prostaglandins, the regulation of inflammation, mental function and development and skin, hair and immune system health.

Many people take cod liver oil to help "lubricate their joints" but, in actuality, cod liver oil is an effective anti-inflammatory agent and helps reduce joint pain rather than increasing lubrication!

| Omega 3 fatty acids | Omega 6 fatty acids |
|---|---|
| Oily fish | Sunflower seeds and oil |
| Flax oil | Safflower oil |
| Walnuts | Pumpkin seeds |
| Note: all oils need to be cold presses, "extra virgin" and unprocessed | |
| An ideal ratio of Omega 3 to 6 fatty acids is 1:2 or 1:1 | |

EFAs have been shown to reduce blood clotting, lower triglyceride levels, lower total cholesterol levels, raise good HDL cholesterol levels and reduce overall heart disease risk.

## *TRANS FATS*

## Hydrogenation And Trans Fats

Trans fats occur in nature and, when consumed in relatively small amounts, do not present any real problems for your health. However, many man-made foods and modern food preparation methods result in an abundance of trans fats being formed and consumed.

Overconsumption of trans fats is strongly linked to immune system dysfunction, bone and tendon weakness, sterility, coronary heart disease, high cholesterol and triglyceride levels, inability to lactate, learning difficulties and low birth weight babies.

In food manufacturing, large amounts of unsaturated oils are heated and then, after a catalyst (nickel usually) is added, hydrogen is pumped in under high pressure. This causes the normally "bent" fatty acid chain to straighten and therefore take on the properties of saturated fat but the arrangement of the hydrogen atoms means that trans fats do not behave like "real" saturated fats. Trans fats "block" healthy mono and polyunsaturated fats from entering cells resulting impairment of cellular function which may lead to poor health.

- **Normal placement of hydrogen atoms: as seen in mono or polyunsaturated fat.**
- **Diagonal placement of hydrogen atoms: as seen in a trans fat.**

You can minimise your consumption of trans fats by not overeating mono and polyunsaturated fats, cutting down on processed and takeaway foods, using saturated fats for high-temperature cooking and avoiding food products that contain hydrogenated or partially hydrogenated vegetable oils. It is also a good idea to keep your mono and polyunsaturated oils in dark glass air-tight containers, buying extra-virgin cold-pressed oils and consider using butter instead of margarine as many margarine type spreads contain hydrogenated vegetable oils. Check the label to be sure.

## Common Sources of Trans Fats

- **Most margarines and vegetable oil spreads**
- **Biscuits**
- **Cakes**
- **Take-away foods**
- **Pies**
- **Pastries**
- **Pre-prepared foods**
- **Many "low-fat" foods**
- **Ice cream**

## *Fats – maybe not as bad for us as we are often lead to believe.*

Many of the health problems associated with fats are due to the fact they can make you fat. Being over-fat presents a much greater health risk than fats alone ever could. Your body needs a certain amount to fat for health and eliminating fat from your diet can lead to a host of medical problems. By being more "fat aware" you can make sure you consume the fats that are best for you while avoiding those that can cause you harm.

## Whole Sources of Fat

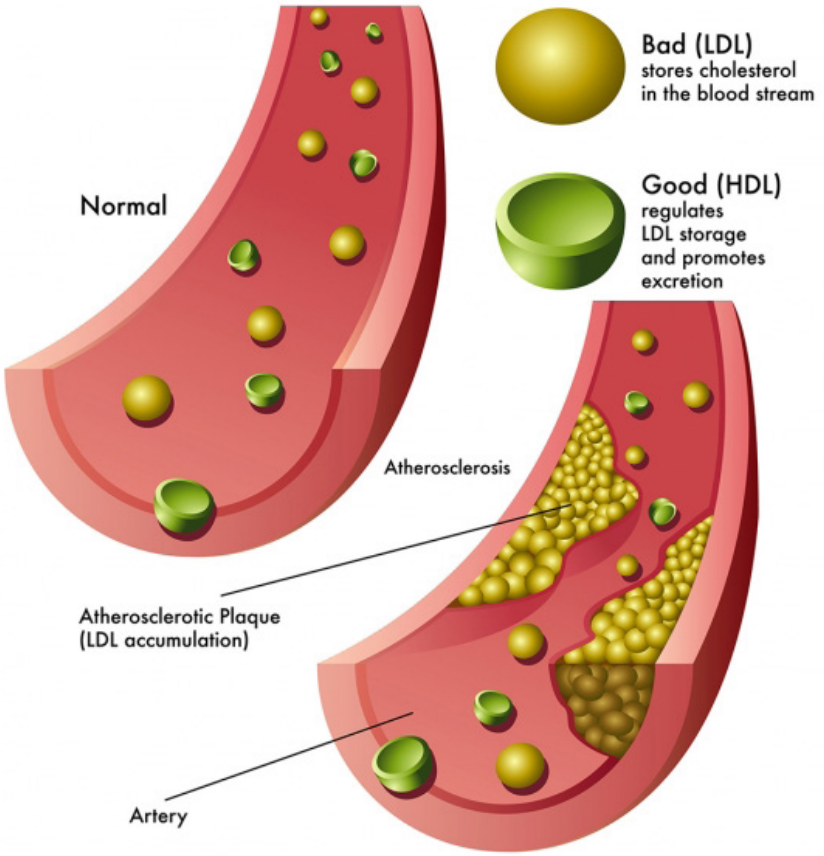
## (Where fat is the greatest macronutrient)

| Whole Sources of Fat | Amount per 100g | Additional Information |
|---|---|---|
| Avocado | 19.5g | N/A |
| Peanuts | 49.5g | Plain - no salt, no roast |
| Cashew Nuts | 45.7g | N/A |
| Almonds | 51.7g | N/A |
| Egg (Yolk) | 27g | N/A |
| Beef (20% Fat Mince) ** | 19.8g | N/A |
| Pork (Belly) ** | 20.2g | N/A |
| Sunflower Seeds | 47.5g | Used for Vegetarian Protein Sources |
| Pumpkin Seeds | 45.6g | Used for Vegetarian Protein Sources |
| Sesame Seeds | 56.4g | Used for Vegetarian Protein Sources |
| Mackerel | 20.1g | Whilst also a source of protein this food has a greater amount of fats per 100g |
| Single Cream | 19.1g | N/A |
| Greek Style Yoghurt | 9.5g | N/A |
| Cheddar Cheese | 34.9g | N/A |
| Red Leicester | 33.6g | N/A |
| Olive Oil | 91.3g | Per 100ml |
| Sunflower Oil | 100g | Per 100ml |
| Rapeseed/Canola Oil | 91.7g | Per 100ml |
| Walnut Oil | 100g | Per 100ml |
| Lurpak | 78g | Spreadable Variety |
| Lower Fat Spreadable | 42g | "I can't believe it's not butter" |
| Dark Chocolate | 46g | Lindt 85% cocoa |

* Colours are representative of their location within the eat-well plate.
** The eat-well plate advises lower fat meats as protein sources however, this is only advisory and these food groups will still belong here in their raw form.

ORIGYM

## Cholesterol




Cholesterol is a lipid molecule that effectively contains no calories and does not represent a source of energy despite being present in many foods.

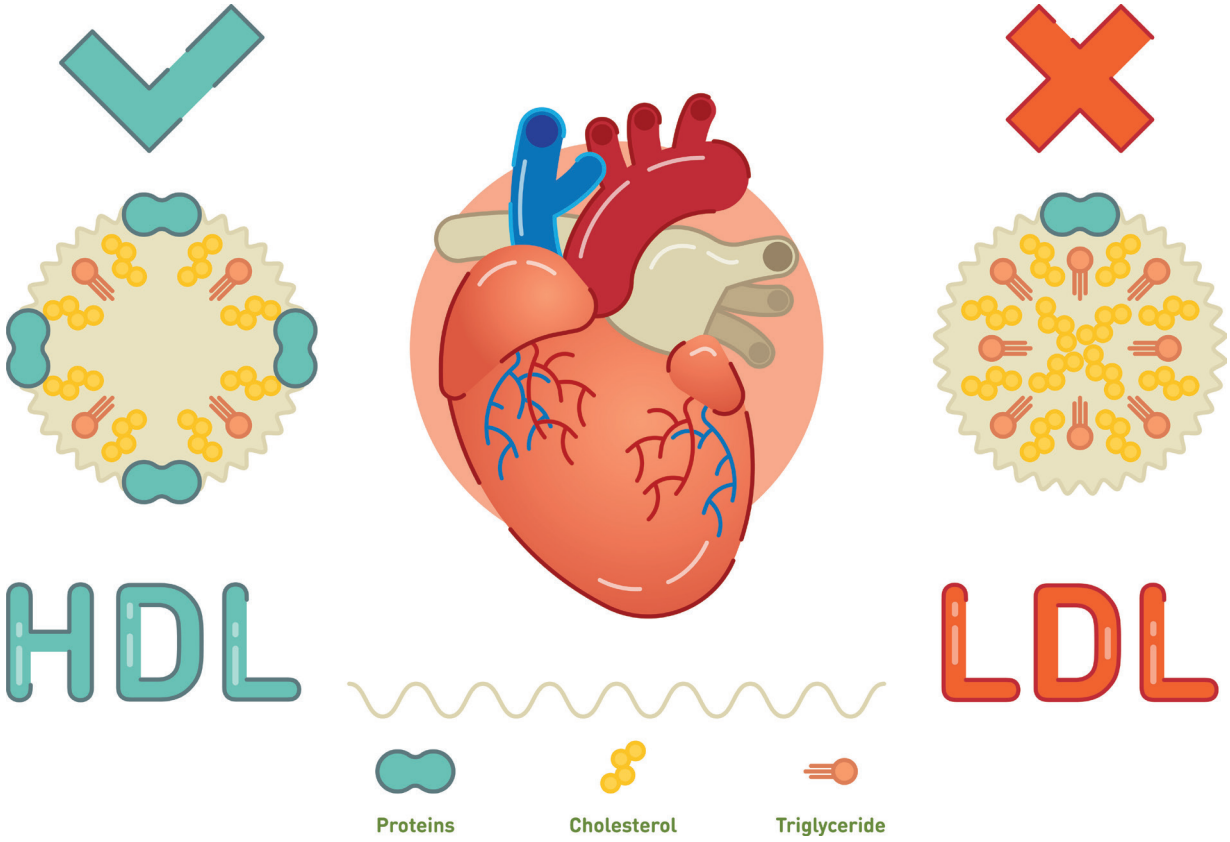
However, and despite often being labelled as unhealthy, cholesterol has several important functions:

- **A vital part of cell membranes.**
- **Essential in the production of steroid hormones.**
- **Necessary for the production of bile acid.**
- **Vital for the synthesis of vitamin D.**

Although cholesterol is present in a number of foods, most notably eggs and seafood, cholesterol is so important for body health and function that it is synthesised by the liver. In fact, 70-80% of the body's supply of cholesterol is made by the liver and if dietary cholesterol intake should be insufficient, the liver will increase production to meet any shortfall. Typically, the body needs between 1000 to 1500mg of cholesterol per day.

Because cholesterol is a lipid, it is not soluble in water and, therefore, will not mix with blood plasma which is predominately water. Therefore the body uses protein-based transporters called lipoproteins to carry cholesterol around the body.

## THERE ARE THREE KEY LIPOPROTEINS:




**Very low-density lipoproteins (VLDLs):** manufactured by the liver, VLDLs contain both triglycerides and cholesterol and are responsible for transporting triglycerides into adipose (fat) cells.

**Low-density lipoproteins (LDLs):** formed from VLDs that have deposited their triglyceride payloads into the adipose cells, LDLs transport cholesterol throughout the body to the cells where it is needed.

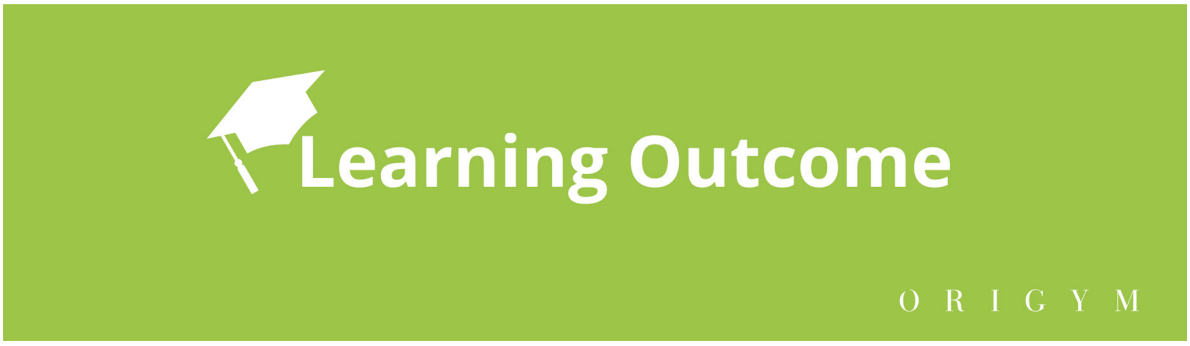
**High-density lipoproteins (HDLs):** synthesised by the liver, HDLs "mop up" excess cholesterol from the tissues and blood and transport it back to the liver.

Measuring serum cholesterol and triglyceride levels have become a key risk indicator and pathology marker for cardiovascular disease. Elevated triglyceride, LDLs and cholesterol and a 25% lower HDL reading have all been identified as multipliers for the risk of developing heart disease. The upper desirable limit for serum cholesterol in the UK is 5.2mmol/L (millimoles of cholesterol per litre of blood plasma) and levels exceeding this will usually result in lifestyle changes (increase exercise, lose weight, cut down on fat intake, give up smoking, reduce stress etc.) and the possible use of cholesterol-lowering drugs called statins.

However, and controversially, several prominent experts suggest that lowering cholesterol using statins is like running the police out of an area of high crime as cholesterol levels often increase because of overconsumption of trans fats and the cholesterol is necessary for repairing the damage done by this harmful lipid.

# Micronutrients

## *MODULE 2:*
## *THE VERTEBRAE, CONNECTIVE TISSUES, MACROS AND MICRONUTRIENTS*




### IN THIS SECTION YOU WILL LEARN THE FOLLOWING:

- **Describe the function of vitamins**
- **Describe the function of minerals**
- **Understand vitamin and mineral supplementation**

## Micronutrients & Vitamins

Vitamins and minerals are the very spark plugs your body needs for life. In fact, if your diet is deficient in vitamins and/or minerals, ill health is likely to be the result. Whilst vitamins and minerals don't contain any meaningful energy themselves, they allow your body to unlock energy within the macronutrients and also act as biological catalysts in the myriad reactions that occur in your body. A diet that is lacking in vitamins and minerals results in sluggish or even a complete absence of life-sustaining reactions.

For example, it is common knowledge that vitamin C can help you ward off a cold. This is because vitamin C plays an important role in immune system function. Ironically, many people only worry about their vitamin C intake when they actually get a cold, by which time it's too late!

# Selected Vitamins and Their Uses

We get vitamins from plant foods or from animals that have eaten plant foods. We also synthesise a small number of vitamins in our digestive tracts. We also get vitamins from substances called pro-vitamins.

Provitamins are organic compounds that can be synthesized into vitamins once eaten. For example, the provitamin beta-carotene converted into vitamin A. Vitamins are organic compounds that can be classed as water or fat-soluble.

## Vitamin uses

| Vitamin | Purpose | Sources |
|---|---|---|
| A | Stimulates gastric juices for protein digestion | Butter from grass- fed cows |
| | Plays a vital role in bone building | Pasteurized whole eggs |
| | Promotes blood cell health | Liver |
| | Protects against pollution and degenerative damage | Seafood |
| D | Needed for calcium and phosphorus absorption | Butter from grass- fed cows |
| | Helps form strong bones and teeth | Pasteurized whole eggs |
| | Helps protect against cancer and multiple sclerosis | Liver |
| E | Aids blood circulation | Unrefined vegetable oils |
| | Helps with tissue repair and healing | Butter |
| | Slows the aging process | Organ meats |
| | Powerful antioxidant | Raw nuts and seeds |
| K | Important for blood clotting | Liver |
| | Aids in bone formation | Pasteurized whole eggs |
| | | Whole grains |
| | | Dark leafy green vegetables |
| B | Promotes healthy nerves, skin, eyes, hair, liver and muscle tone | Whole refined grains |
| | Prevents fatigue | Fresh fruit |
| | Vital for carbohydrate metabolism | Fresh vegetables |
| | Helps produce cholesterol | Raw nuts |
| | Helps maintain iron levels in blood | Legumes |
| C | Aids tissue growth and repair | Fresh fruit |
| | Strengthens capillary walls | Fresh vegetables |
| | Supports lactation | Some organ meats |
| | Supports adrenal gland function | |
| | Vital for collagen formation | |

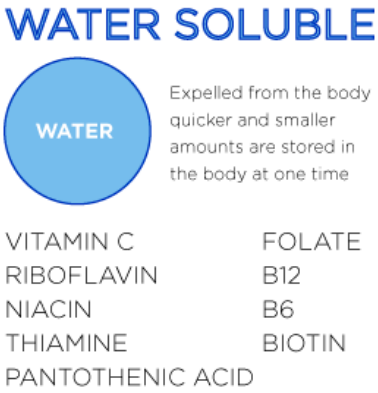
# Vitamins

## *Water Soluble*

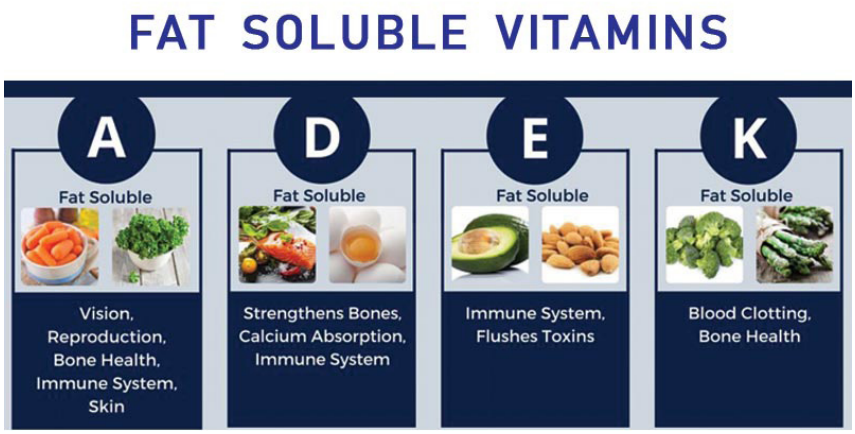
Vitamins B and C are soluble in water. This means that you need to consume them on a daily basis as your body is unable to store them in any meaningful amounts.

Any excess is eliminated in your urine which is why high doses of vitamin C can turn your urine bright green! Too much vitamin B and C are seldom toxic as your body
simply flushes away the surplus but that doesn't mean you should go overboard.

Too much vitamin C can increase the acidity levels in your digestive and urinary system and cause an upset stomach. Some B vitamins, specifically biotin and riboflavin, are also produced by the bacteria in the digestive tract.




## *Fat Soluble*




Vitamins A, D, E and K are transported and utilized in the presence of fat and, subsequently, do not have to be eaten every day as you can store them in your body. Because you can build up high levels of these micronutrients, it is possible, albeit unlikely, to reach toxic levels if you consume a large amount.

A diet low in fat can lead to a deficiency in the fat-soluble vitamins. The manufacture of steroid hormones (testosterone, oestrogen and cortisol) from cholesterol requires a plentiful supply of vitamin A.

While it is not essential to know all the functions that vitamins perform in human metabolism, it may be useful to have a broad understanding of some of the major purposes of the fat and soluble vitamins.

| Vitamin | Uses |
|---|---|
| A | Protects cells from free radical damage |
| D | Activates carrier proteins which transport calcium for bone formation |
| E | Protects cells from free radical damage, helps maintain skin health |
| K | Essential for formation of platelets for blood clotting |
| B | Needed to releasing energy from carbohydrate |
| C | Vital for immune system function |

## Selected Minerals and Their Uses

Minerals are inorganic compounds that are present in the very earth in which your food grows. Plants absorb the minerals and then we eat the plants. Minerals are vital for numerous processes within your body including regulating fluid balance, muscle contractions, bone formation and nerve function and makeup around 4% of total body mass.

Like vitamins, minerals are essential for health and well-being. For example, a lack of calcium could increase your risk of developing osteoporosis whereas a lack of iron will negatively affect your ability to transport oxygen in your blood.

Minerals can be sub-divided into two categories: **macro** and **trace**. Although all minerals are important, the macro minerals are required in greater amounts than the trace minerals.

## Minerals

| Mineral | Functions | Sources |
|---|---|---|
| Calcium | Bone growth | Dairy products |
| | Muscle contractions | Fish with soft bones |
| | Regulates acid/alkali balance | Green leafy veg |
| Chloride | Regulates acid/alkali balance | Natural unprocessed sea salt |
| | Regulates fluid balance | Coconut flesh |
| | Aids protein and carbohydrate digestion | |
| Magnesium | Nerve transmission | Natural unprocessed sea salt |
| | Bone formation | Fish |
| | Metabolism of carbohydrates | Dairy produce |
| | Absorption of other minerals | Nuts |
| | Tooth enamel | |
| Phosphorus | Bone growth | Animal produce |
| | Kidney function | Whole grains |
| Potassium | Fluid balance | Natural unprocessed sea salt |
| | Cellular chemistry | Raw nuts |
| | | Vegetables |
| Sodium | Water balance | Natural unprocessed sea salt |
| | Cellular fluid distribution | Meat broths |
| | Nerve stimulation | Zucchini |
| Sulphur | Protects from infection | Cruciferous vegetables |
| | Helps form cartilage and skin | Eggs |
| | Protects against radiation and pollution | Dairy products |

**In addition to the macro minerals, many other minerals are to be found in the food we eat. Essential for good health but required in much smaller amounts, there are many recognised trace minerals; the most important are listed below:**

- **Copper**
- **Manganese**
- **Iodine**
- **Boron**
- **Iron**
- **Nickel**
- **Selenium**
- **Zinc**
- **Cobalt**
- **Chromium**
- **Molybdenum**
- **Silicon**

# Micronutrients Requirements


The nutritional information label on pre-packaged food often lists vitamin and mineral content. Food manufacturers boast that their products contain 100% of, for example, your RDA of vitamin C. But what does RDA actually mean and is 100% actually worth boasting about?

When it comes to vitamin and mineral consumption, there are a wide number of opinions as to how much you actually need. While one authority may recommend fractions of a gram, another will recommend multiple grams. It seems no one can really agree as to what quantity of vitamins and minerals you need to consume for health and well-being. Subsequently, there are a number of dietary reference values or DRVs for vitamin and mineral consumption.

RDA – Recommended Daily Allowance. RDA is the absolute minimum amount of vitamins and minerals required. This does not guarantee good health but simply survival. This is a very low figure! RDA is so low that many food manufacturers' can boast their products contain upward of 100% of your RDA. 100% of a small number is still a small number. Most people would benefit from exceeding their vitamin and mineral RDA.

EAR – Estimated Average Requirements. EAR caters for around 50% of the population. It's a bigger amount than RDA but some groups will still be deficient if they only meet these targets. The elderly, children, nursing mothers, hard training sportsmen and those convalescing from illness need more vitamins and minerals than the EAR suggested figures.

RNI – Reference Nutritional Intake (RNI) caters for around 70% of the population but some groups such as hard training sportsmen would still deficient even if they achieved the RNI intake guidelines.

Because this is a significantly higher figure than RDA, it is very unlikely you will see many foods manufactures boasting about 100% RNI scores.

While RDA is the accepted minimum level of micronutrients required to maintain health, there are several special population groups who are more likely to experience nutritional deficiency and therefore may benefit from an increase in micronutrients. Because of their limited level of qualifications, personal trainers should always defer to dieticians in these instances.

Populations that may require increased micronutrients due to possible deficiencies include are but not limited to:

- **Children**
- **The elderly**
- **Pregnant or lactating women**
- **Those with chronic diseases**
- **Athletes**
- **Those following a restrictive diet e.g. vegetarians**

## Vitamin And Mineral Supplements

While it is beyond the scope of this qualification to recommend supplements of any kind, a personal trainer needs to have some awareness of the use of vitamin and mineral supplements as it is so common. While some supplements can be deemed “natural” such as fish oils, others are made in laboratories. Some supplements are derived from natural precursors however even these products are not as natural as consumers are led to believe as they have to be processed into tablet, capsule or oil form for consumption.

Should you wish to learn more about supplementation ask an Origym team member about the Level 4 Advanced Certificate in Nutrition for Weight Management and Athletic Performance.

Another potential shortfall of vitamin and mineral supplementation is that vitamins come in a wide number of varieties. For example, there are a large number of B vitamins and even so-called B complex supplements do not contain all forms of vitamin B.

Supplementary vitamin C is almost always in the form of ascorbic acid but, in nature, seldom occurs in isolation and is normally accompanied by a substance called rutin which acts as an acidity buffer and increases bioavailability.

Minerals, like vitamins, seldom occur in isolation but are usually found in complexes; often with vitamins.

Isolated minerals, like isolated vitamins, do not exhibit the same degree of bioavailability as naturally occurring vitamins and minerals. Additionally, minerals are usually found in several different forms, only some of which offer any real nutritional benefits. Vitamin and mineral supplements are also devoid of the majority of phytochemicals and other essential nutrients.

While taking vitamin and mineral supplements may help provide a nutritional “safety blanket”, even the best nutritional supplement is no match for what is commonly found in nature. Any supplementation should only use the best possible quality products and should follow the advice of a dietician.

## Micronutrient Summary

With a basic understanding of the micronutrients and their effect on the body, a personal trainer should be able to provide some general food recommendations so that clients can adapt their diet for improved health and performance. These recommendations should include:

| Avoid | Advise |
|---|---|
| Limiting food choices | Eat a wide variety of fruit and vegetables |
| "Fresh" produce from overseas | Eat seasonal, fresh produce |
| Fortified foods | Eat locally produced fruit and vegetables |
| Processed fruit and vegetables | Eat raw or lightly cooked food where possible |
| Cooking at high temperatures | |
| Cheap/low quality vitamin and mineral supplements | |

# National Food and Nutritional Government Guidelines

***MODULE 2:***
***THE VERTEBRAE, CONNECTIVE TISSUES, MACROS AND MICRONUTRIENTS***

## The UK Eatwell Guide


**IN THIS SECTION YOU WILL LEARN THE FOLLOWING:**

- **Explain key healthy eating advice that underpins a healthy diet**
- **Describe the nutritional principles and key features of the National food model/guide**
- **Identify the 8 healthy eating tips laid out by National Food Model Guide for the UK**
- **Explain the advantages and disadvantages of the National Food Model Guides**
- **Distinguish between evidence-based knowledge versus the unsubstantiated marketing claims of suppliers**

## US Department of Agriculture (USDA) Food Pyramid

For many years, various governments around the world have used a food pyramid model to help us decide what to eat. These models, which vary slightly from country to country, provide a graphic representation of what we should eat and in what quantities. Easy to understand and simple to follow, food pyramid models are designed to make it obvious which foods you should be eating more of (the ones in the lower tiers) and which foods you should be eating less of (the ones in the upper tiers).

The first US Department of Agriculture food pyramid was released in 1992 and updated in 2005 and again in 2011. All models suggest that the majority of the energy in your diet should be derived from carbohydrates, especially grains and grain foods such as bread, rice and pasta. Next, you should be consuming around three to five servings of fruits and vegetables.

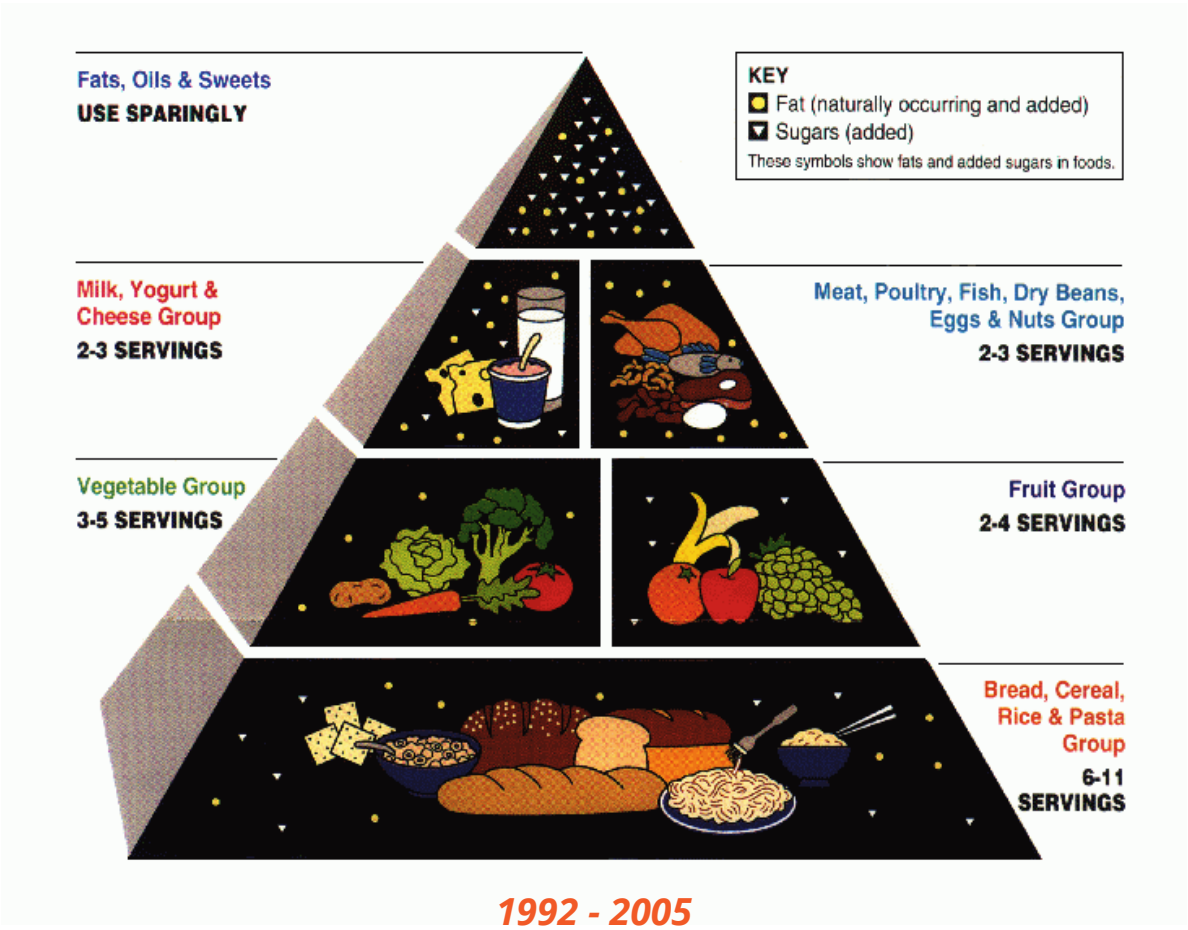
Protein-rich foods make up the next level with, according to the USDA, meats, fish, eggs and dairy all being equally comparable. Finally, at the top of the pyramid are the foods you should be eating the least – specifically fats, oils and sugar.

Since their inception, all of the food pyramid models have been criticised. Accused of being shaped by agriculture rather than nutritional requirements of the majority of the population, it has been suggested that the pyramid is biased in favour of vegetable and grain farmers over meat farmers.

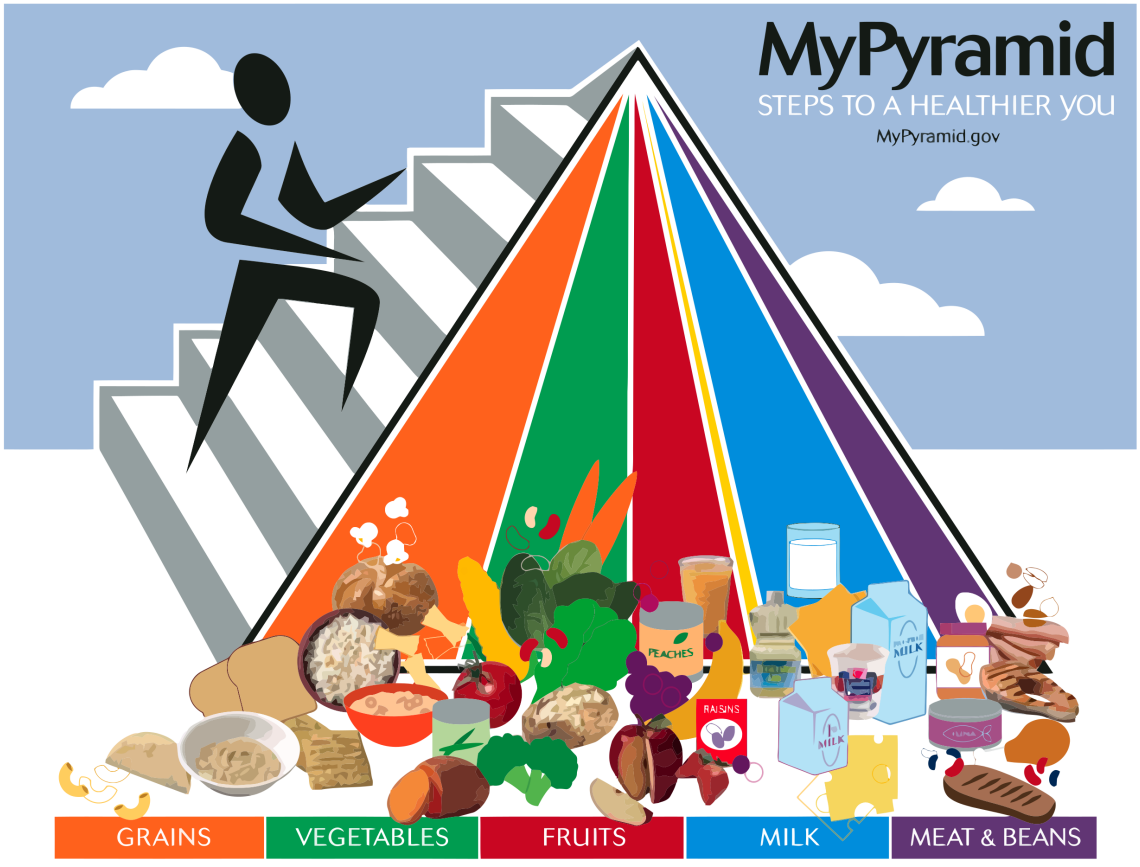
Dieticians also point out that comparing soya, nuts and beans with meat, as the food pyramid suggests, sends out the wrong message about the protein content and quality of two very different food groups. Finally, anyone with gluten or dairy intolerance or following a vegetarian diet is not catered for in the food pyramid.

Others suggest that the food pyramid is an acceptable method of eating if you are very active but a carbohydrate-based diet is not suitable for those members of the population that are sedentary. Some theorists suggest that the food pyramid models are actually responsible for the current obesity epidemic but this accusation is more properly aimed at food manufacturers and the abundance of high calorie/low nutrient junk food that many people eat far too much of.

## Food Pyramid Versions

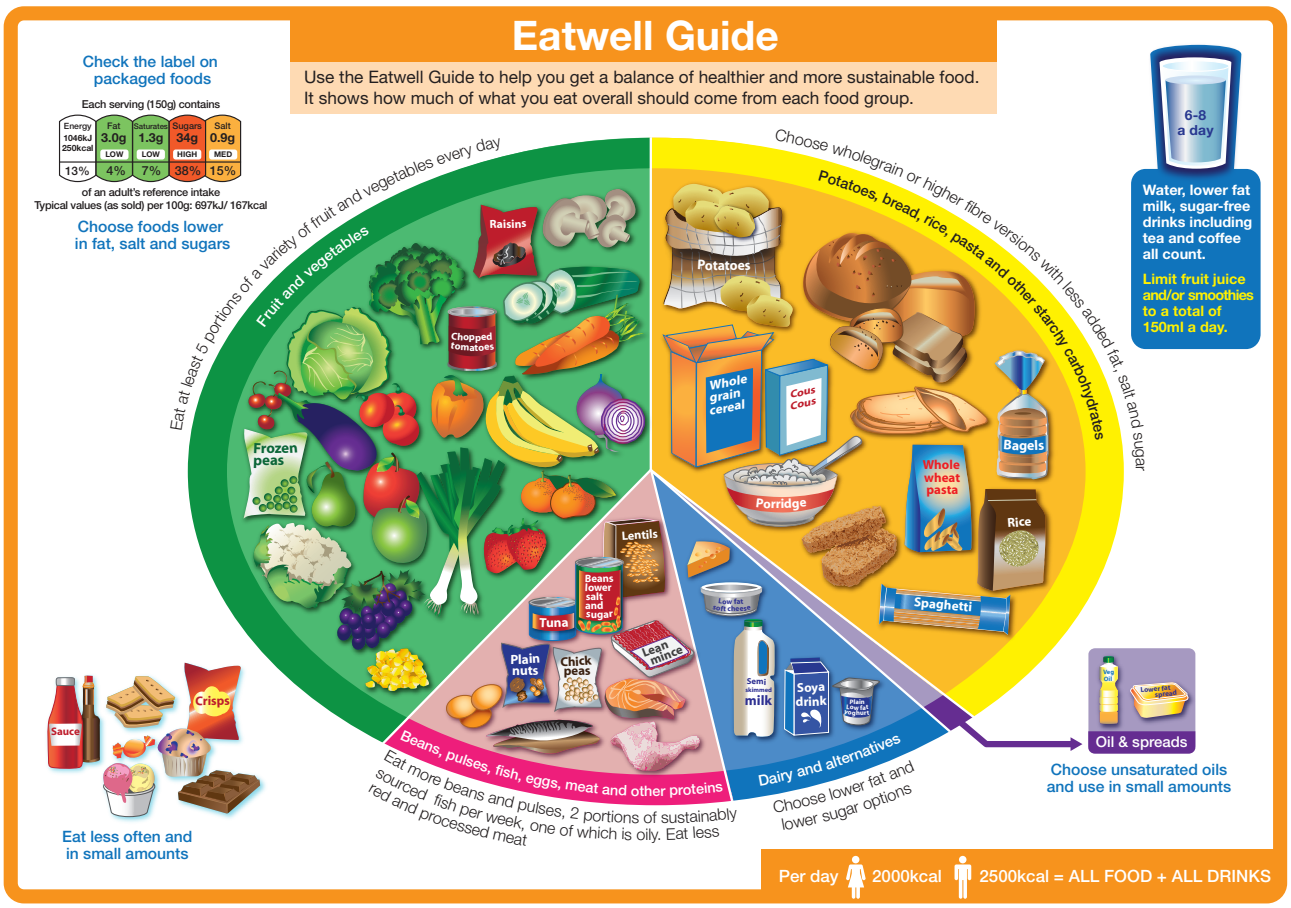



*1992 - 2005*




*2005 - Present*

# The UK Eatwell Guide




Source: Public Health England in association with the Welsh Government, Food Standards Scotland and the Food Standards Agency in Northern Ireland



The Eatwell Guide shows the proportions of the main food groups that form a healthy, balanced diet and suggests a person should:

- **Eat at least 5 portions of a variety of fruit and vegetables every day.**
- **Base meals on potatoes, bread, rice, pasta or other starchy carbohydrates; choosing wholegrain versions where possible.**
- **Have some dairy or dairy alternatives (such as soya drinks); choosing lower fat and lower sugar options.**
- **Eat some beans, pulses, fish, eggs, meat and other proteins (including 2 portions of fish every week, one of which should be oily).**
- **Choose unsaturated oils and spreads and eat in small amounts.**
- **Drink 6-8 cups/glasses of fluid a day.**

| Age | Daily energy requirements | | | |
|---|---|---|---|---|
| | Males | | Females | |
| | kcal | kJ | kcal | kJ |
| 1 | 765 | 3201 | 717 | 3000 |
| 2 | 1004 | 4201 | 932 | 3899 |
| 3 | 1171 | 4899 | 1076 | 4502 |
| 4 | 1386 | 5799 | 1291 | 5402 |
| 5 | 1482 | 6201 | 1362 | 5699 |
| 6 | 1577 | 6598 | 1482 | 6201 |
| 7 | 1649 | 6899 | 1530 | 6402 |
| 8 | 1745 | 7301 | 1625 | 6799 |
| 9 | 1840 | 7699 | 1721 | 7201 |
| 10 | 2032 | 8502 | 1936 | 8100 |
| 11 and over | 2500 | 10,460 | 2000 | 8368 |

**Eat only as much food as you need. Improve the balance of your diet by looking at the Eatwell Guide**

**Get more active! If you're eating a good balance of the different food groups, and you're a healthy weight, you're probably eating about the right amount.**

| Food group | What's included? | How much? | Tips |
|---|---|---|---|
| Fruit and vegetables | All fruit and vegetables including fresh, frozen, canned, dried and juiced varieties. Potatoes do not count as they are considered a starchy carbohydrate food. | Eat plenty of fruit and vegetables. Aim for at least 5 portions of a variety of fruit and vegetables every day. Remember that a portion of dried fruit is 30g and should be kept to mealtimes. Limit fruit juice and smoothies to a combined total of 150ml which counts as 1 of your 5 A Day. There is evidence to suggest that people who eat lots of fruit and veg are less likely to develop chronic diseases such as coronary heart disease and some types of cancer. | Try to eat as many different types of fruit and vegetables as possible. Avoid adding sauces/dressing high in fat, salt or sugar to your fruit and veg e.g. chocolate sauce on banana or honey/butter glaze on your parsnips. Bulk out your meals with vegetables such as grated carrot, mushrooms or peppers for an extra portion of your 5 A Day which will make your meal spread further. Remember to keep fruit in your bag as a convenient and healthy snack and frozen vegetables in your freezer so you don't run out. |
| Potatoes, bread, rice, pasta and other starchy carbohydrates | • bread, including: soda bread, rye bread, pitta, flour tortilla, baguettes, chapatti, bagels<br>• rice<br>• potatoes<br>• breakfast cereals, oats<br>• pasta, noodles<br>• maize, commeal,<br>• couscous, bulgur<br>• polenta<br>• millet, spelt<br>• wheat, pearl barley<br>• yams and plantains | Eat plenty of starchy carbohydrates including potatoes, bread, rice and pasta. Choose wholegrain varieties, or keep the skins on potatoes, for more fibre, vitamins and minerals. | Base your meals around starchy carbohydrates. Check the labels and choose the products lowest in fat, salt and sugar. If you are having chips, go for oven chips lower in fat and salt. If you are serving starchy foods, try to avoid adding too much fat (eg oil or butter on roast potatoes) or sauces (creamy pasta) as these contain lots of calories. |
| Dairy and dairy alternatives | Milk, cheese, yoghurt, fromage frais, quark, cream cheese. This also includes non-dairy alternatives to these foods. Butters and creams are not included in this group as they are high in saturated fat and so they fit into the 'foods to eat less often and in small amounts' section. | Eat some dairy or dairy alternatives. Choose lower fat options when possible. For products like yoghurt, check the label and go for ones lower in fat and sugars. | Try swapping to 1% fat milk as opposed to whole or semi-skimmed milk. Cheese is high in saturated fat, so try buying reduced fat cheese. Alternatively grate it instead of slicing it to avoid using more than you need. Try to use low fat plain yoghurt as opposed to cream, crème fraiche or mayonnaise. |
| Beans, pulses, fish, eggs, meat and other proteins | • meat, poultry and game, including: lamb, beef, pork, chicken, bacon, sausages, burgers<br>• white fish (fresh, frozen or canned), including: haddock, plaice, pollock, coley, cod, tuna<br>• oily fish (fresh, frozen or canned), including: mackerel, sardines, trout, salmon, whitebait<br>• shellfish (fresh, frozen or canned), including: prawns, mussels, crab, squid, oysters<br>• nuts<br>• eggs<br>• beans and other pulses, including: lentils, chickpeas, baked beans, kidney beans, butter beans<br>• vegetarian meat alternatives eg tofu, mycoprotein | Eat some beans, pulses, fish, eggs, meat and other proteins. Eat at least 2 portions (2 x 140g) of fish each week, one of which is oily. Limit processed meats such as sausages, bacon and cured meats. If you eat more than 90g per day of red or processed meats, try to reduce the amount to no more than 70g per day. | When you're cooking and serving these foods, try not to add extra fat or oil.<br>When you're buying meat, ask your butcher for a lean cut or compare the labels on different products and choose the one lower in saturated fat.<br>Watch out for meat and fish products in pastry, batter or breadcrumbs as these can be high in fat and/or salt.<br>Remember that an 80g portion of beans or pulses can count as 1 of your 5 A Day! |
| Oils and spreads | Unsaturated oils including vegetable oil, rapeseed oil, olive oil and sunflower oil. Soft spreads made from unsaturated oils. Butters are not included in this section as these are high in saturated fat and are included in the 'foods to eat less often and in small amounts' section. | Use these products sparingly as they are high in fat. Cutting down on these types of foods could help to control your weight as they are high in calories. | Choose lower fat spreads where possible and use sparingly.<br>Check the label and choose oils high in unsaturated fat and low in saturated fat. Oils expand when heated and so heating oil in the pan before you use it will make it go further so you don't need to use as much. |
| Foods to eat less often and in small amounts | • cakes<br>• biscuits<br>• chocolate<br>• sweets<br>• puddings<br>• pastries<br>• ice cream<br>• jam<br>• honey<br>• crisps<br>• sauces<br>• butter<br>• cream<br>• mayonnaise | These foods are not required as part of a healthy, balanced diet. If included, they should only be consumed infrequently and in small amounts. Most of us need to cut down on the amount of high fat, salt and sugar foods we eat and drink. | Use lower fat spread instead of butter. Swap cakes and biscuits for a slice of malt loaf or a teacake with low fat spread. If you add sugar to your food or drinks, gradually reduce the amount you add until your taste buds adapt and you can cut it out altogether. Alternatively try using a calorie-free sweetener instead. |

## 8 Tips for Eating Well (Healthy Eating)


Previously the Eatwell Guide was known as the Eatwell Plate. The document below outlines the changes and the reasons for the changes to occur.

## Fruit and Vegetables


Most people know we should be eating more fruit and veg, but many of us aren't eating enough. Fruit and veg should make up just over a third of the food we eat each day.

Aim to eat at least five portions of a variety of fruit and veg each day. If you count how many portions you're having, it might help you increase the amount and variety of fruit and veg you eat.

Choose from fresh, frozen, canned, dried or juiced.

A portion is 80g or any of these: 1 apple, banana, pear, orange or other similar-size fruit, 3 heaped tablespoons of vegetables, a dessert bowl of salad, 30g of dried fruit (which should be kept to mealtimes) or a 150ml glass of fruit juice or smoothie (counts as a maximum of one portion a day).

## Dairy and Alternatives

Try to have some milk and dairy food (or dairy alternatives) – such as cheese, yoghurt and fromage frais.

These are good sources of protein and vitamins, and they're also an important source of calcium, which helps to keep our bones strong. Some dairy food can be high in fat and saturated fat, but there are plenty of lower-fat options to choose from.

Go for lower fat and lower sugar products where possible. For example, why not try 1% fat milk which contains about half the fat of semi-skimmed milk without a noticeable change in taste or texture? Or reduced fat cheese which is also widely available. Or you could have just a smaller amount of the full-fat varieties less often.

When buying dairy alternatives, go for unsweetened, calcium-fortified versions.

## Potatoes, Bread, Rice, Pasta and Other Starchy Carbohydrates


Starchy food is a really important part of a healthy diet and should make up just over a third of the food we eat.

Choose higher-fibre, wholegrain varieties when you can by purchasing whole-wheat pasta, brown rice, or simply leaving the skins on potatoes.

Base your meals around starchy carbohydrate foods. So, you could:

- **Start the day with a wholegrain breakfast cereal; choose one lower in salt and sugars.**
- **Have a sandwich for lunch.**
- **Round off the day with potatoes, pasta or rice as a base for your evening meal.**

Some people think starchy food is fattening, but gram for gram it contains less than half the calories of fat. You just need to watch the fats you add when you're cooking and serving this sort of food because that's what increases the calorie content.

### WHY CHOOSE WHOLEGRAIN?

Wholegrain food contains more fibre than white or refined starchy food, and often more of other nutrients. We also digest wholegrain food more slowly so it can help us feel full for longer. Wholegrain food includes wholemeal and wholegrain bread, pitta and chapatti, whole-wheat pasta, brown rice, wholegrain breakfast cereals and whole oats. Remember, you can also purchase high fibre white versions of bread and pasta which will help to increase your fibre intake using a like-for-like substitute of your family favourites.

## Beans, Pulses, Fish, Eggs, Meat and Other Proteins


These foods are sources of protein, vitamins and minerals, so it is important to eat some foods from this group.

Beans, peas and lentils (which are all types of pulses) are good alternatives to meat because they're naturally very low in fat, and they're high in fibre, protein, vitamins and minerals.

Pulses, or legumes as they are sometimes called, are edible seeds that grow in pods and include foods like lentils, chickpeas, beans and peas.

Other vegetable-based sources of protein include tofu, bean curd and mycoprotein; all of which are widely available in most retailers.

Aim for at least two portions (2 x 140g) of fish a week, including a portion of oily fish.

Most people should be eating more fish, but there are recommended limits for oily fish, crab and some types of white fish. For more information on fish please see www.nhs.uk/Livewell/Goodfood/Pages/fish-shellfish.

Also www.msc.org/ for more guidance on sustainably sourced fish.

Some types of meat are high in fat, particularly saturated fat. So when you're buying meat, remember that the type of cut or meat product you choose, and how you cook it, can make a big difference.

To cut down on fat, choose lean cuts of meat and go for leaner mince, cut the fat off of meat and the skin off of chicken, try to grill meat and fish instead of frying and have a boiled or poached egg instead of fried.

If you eat more than 90g of red or processed meat per day, try to cut down to no more than 70g per day. The term processed meat includes sausages, bacon, cured meats and reformed meat products.

## Hydration

Aim to drink 6-8 glasses of fluid every day. Water, lower-fat milk and sugar-free drinks including tea and coffee all count.

Fruit juice and smoothies also count towards your fluid consumption, although they are a source of free sugars* and so you should limit consumption to no more than a combined total of 150ml per day.

Sugary drinks are one of the main contributors to excess sugar consumption amongst children and adults in the UK. Swap sugary soft drinks for diet, sugar-free or no added sugar varieties to reduce your sugar intake in a simple step.

Alcohol also contains lots of calories (kcal) and should be limited to no more than 14 units per week for men and women. The calorific content of an alcoholic beverage depends on the type of alcohol, the volume served and the addition of mixers.

As an example, 1 pint of standard strength lager contains approximately 136kcal, a 175ml medium glass of wine contains approximately 135kcal and a 25ml shot of spirit (40% vol) contains approximately 56kcal.


## Foods High in Fat, Salt and Sugars


This includes products such as chocolate, cakes, biscuits, full-sugar soft drinks, butter and ice-cream. These foods are not needed in the diet and so, if included, should only be done infrequently and in small amounts.

If you consume these foods and drinks often, try to limit their consumption so you have them less often and in smaller amounts.

Food and drinks high in fat and sugar contain lots of energy, particularly when you have large servings. Check the label and avoid foods which are high in fat, salt and sugar!

## Oils and Spreads

Although some fat in the diet is essential, generally we are eating too much saturated fat and need to reduce our consumption.

Unsaturated fats are healthier fats that are usually from plant sources and in liquid form as oil, for example, vegetable oil, rapeseed oil and olive oil. Swapping to unsaturated fats will help to reduce cholesterol in the blood, therefore it is important to get most of our fat from unsaturated oils.

Choosing lower fat spreads, as opposed to butter, is a good way to reduce your saturated fat intake.

Remember that all types of fat are high in energy and should be limited in the diet.

## Advantages and Disadvantages of the Eatwell Guide (Limitations)

| Advantages | Disadvantages |
|---|---|
| Easy on the eye – Colours help with association. | Incorrectly uses a "one size fits all" ideology |
| Allows for a greater emphasis on food choices | Criticised as being shaped by food companies rather than dieticians |
| Highlights the importance of fruit and vegetables. | Non-specific for special population groups |
| Ensures that every plate of food can be balanced | Does not highlight portion sizes |
| Does aim to reduce processed food consumption. | Permits the use of highly processed foods. |
| Shows food to help guide the people who use it. | Assumes that all macronutrients are created equal. |
| Allows alcohol use but it is not moderated. | |

## The importance of healthy eating in relation to growth, repair and injury.

The body needs all nutrients in appropriate amounts to be able to grow and repair itself following injury. Without the right balance of all required nutrients (particularly calcium and other minerals for bone growth and protein for muscle growth and repair), the body does not have the available resources to build and rebuild the appropriate structures in the body.