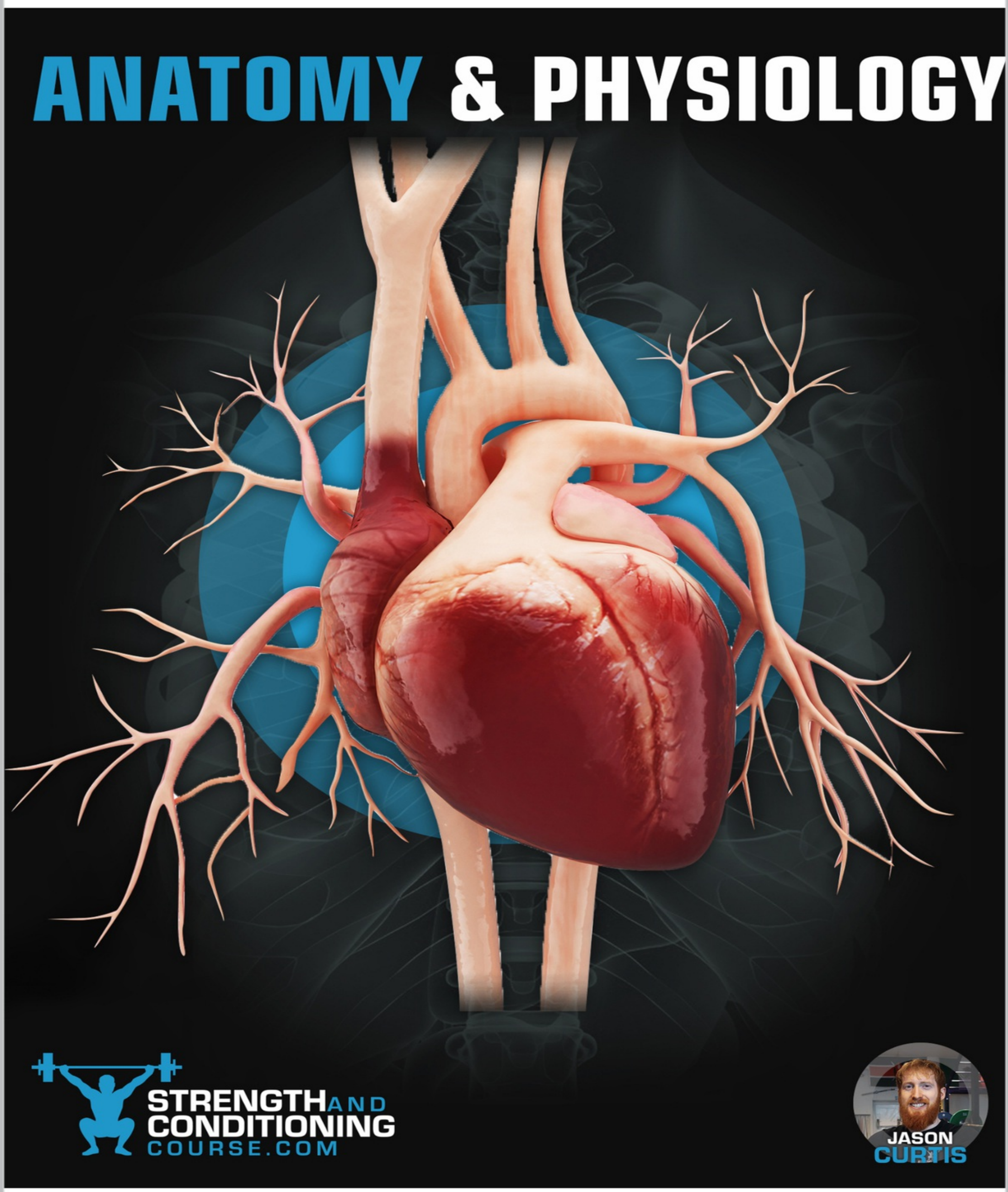
ANATOMY & PHYSIOLOGY



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ANATOMY & PHYSIOLOGY

A SIMPLIFIED GUIDE TO THE STRUCTURES AND SYSTEMS OF THE HUMAN BODY

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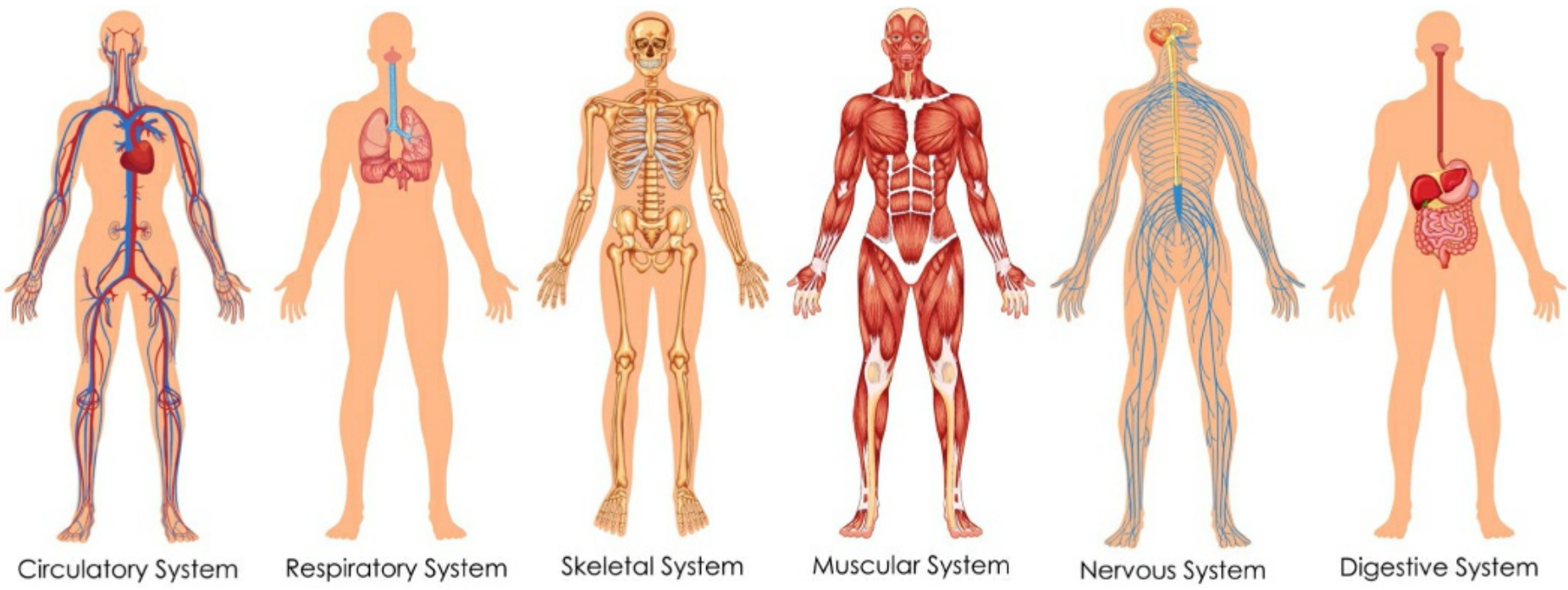
INTRODUCTION

Anatomy is the study of the structures of the body and physiology is the study of the functions of the body.

The manual is specifically designed for fitness professionals who are looking to pass their anatomy and physiology exams and enthusiasts who want to learn more about the human body. Therefore, it is straight to the point.

In this manual, we will look at the below nine sections:

- Cardiorespiratory System.
- Skeletal System.
- Muscular System.
- Nervous System.
- Endocrine System.
- Energy Systems.
- Digestive System.
- Components of Fitness.
- Injuries.



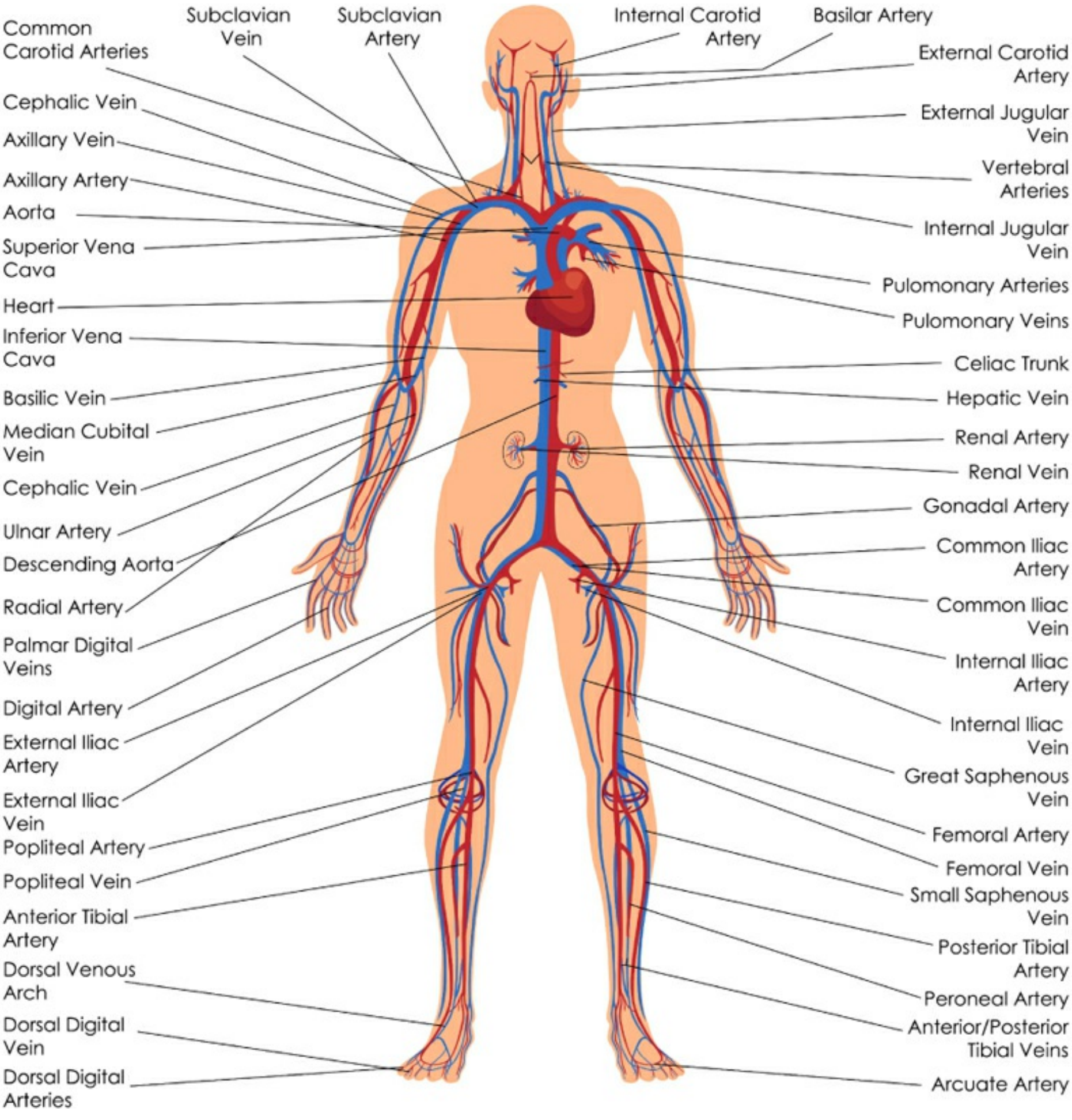
THE CARDIORESPIRATORY SYSTEM

The circulatory system, aka cardiovascular (CV) system or vascular system, is made up of the heart, the blood vessels and the blood itself.

The system circulates blood which transports nutrients, oxygen, carbon dioxide, hormones, and blood cells to and from the cells (muscles and other structures) in the body to provide nourishment, stabilize temperature, repair injury, fight disease and maintain homeostasis.

The biological definition of homeostasis is “the tendency of an organism or cell to regulate its internal environment and maintain equilibrium”.

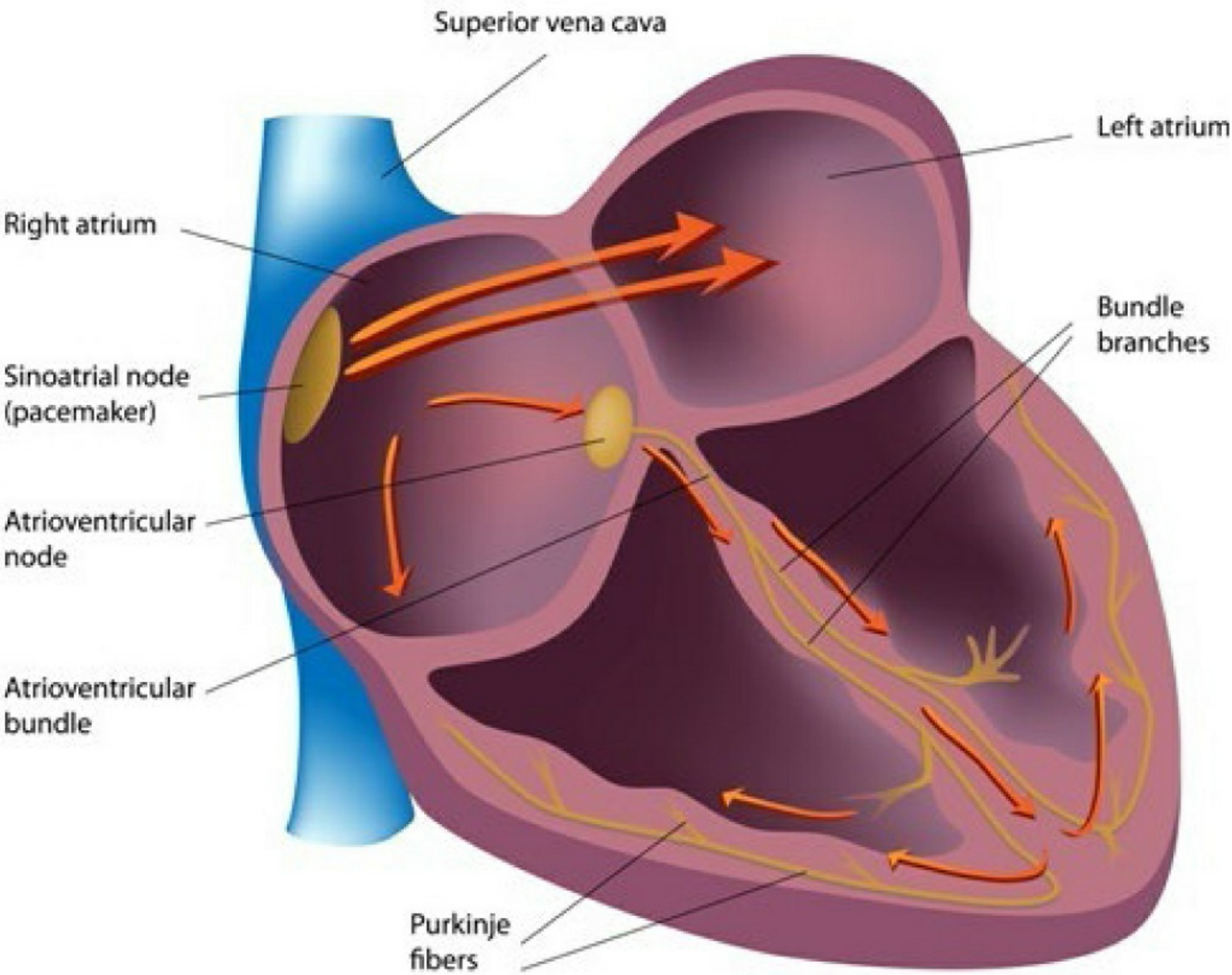
The circulatory system also includes the lymphatic system, which we will see look at on later pages.



CONTRACTION OF THE HEART

The bullet points below detail the processes taken to contract the heart.

- An Action potential (AP)/electrical impulse is generated in the Sinoatrial (SA) Node.
- The AP is passed from cell to cell across the atria – cells of the atria contract.
- The AP reaches the Atrioventricular (AV) Node.
- The AV Node stimulates the ventricular myocardium (muscular tissue of the heart).



PULMONARY AND SYSTEMIC CIRCULATION

Pulmonary System:

- Blood flow between the heart and lungs.

Pulmonary blood vessels include:

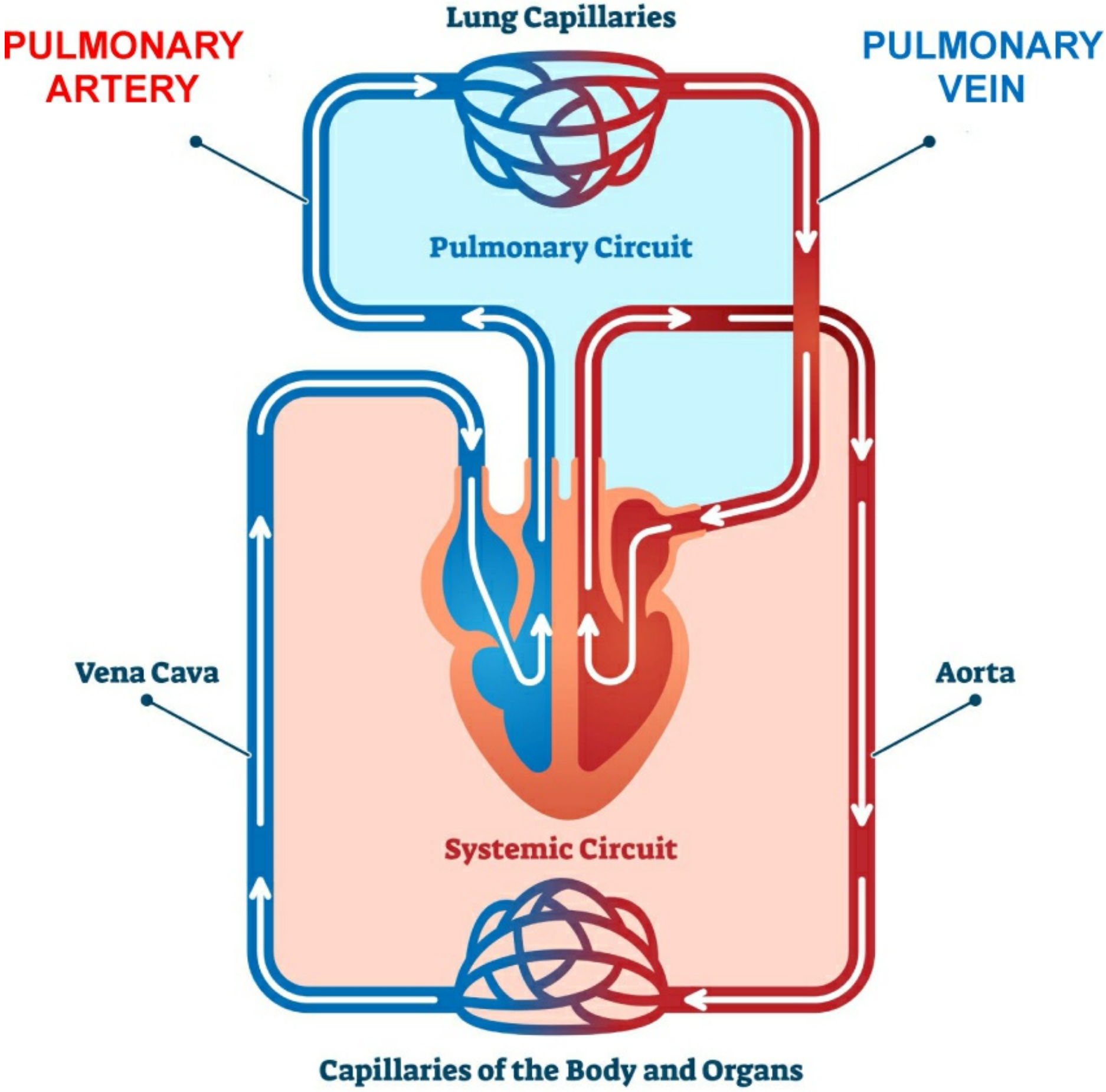
- Pulmonary arteries, arterioles, capillaries, venules and veins.

Systemic System:

- Blood flow between the heart and the rest of the body.

Systemic blood vessels include:

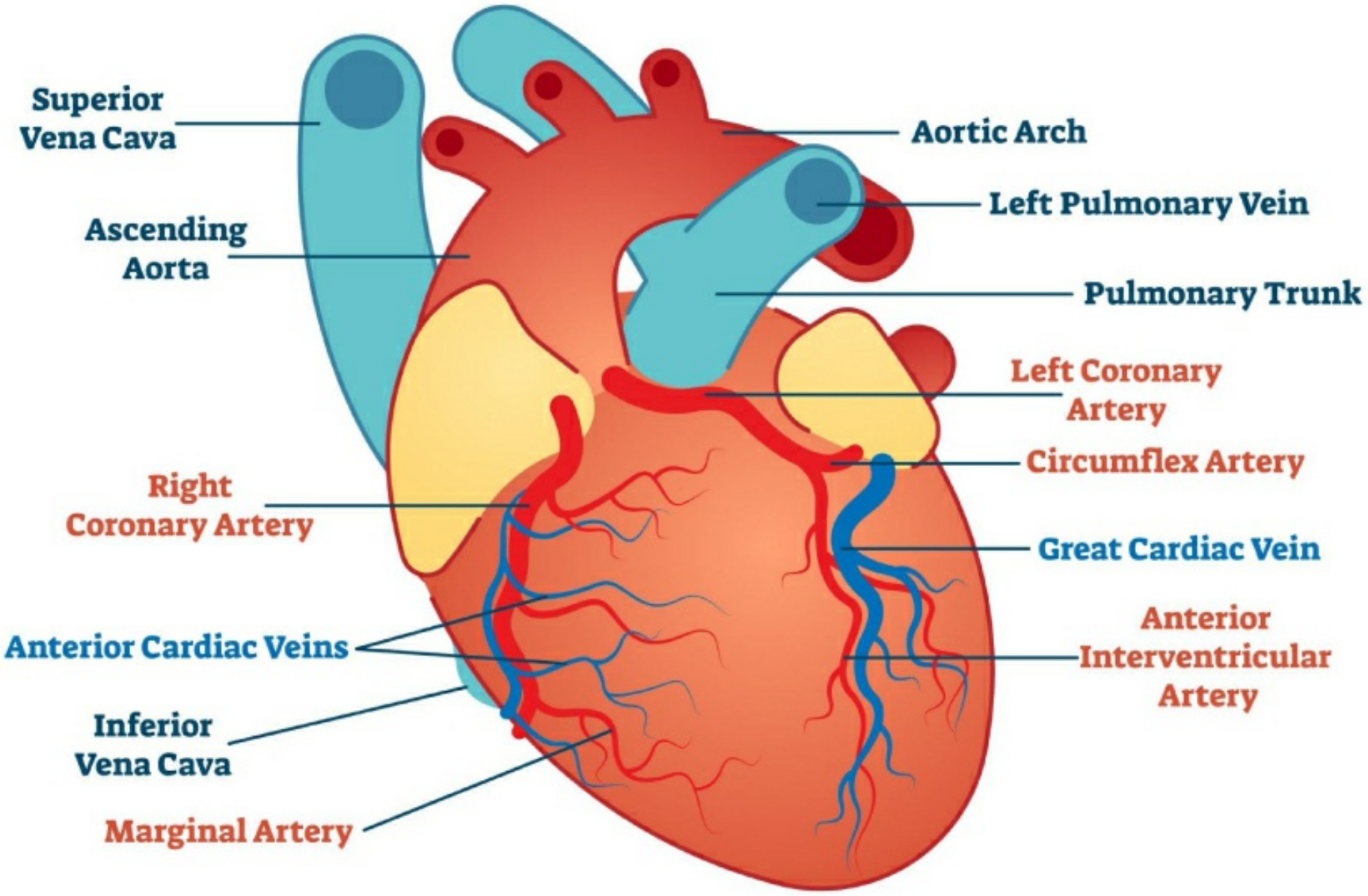
- Aorta, systemic arteries, arterioles, capillaries, venules, veins and vena cava.



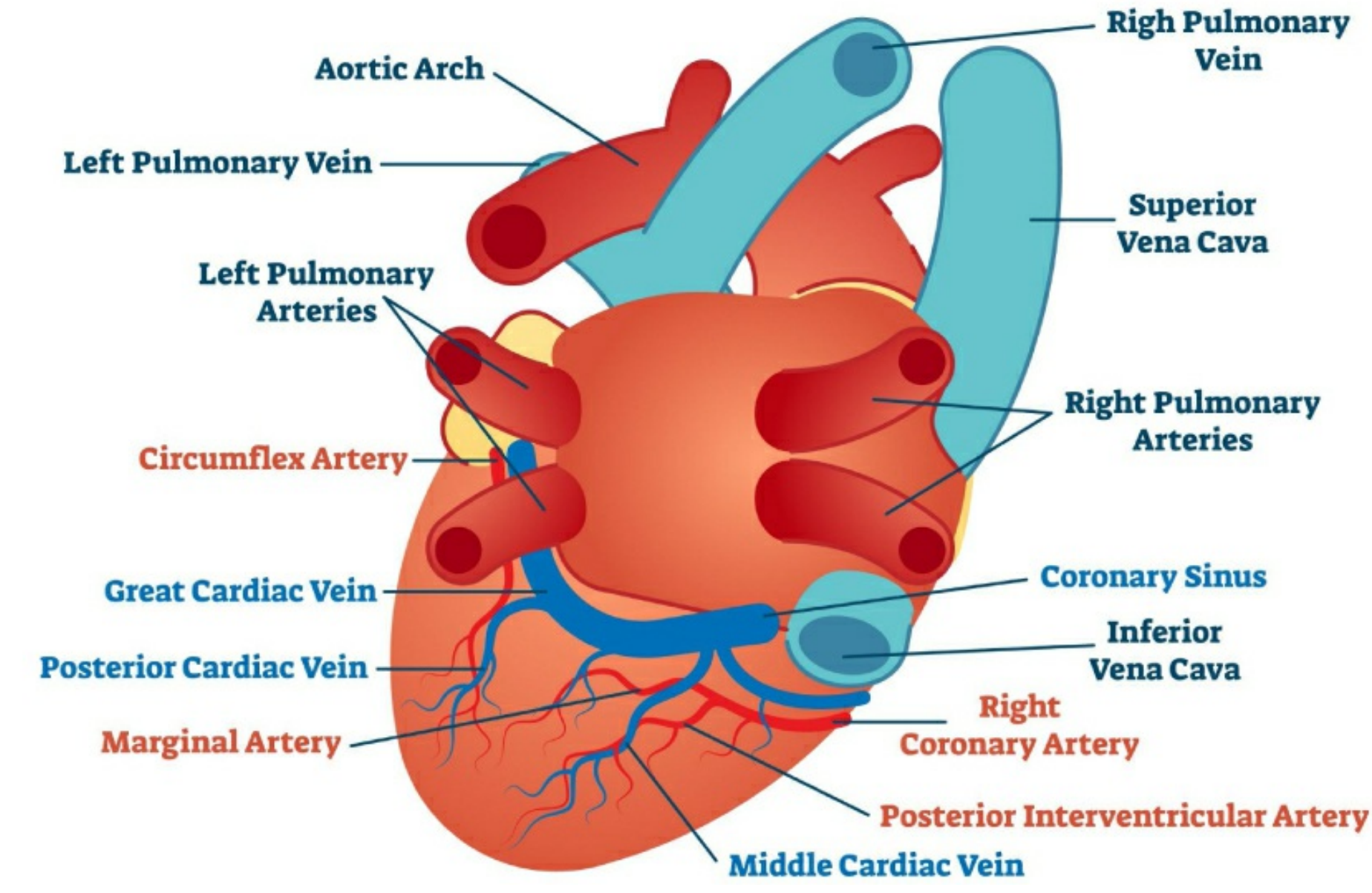
CORONARY VESSELS

These vessels transport blood to the heart tissue (myocardium).

Anterior View:



Posterior View:



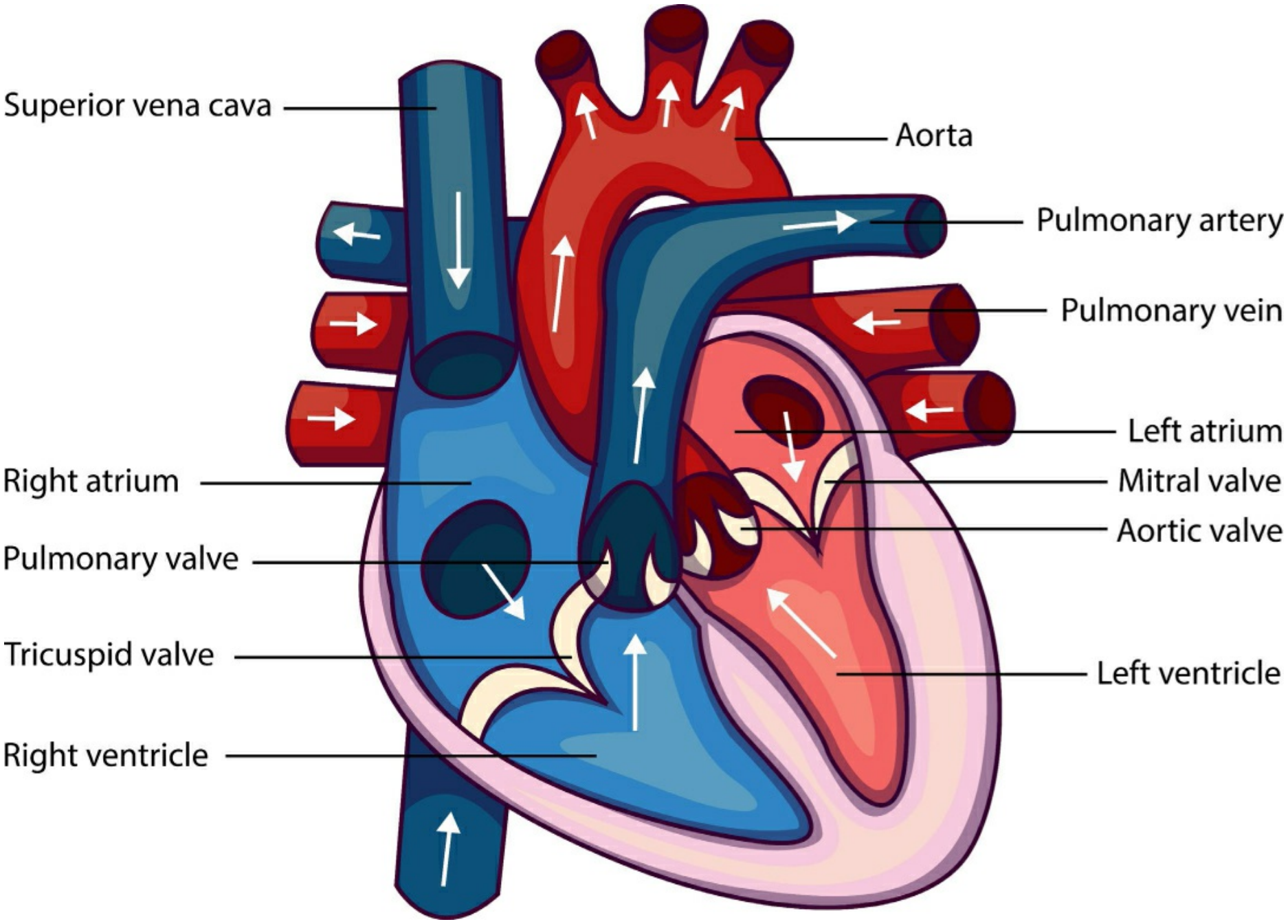
BLOODFLOW THROUGH THE HEART

The direction of blood flow through the heart is a topic that comes up A LOT in fitness professionals' anatomy and physiology tests.

Start from the superior and inferior vena cava and work your way from there.

Vena Cava – Right Atrium – Right Ventricle – Pulmonary Artery (Right & Left) – Pulmonary Veins (Right & Left) – Left Atrium – Left Ventricle – Aorta – Around the Body – Vena Cava.

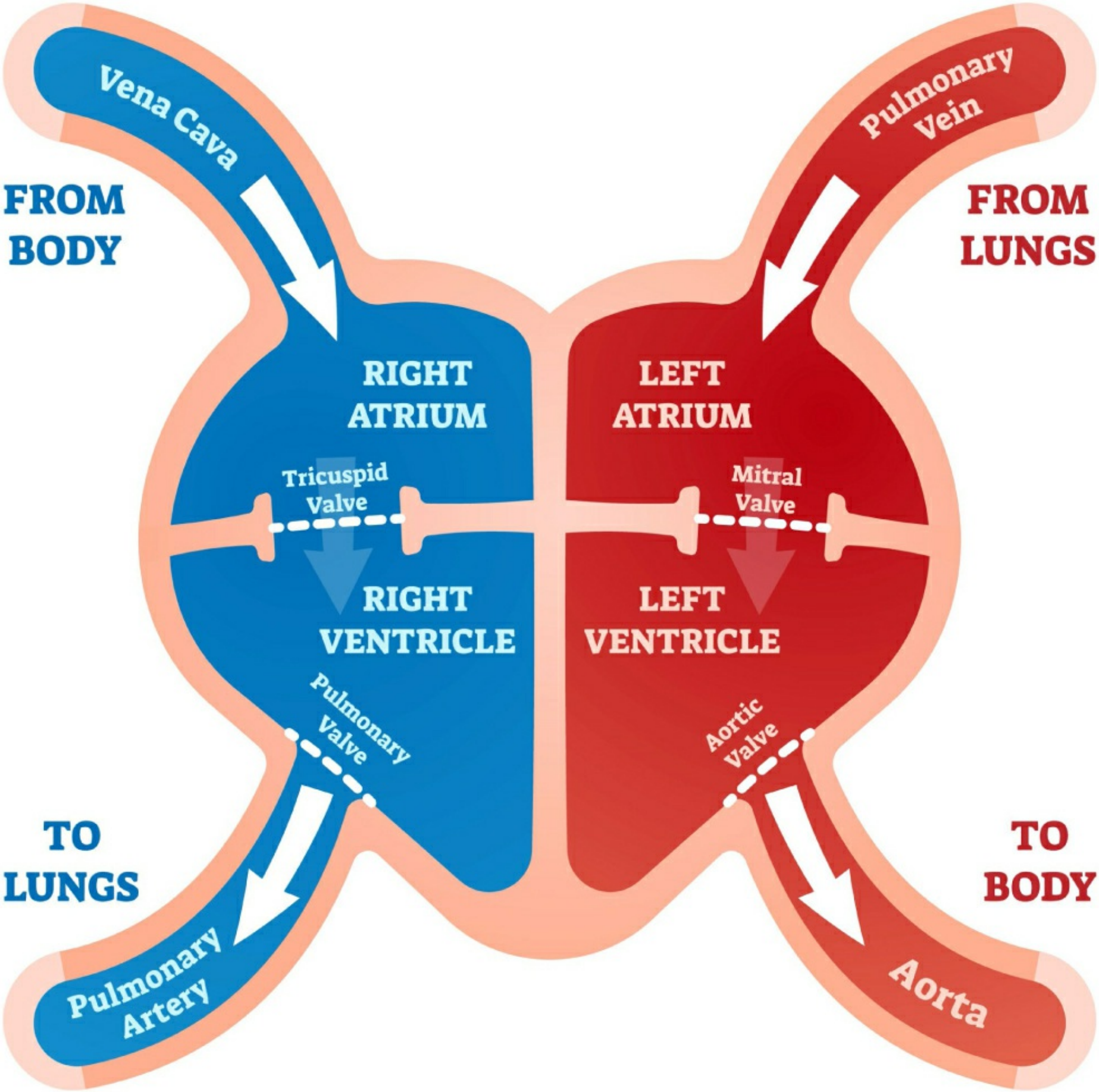
Note: Heart diagrams are drawn as if the cadaver is lying on their back.



Here is a diagram of the heart. This diagram is an inaccurate illustration in terms of the positioning of the vessels. However, it clearly shows how the blood flows from one structure to the next.

The blue depicts deoxygenated blood, while the red depicts oxygenated blood. From this, many ask why the pulmonary artery is blue when arteries usually carry oxygenated blood around the body.

Arteries carry blood Away from the heart (capital "A" to aid memory). Therefore, the pulmonary arteries are the only arteries that carry deoxygenated blood. The pulmonary veins are the only veins that carry oxygenated blood (veins carry blood back to the heart).


Vena Cava
FROM BODY
Pulmonary Vein
FROM LUNGS
RIGHT ATRIUM
LEFT ATRIUM
Tricuspid Valve
Mitral Valve
RIGHT VENTRICLE
LEFT VENTRICLE
Pulmonary Valve
Aortic Valve
TO LUNGS
TO BODY
Pulmonary Artery
Aorta

VALVES

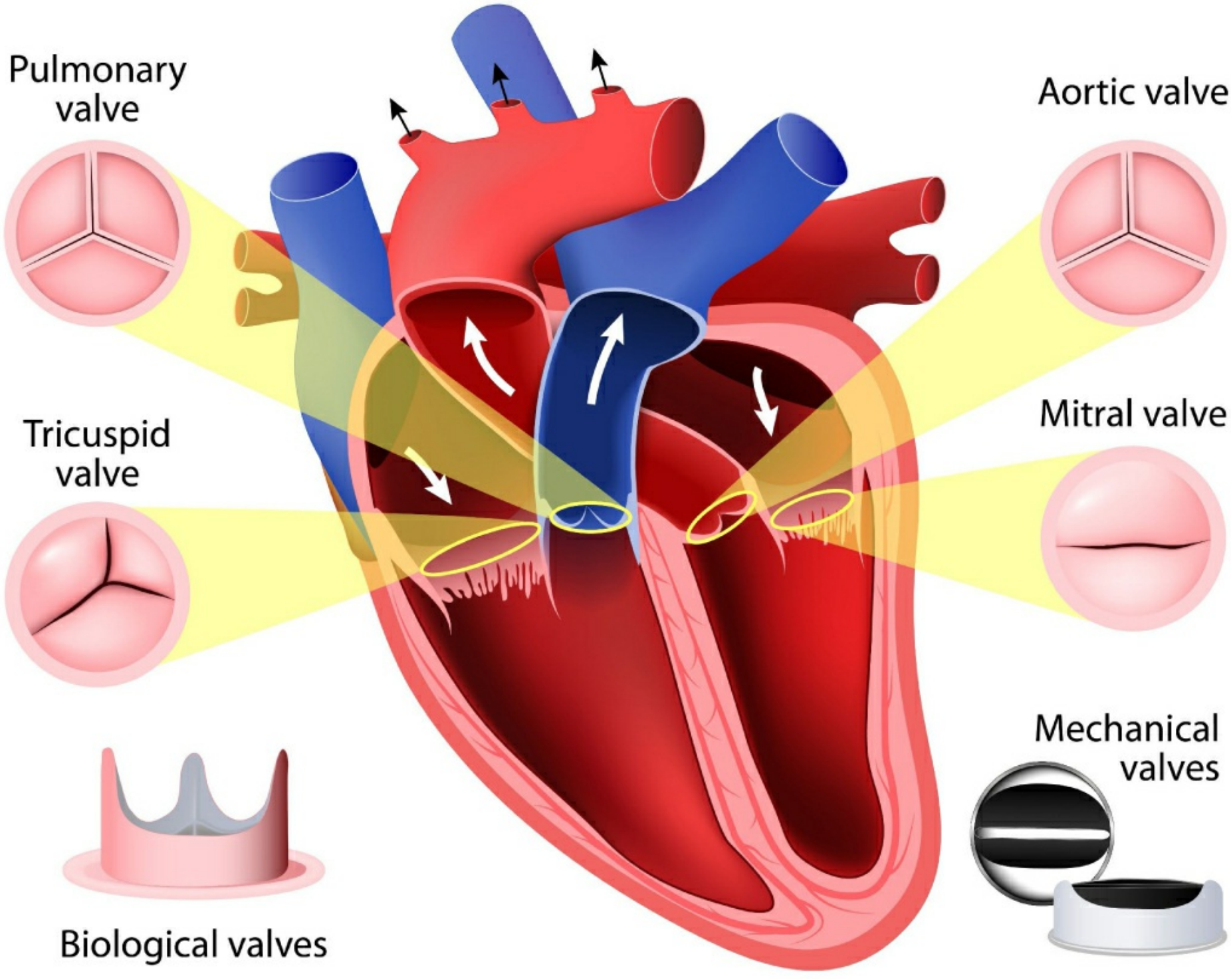
The heart has four valves that keep blood moving through the heart in the right direction.

The mitral and tricuspid valves are located between the atria (upper heart chambers) and the ventricles (lower heart chambers).

- The tricuspid valve is also known as the right atrioventricular (AV) valve.
- The mitral valve is also known as the left atrioventricular (AV) valve.

The aortic and pulmonary valves are located between the ventricles and the major blood vessels leaving the heart.

The valves are made of strong, thin flaps of tissue called leaflets or cusps. These leaflets open to let blood move forward through the heart during half of the heartbeat. They close to keep blood from flowing backward during the other half of the heartbeat.



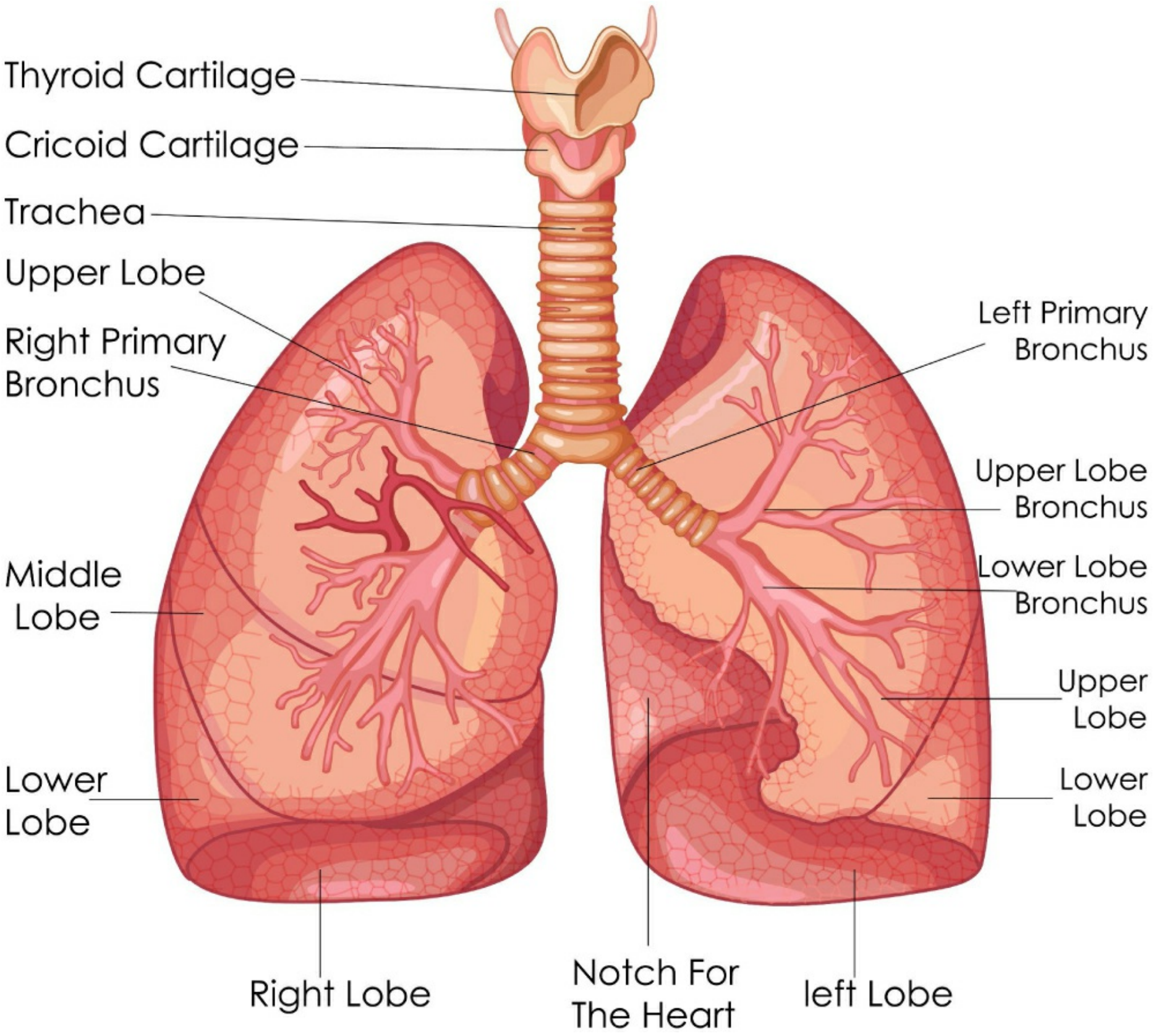
THE LUNGS

Humans have two lungs, a right lung and a left lung. They are situated within the thoracic cavity of the chest. The right lung is bigger than the left, which shares space in the chest with the heart.

At the ends of the bronchus are the bronchioles and alveoli, where gaseous exchange occurs.

The tissue of the lungs can be affected by several respiratory diseases, including pneumonia and lung cancer.

Chronic obstructive pulmonary disease (COPD) includes chronic bronchitis and emphysema and can be related to smoking or exposure to harmful substances.

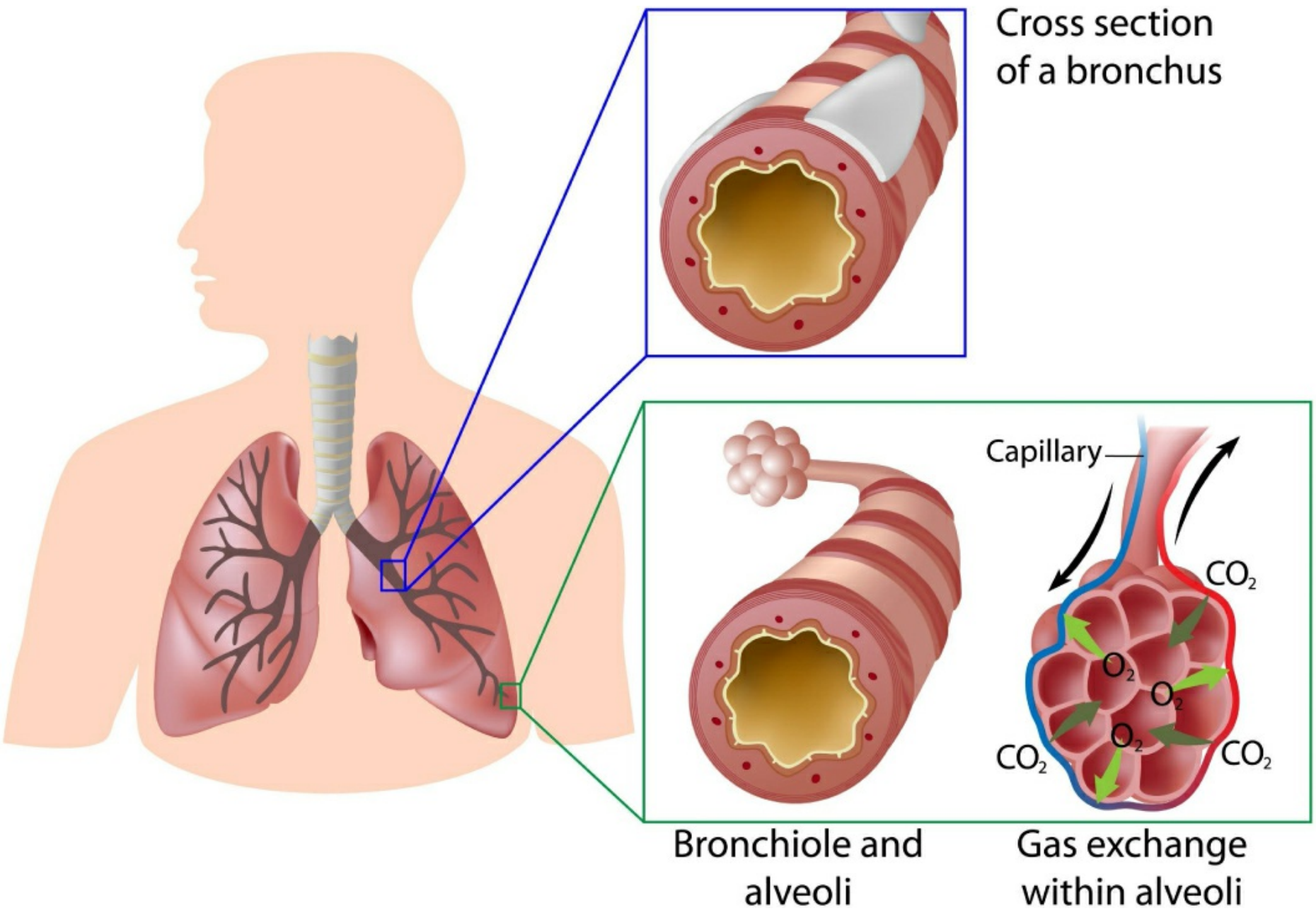


GASEOUS EXCHANGE

Gas exchange is the physical process by which gases move passively by diffusion across a surface – this process requires no energy.

The exchange of gases occurs as a result of diffusion down a concentration gradient. Gas molecules move from a region in which they are at high concentration to one in which they are at low concentration.

Within the alveoli, oxygen is exchanged with carbon dioxide and enters the bloodstream.



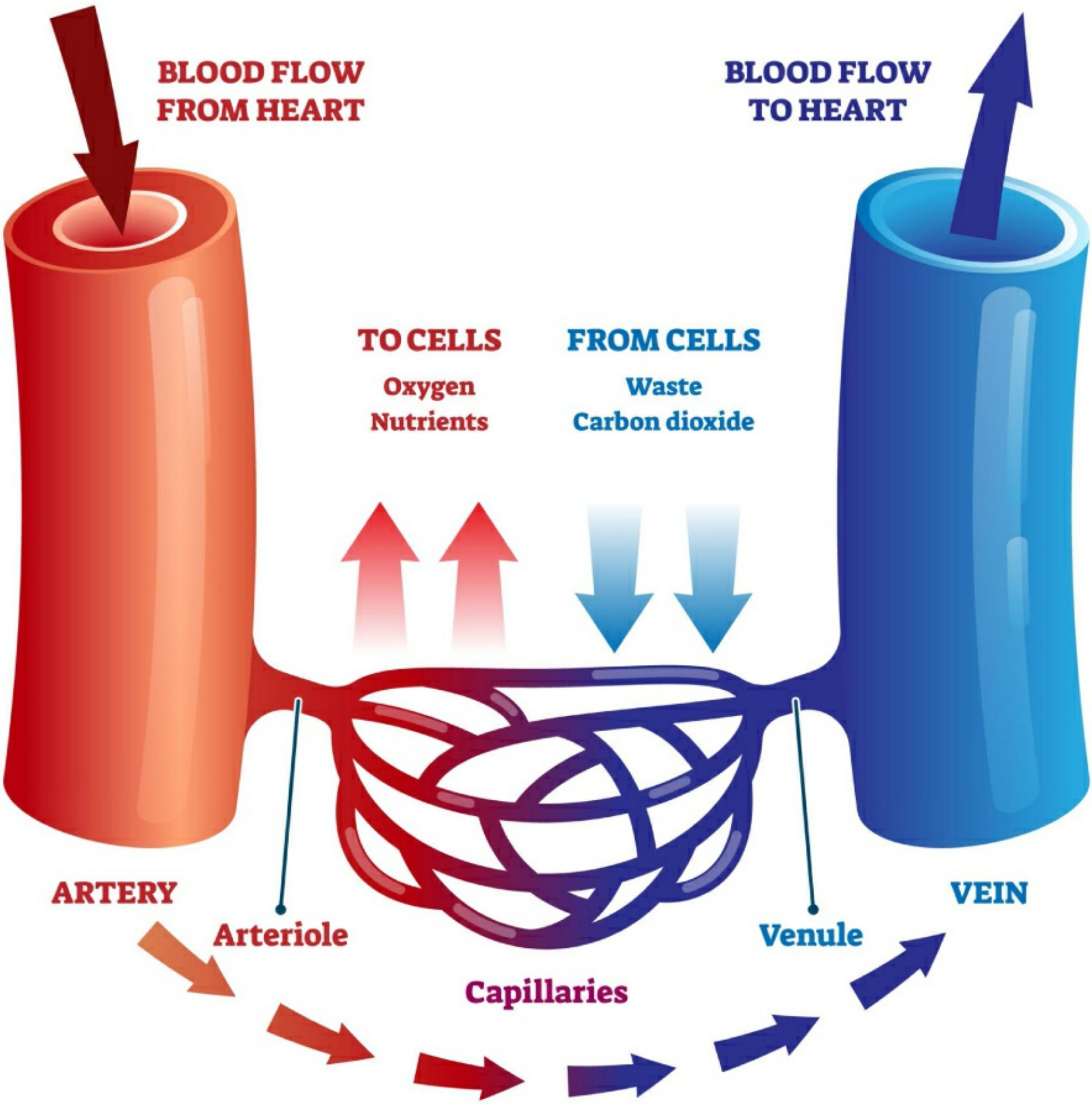
BLOOD VESSELS AND BLOOD

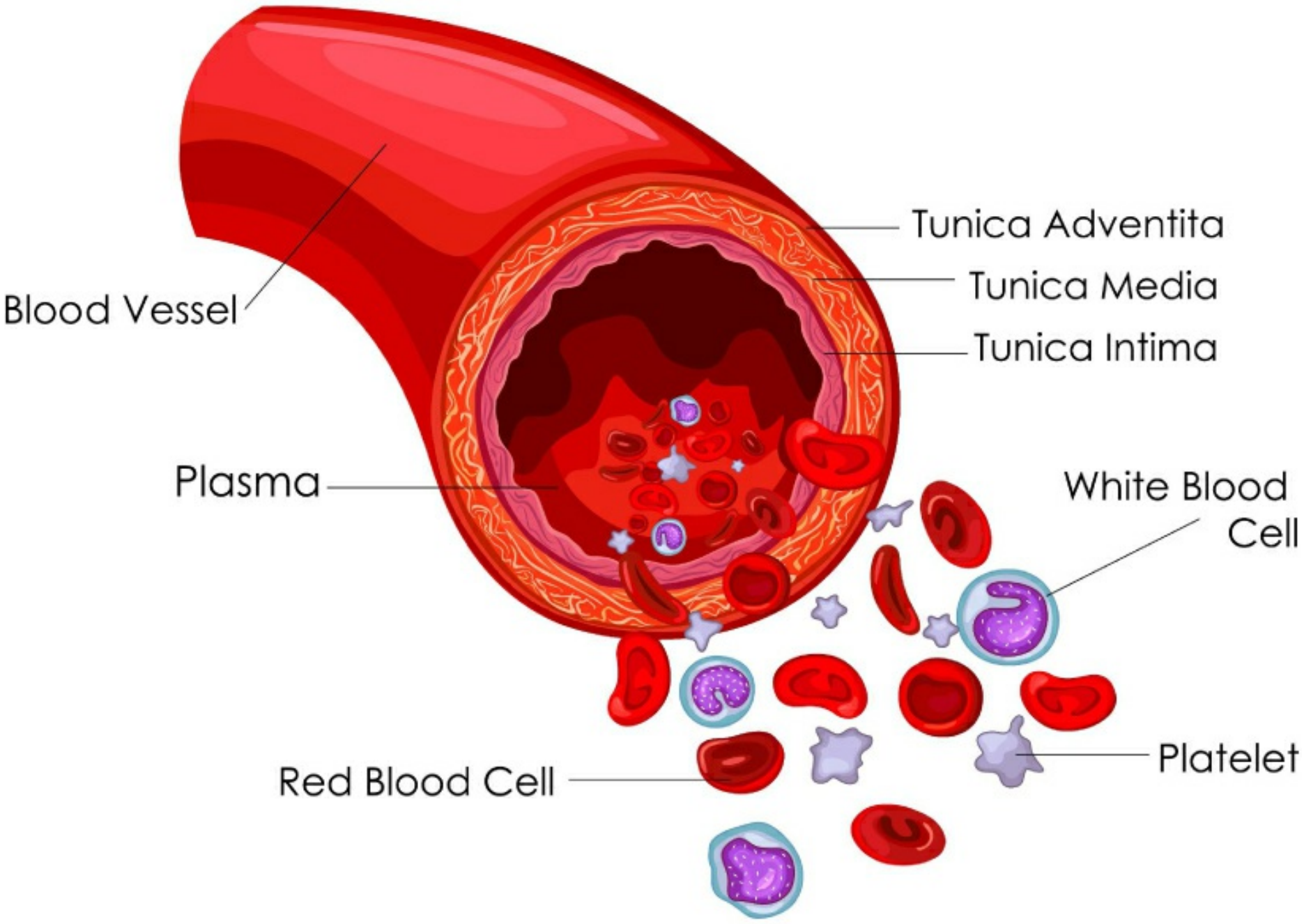
We know that arteries carry blood away from the heart and veins carry blood back to the heart.

The largest artery is the aorta and the largest vein is the inferior and superior vena cava (the inferior is the largest).

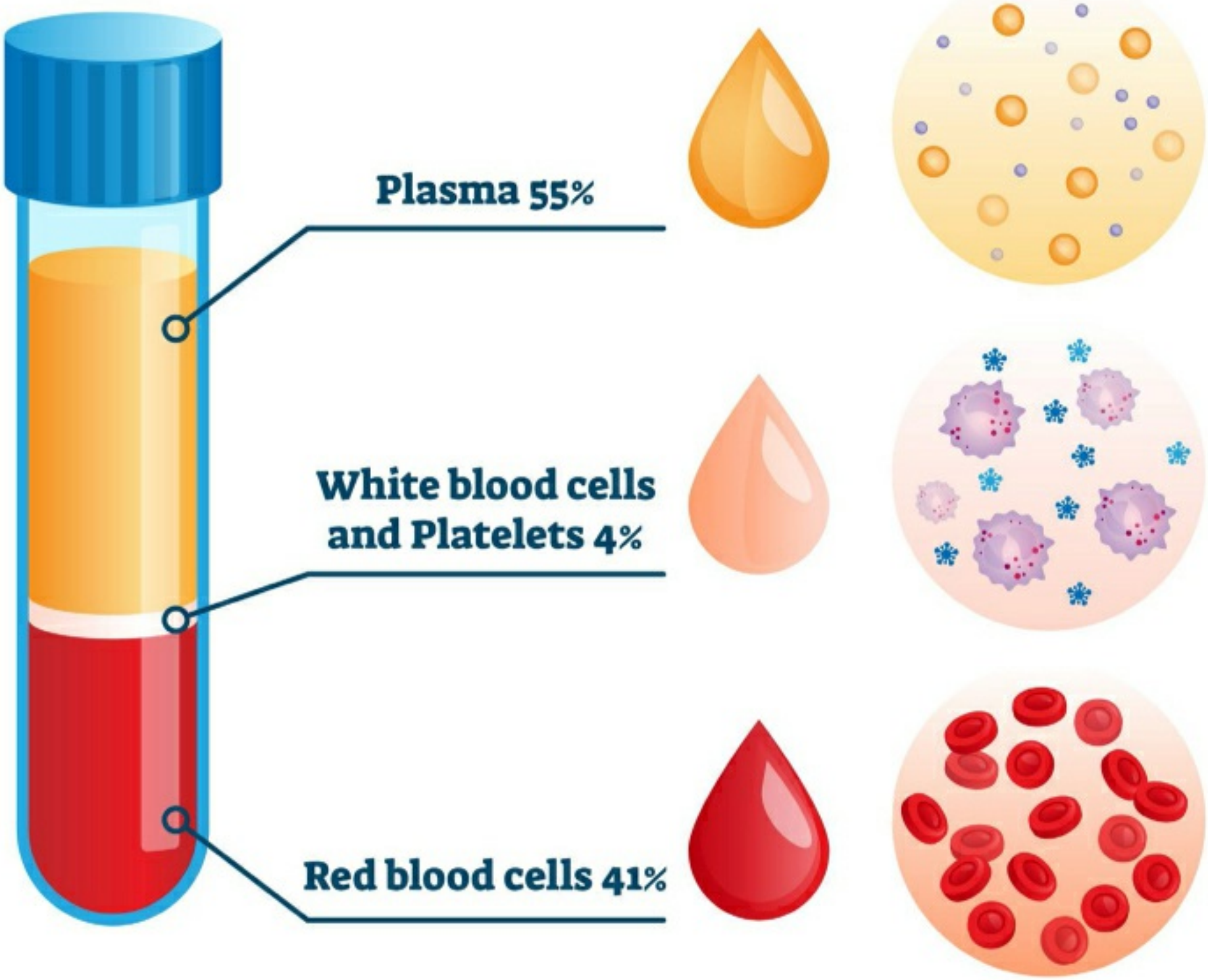
From these vessels, the blood is transported through a network of vessels:

Aorta – Arteries – Arterioles – Capillaries – Muscle Tissue – Capillaries – Venules – Veins – Vena Cava.





Note: Blood plasma is the liquid part of the blood that carries cells and proteins throughout the body.


Plasma 55%
White blood cells and Platelets 4%
Red blood cells 41%

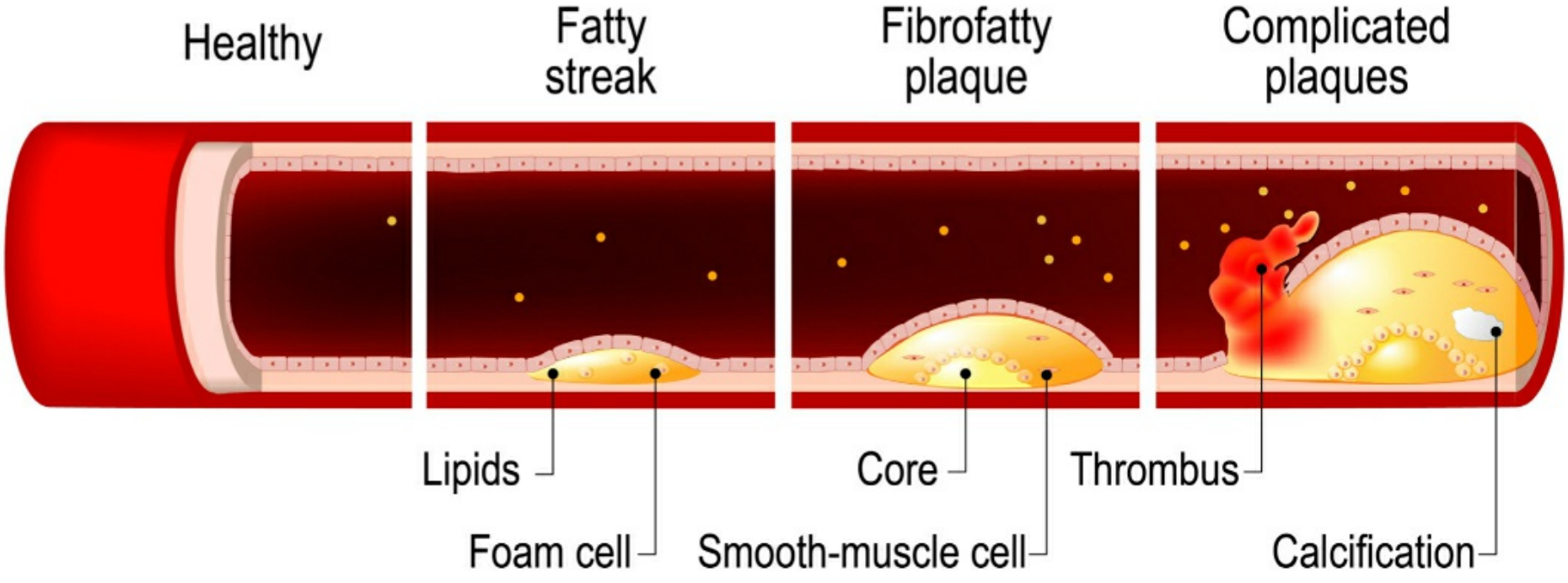
ATHEROSCLEROSIS

Arteriosclerosis (“Art”) occurs when the blood vessels that carry oxygen and nutrients from your heart to the rest of your body (arteries) become thick and stiff – sometimes restricting blood flow to your organs and tissues.

Atherosclerosis (“Ath”) is a specific type of arteriosclerosis where there is the buildup of fats, cholesterol and other substances in and on your artery walls. This buildup is called plaque.

The plaque can cause your arteries to narrow, blocking blood flow. The plaque can also burst, leading to a blood clot.

Stages of Atherosclerosis



BLOOD PRESSURE (BP)

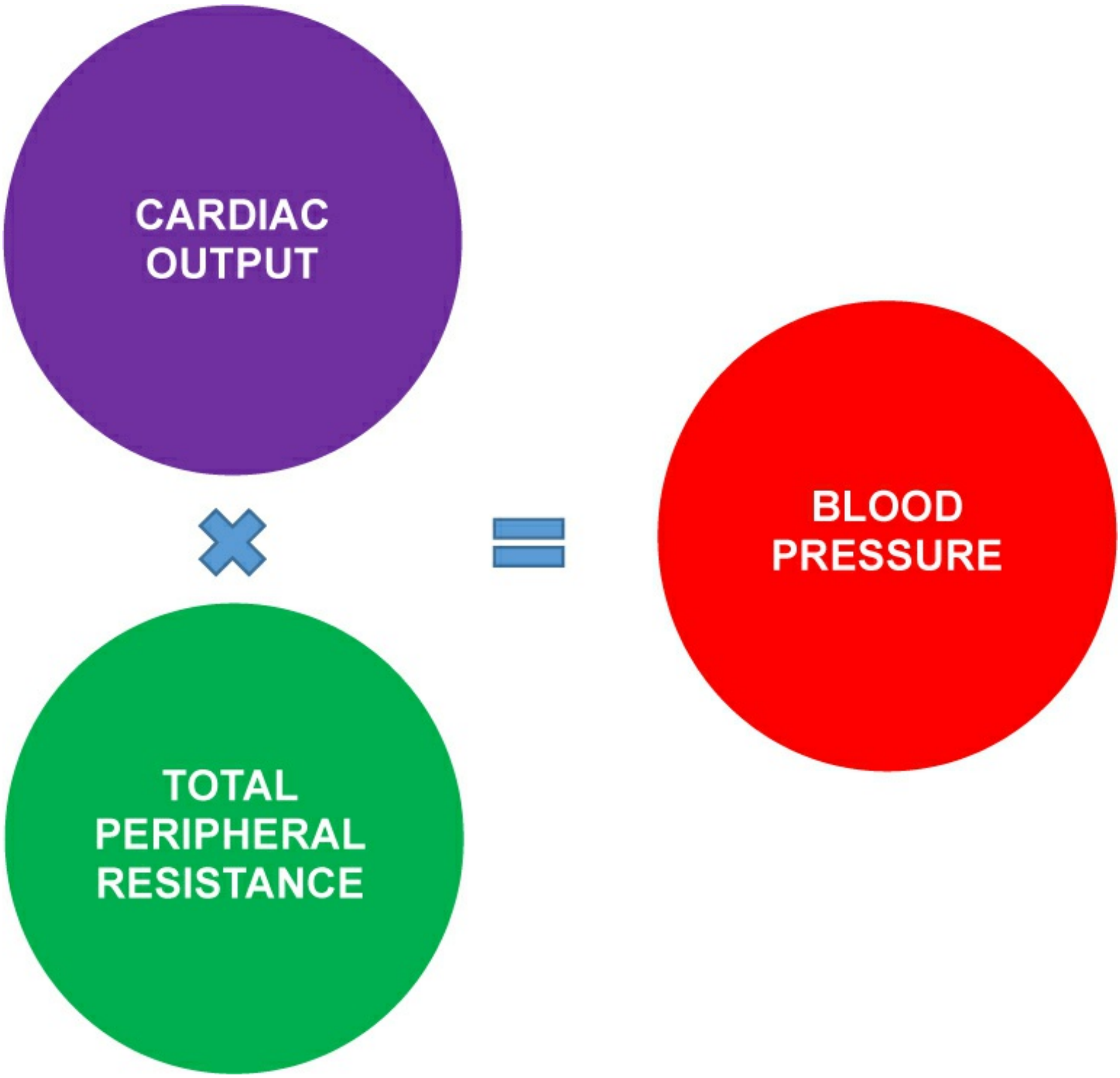
Cardiac Output describes the amount of blood your heart beats in a minute.

Your cardiac output is your **Stoke Volume** x your **Heart Rate** (beats per minute).

Stroke Volume is the amount of blood your heart pumps each time it beats.

Peripheral Resistance is the resistance of the arteries to blood flow. As they constrict, the resistance increases and as they dilate, the resistance decreases.

- **Systolic Blood Pressure:** On the Beat
- **Diastolic Blood Pressure:** Off the Beat.



“Hyper” refers to high, and “Hypo” refers to low.

Category	Systolic (mmHg)	Diastolic (mmHg)	Recommendation
Low	<100	<60	Seek medical guidance prior to exercising (90/60 = hypotension).
Optimal	120	80	If the client had no other causes for concern, exercise is recommended.
Stage 1 Hypertension	140	90	Seek medical guidance prior to exercising.
Stage 2 Hypertension	160	100	Seek medical guidance prior to exercising.
Sever Hypertension	>180	>100	It is a complete contraindication to advise a client to exercise. Any medically recommended exercise should be performed in an appropriate environment under specialist supervision.

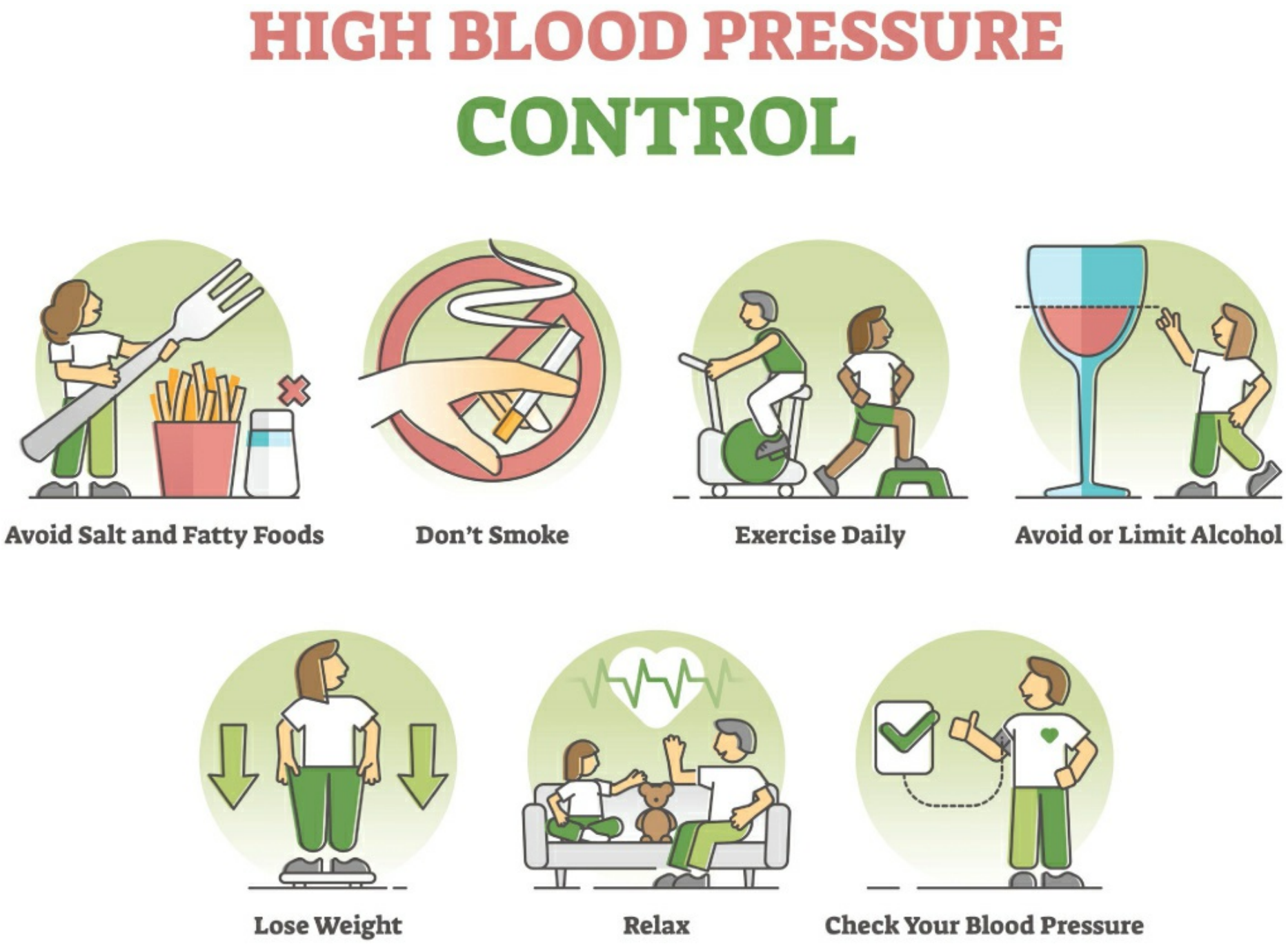
BLOOD PRESSURE AND EXERCISE

Performing heavy weight training and isometric exercise (planks, wall sits, etc) can significantly increase blood pressure (while performing the exercise).

The Valsalva maneuver (a moderately forceful attempted exhalation against a closed airway – often performed during exercise) can also create an increase in blood pressure in an attempt to normalize blood flow following breath-holding.

Postural hypotension (a reduction in blood pressure) can occur in some clients following:

- Quick changes in body position (from lying to standing).
- Long periods of static standing – most commonly experienced by older adults and pregnant women.
- Regular exercise has been shown to help reduce/normalize blood pressure.



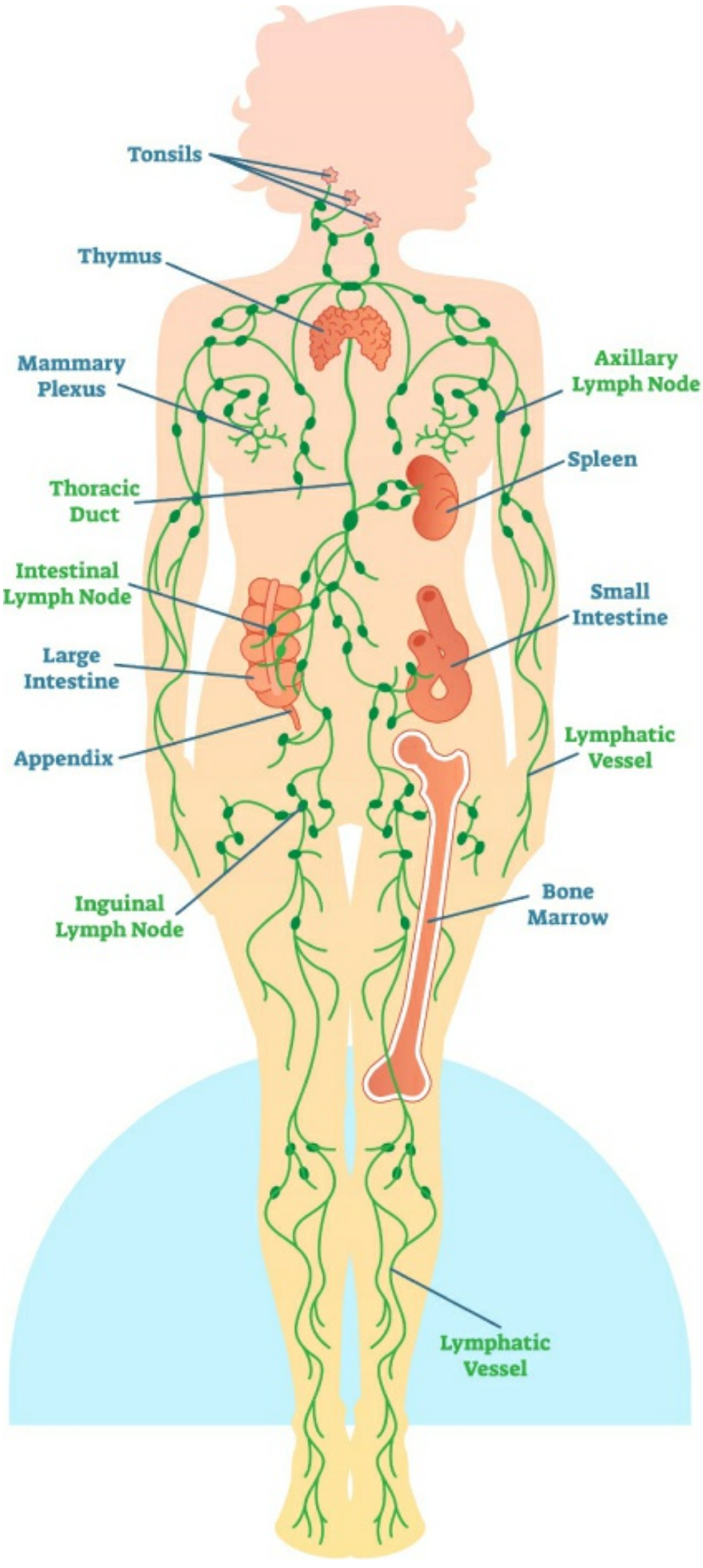
THE LYMPHATIC SYSTEM

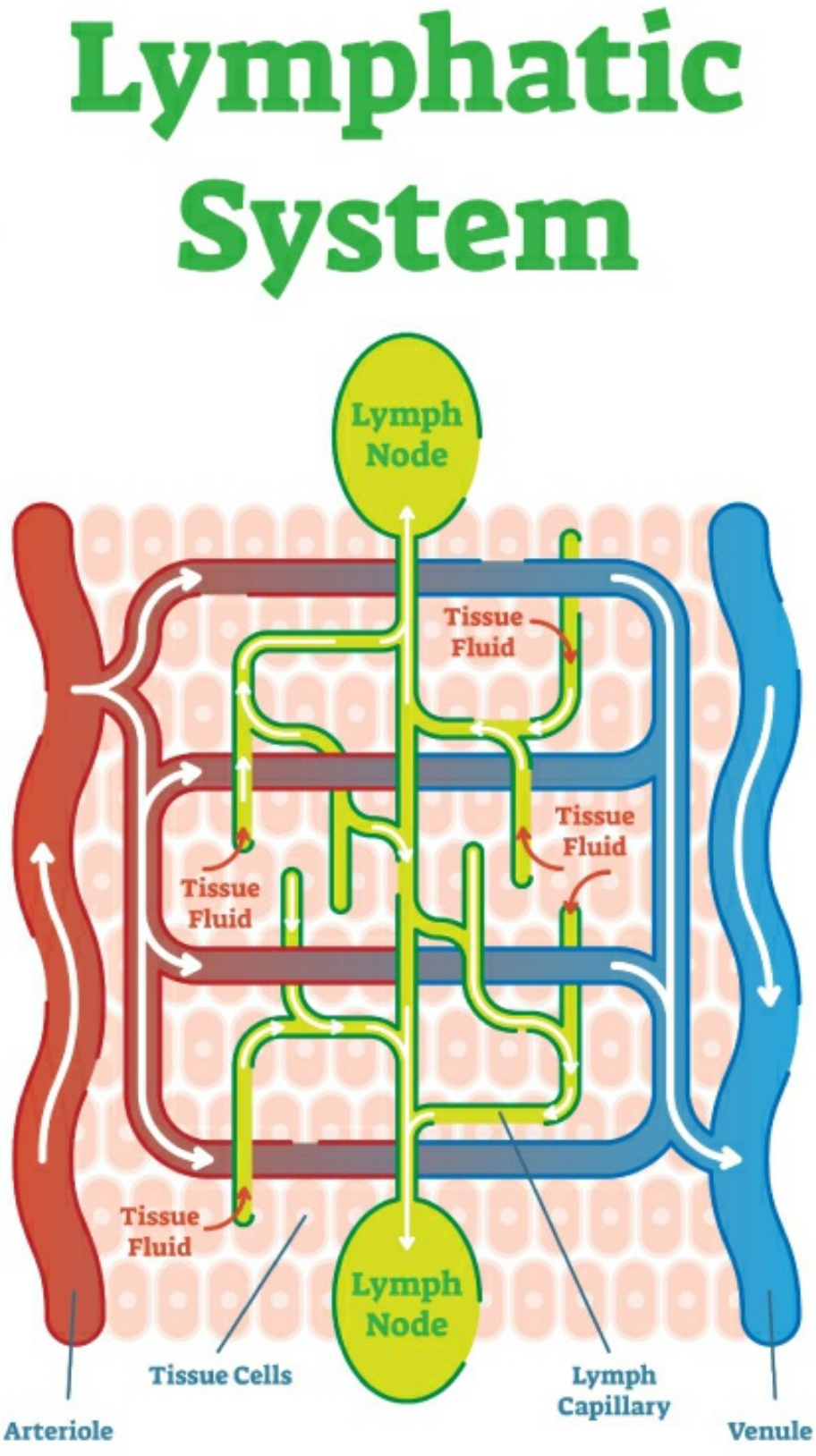
The lymphatic system is part of the circulatory system and immune system.

The lymphatic system helps maintain fluid balance in the body by collecting excess fluid and particulate matter from tissues and depositing them in the bloodstream.

As blood circulates through the body, blood plasma transitions into tissues through the thin walls of the capillaries. The portion of blood plasma that escapes is called interstitial or extracellular fluid, and it contains oxygen, glucose, amino acids, and other nutrients needed by tissue cells. Although most of this fluid is taken back into the bloodstream, a percentage is left behind.

The lymphatic system removes this fluid from tissues, returning them via the lymphatic vessels to the bloodstream.



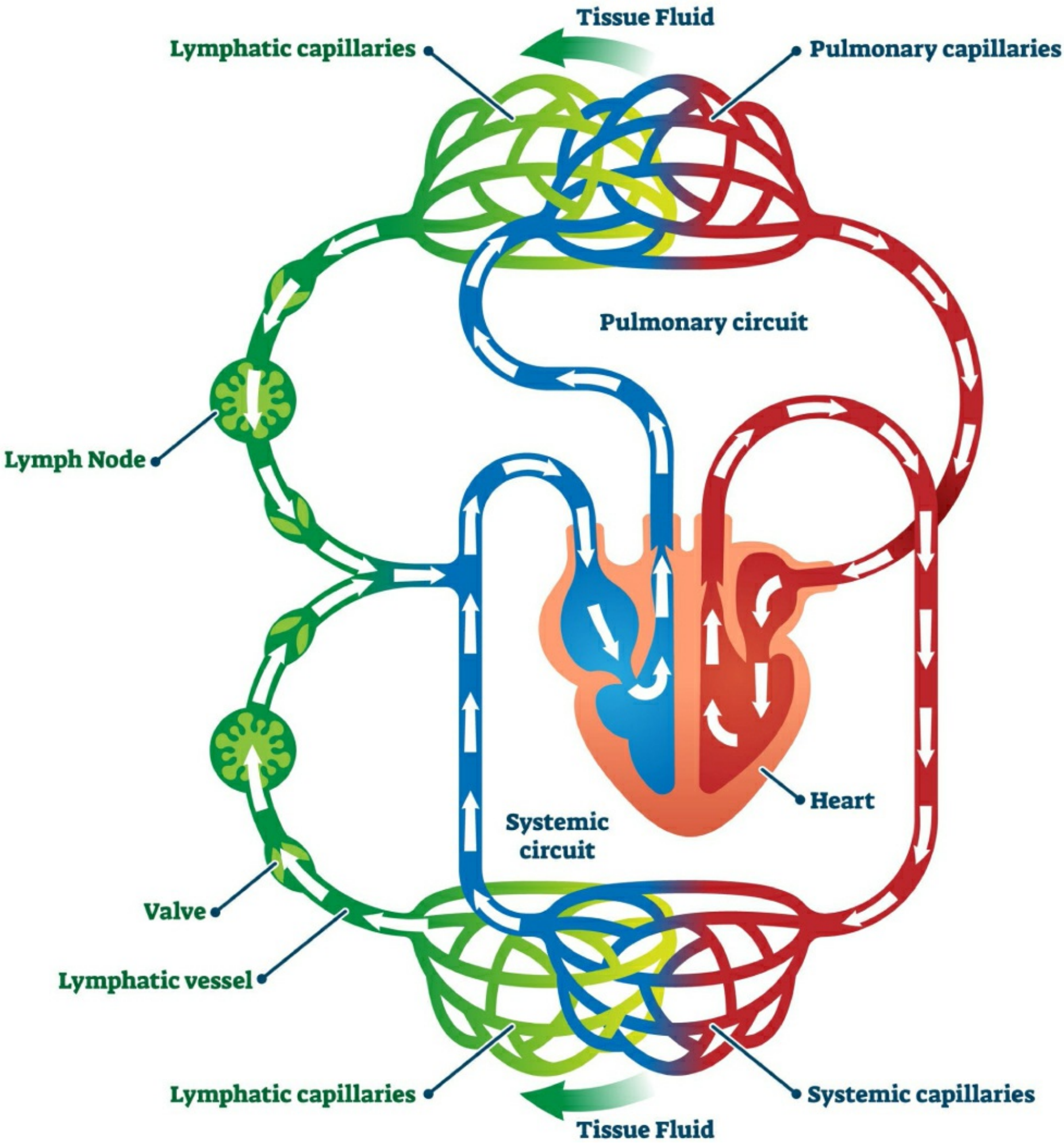


LYMPHATIC CIRCULATION

The lymphatic system also helps defend the body against infection and other issues.

Lymph vessels connect to a group of lymph nodes, which act as filters. They trap or destroy anything harmful that the body does not need.

Inside the lymph nodes are white blood cells, also called lymphocytes. These white blood cells attack and break down bacteria, viruses, damaged cells or cancer cells.



THE SKELETAL SYSTEM

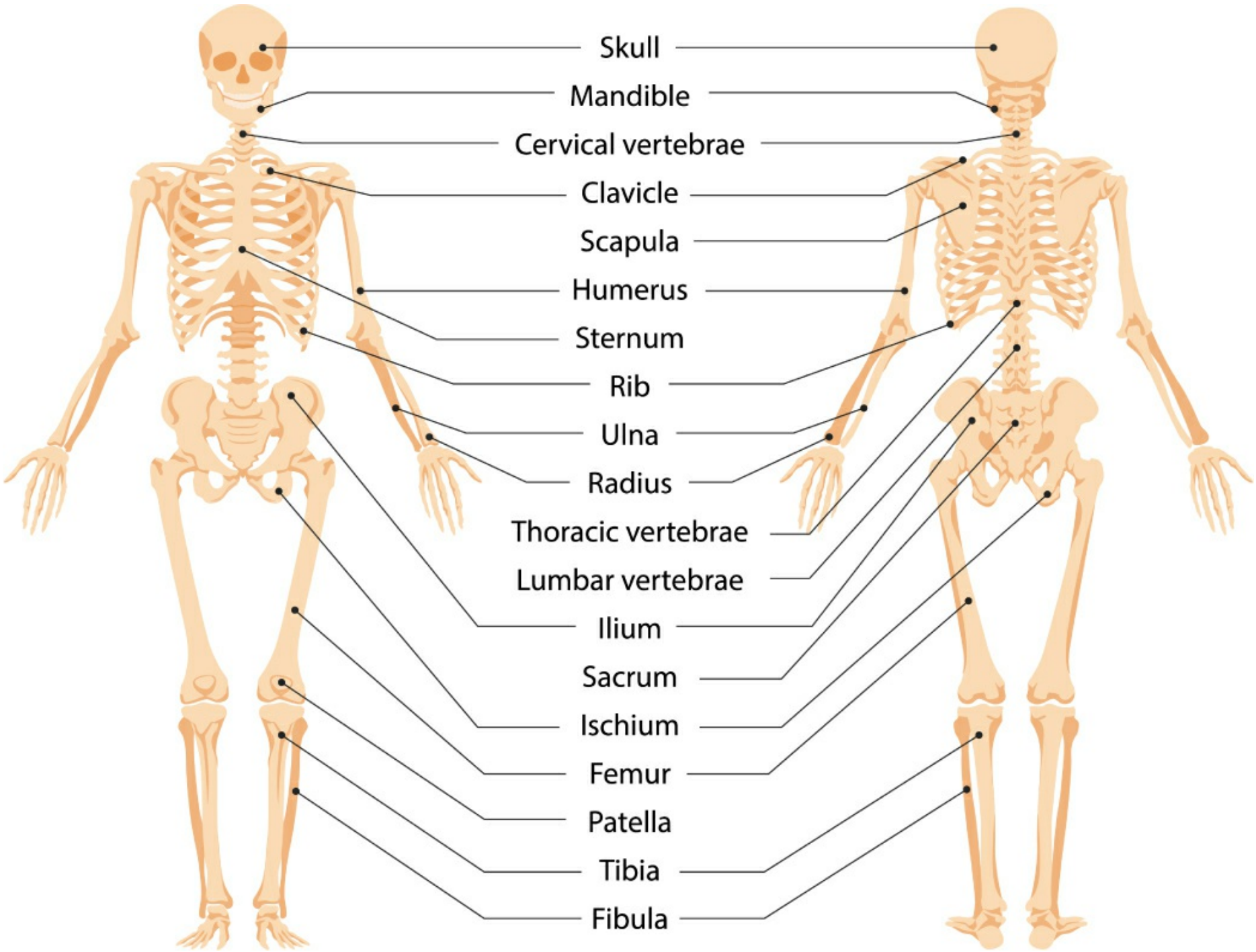
The skeleton provides the framework which supports the body and maintains its shape.

The joints between the bones allow movement, some allowing greater ranges of motion than others – we will look at the different types of joints in later pages.

At the ends of long bones such as the femur (thigh bone) or tibia (shin bone), we find bony prominences called “tuberosities”. These are where tendons and ligaments attach.

The skeleton also protects many vital organs (the skull protects the brain and the ribcage protects the heart and lungs) and is involved in storage (calcium and phosphorus) and endocrine regulation.

The skeletal and muscular system creates lever systems which we will see in a later slide.



FUNCTIONS

Functions	Explanation
Shape	The skeletal system gives the body its basic shape.
Protection	For example, the skull protects the brain and the ribs protect the heart and lungs.
Attachment	Ligaments, tendons and muscles attach to bones to create stability and movement.
Movement	Muscles pull on bones to create movement.
Production	Some bones produce red (to carry oxygen) and white (to fight infection) blood cells from their marrow.
Storage	For example, calcium and phosphorus, which support growth and development.

BONE FORMATION

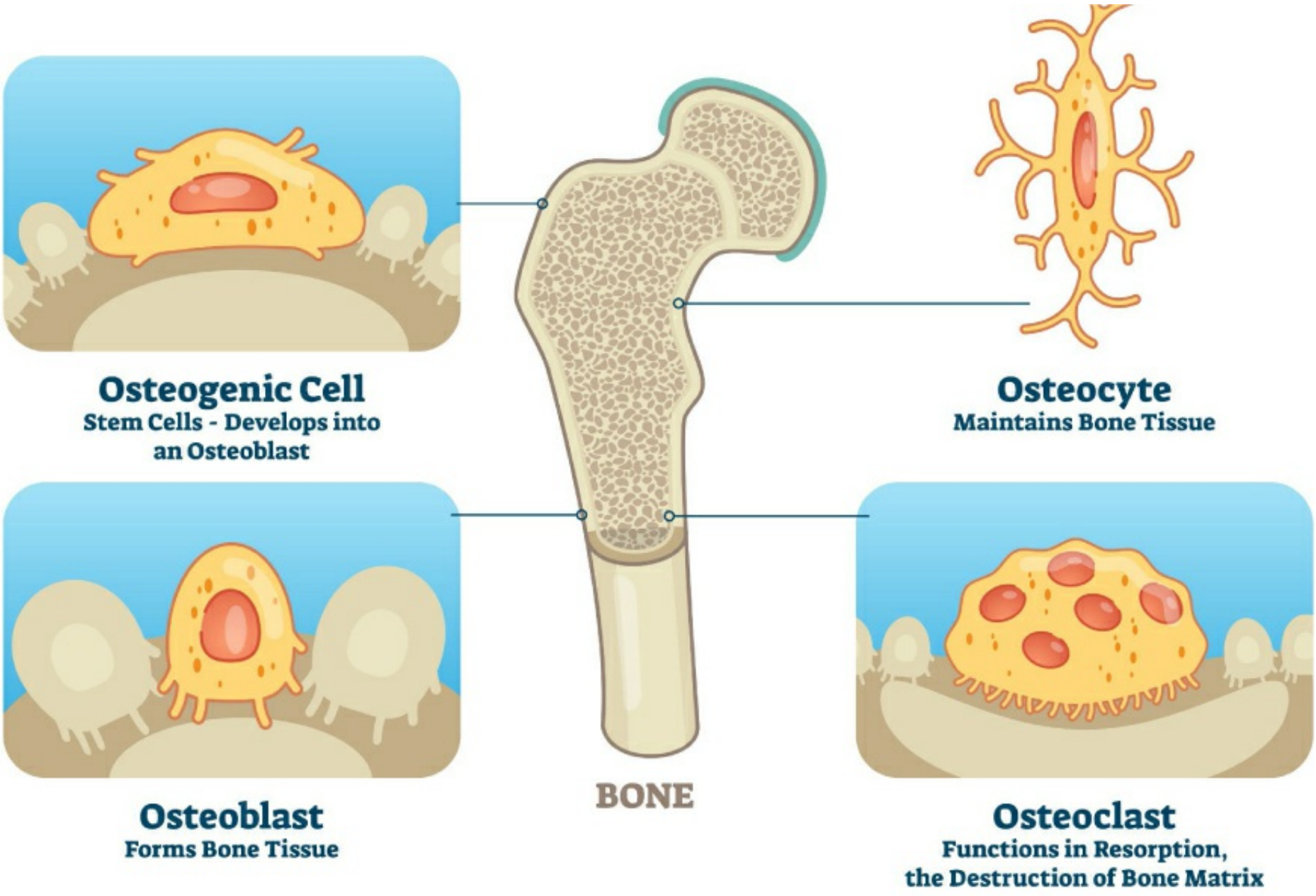
Bones are made up of calcium, phosphorus, sodium and other minerals. **The "living" bone consists of:**

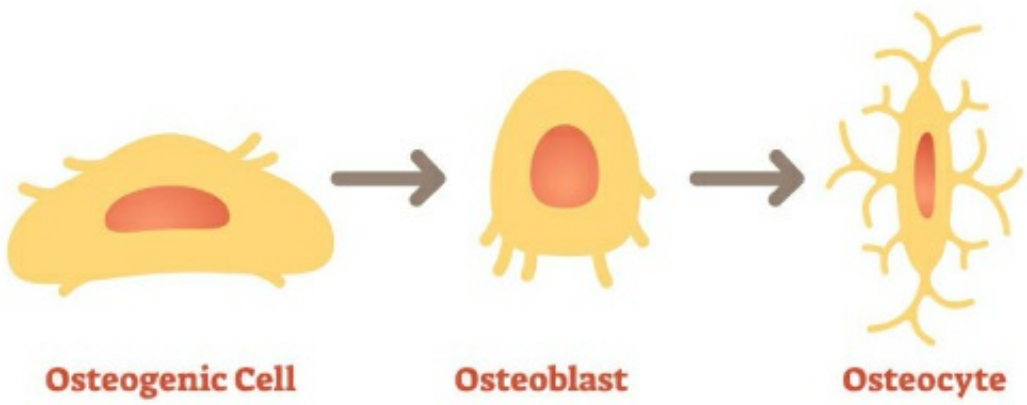
- Blood vessels.
- Nerves.
- Collagen.
- Living cells.

Osteoblasts build new bone (remember 'b' for blast, 'b' for build).

Osteoclasts clear existing bone (remember 'c' for clast, 'c' for clear).

Factors that affect bone growth include nutrition, hormones, sunlight, physical activity type and levels, smoking and alcohol, and genetic make-up.



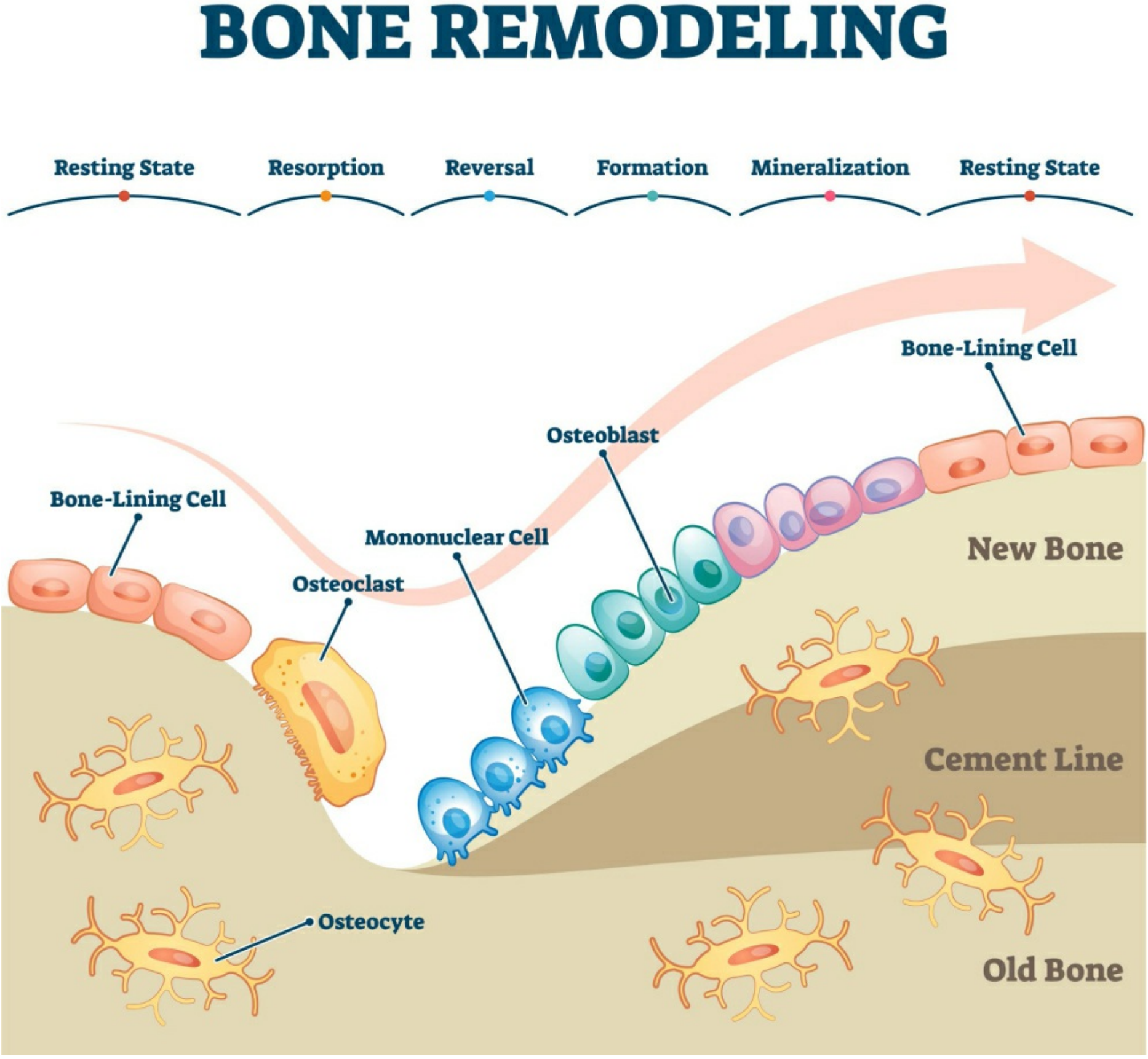


FOETAL STAGE

- Bone is mainly made up of cartilage – a tough, flexible connective tissue that has no minerals or salts.
- Ossification begins (laying down of calcium), and many bones are at least partly formed at the time of birth.
- A newborn baby has around 300 bones, some of which fuse together during early life.

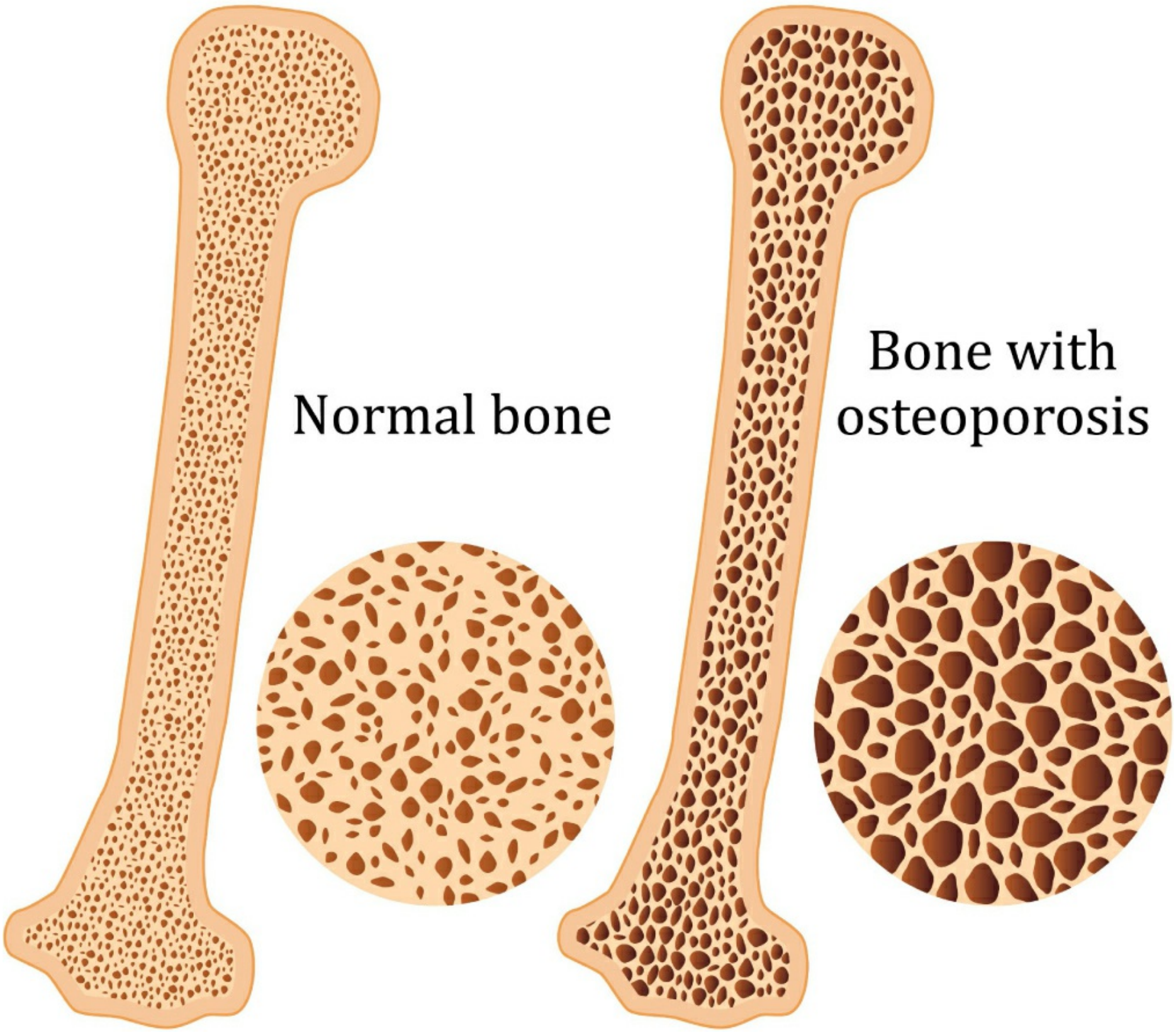
BIRTH TO ADULTHOOD

- Bone growth continues from birth to adolescence.
- Growth takes place in the epiphyseal plates of long bones (at the end of the long bone) – these are re epiphyseal lines (a plate that has become ossified) in adults who have stopped growing.
- The process of ossification is usually complete between the ages of 18 and 30.
- An adult skeleton has 206 bones.
- Bone mineral density (BMD) should be maintained and developed through good diet and exercise – training is key!



LATER-LIFE

- Calcium is progressively lost, and bone strength deteriorates.
- Breakdown of bone happens earlier in women as a result of hormonal differences.
- As we age, the risk of osteoporosis increases, along with fractures.
- Again, a good diet and regular exercise are vital – resistance training provides the stress needed to pro increases in bone mineral density.



OSTEOPOROSIS

The measure of appropriate bone mass is called a T score.

T score = the difference between actual bone mass and expected bone mass and is measured as a standard deviation (SD) from the norm.

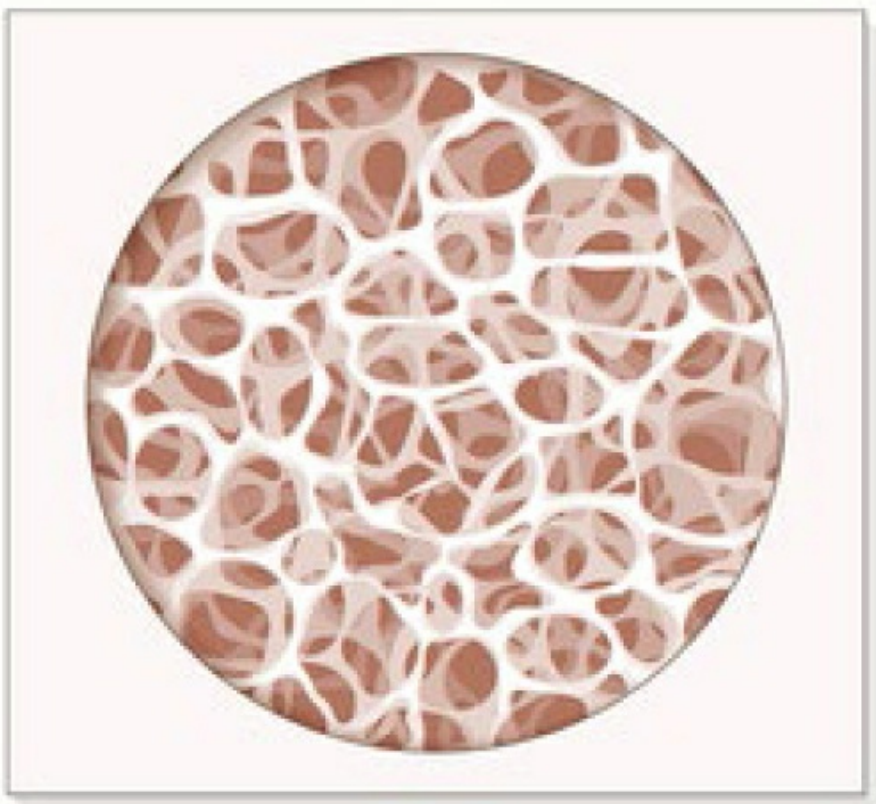
Osteopenia is:

- A condition where bone mass is below what is expected but not yet classified as osteoporosis.
- Between -1 and -2.5 SD.

Osteoporosis is:

- Significantly reduced bone mass where bones are becoming fragile and brittle.
- >-2.5 SD

NORMAL BONE



OSTEOPOROSIS

MAINTAINING/DEVELOPING BONE MINERAL DENSITY

Strength is not just the ability to exert force. It is also directly linked to the health of our skeletal system.

Unfortunately, as we age, our skeletal system's health deteriorates, and this isn't helped by the often sedentary lifestyles many of us live.

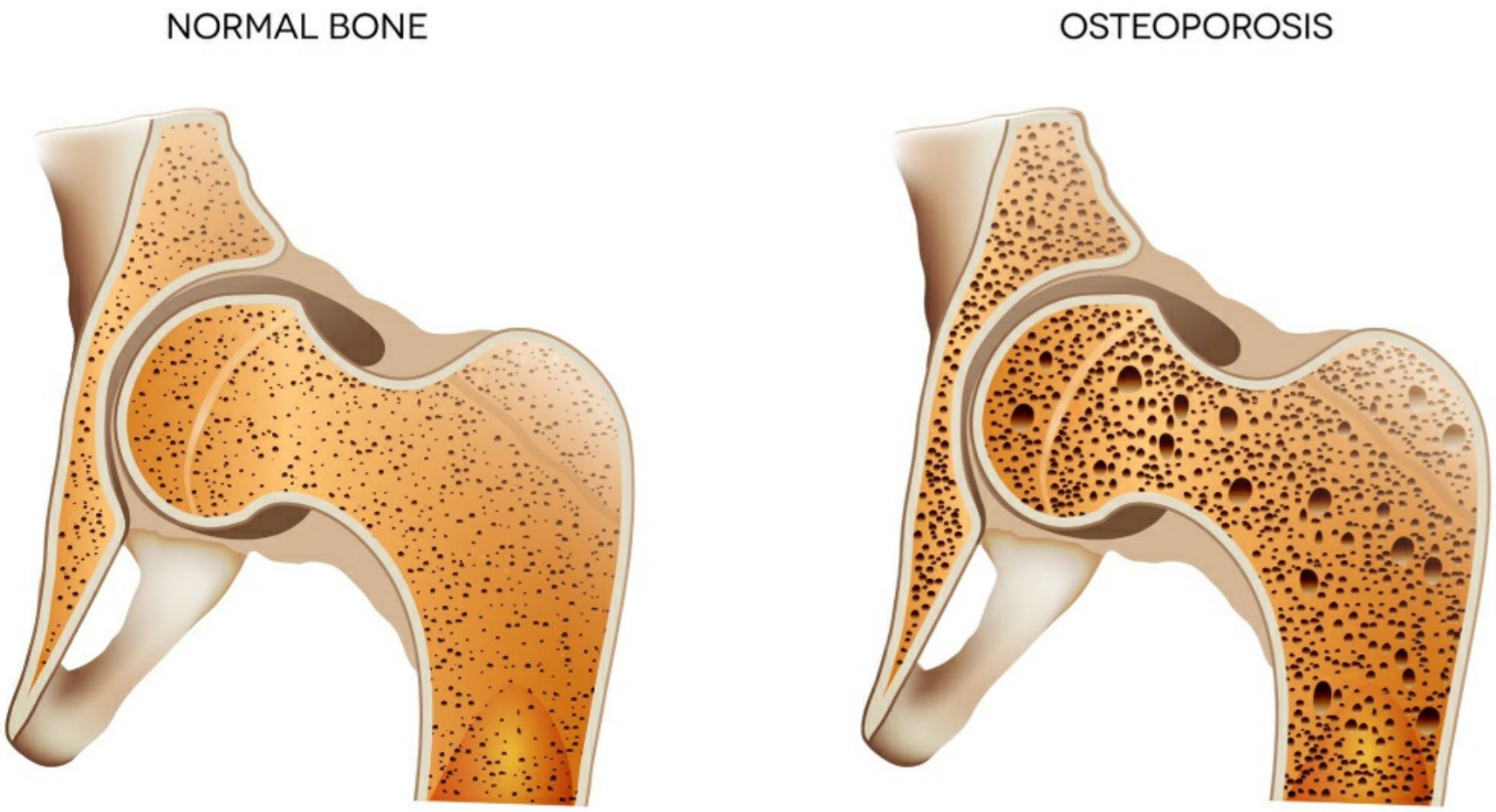
So, what is the solution?

Strength Training! When we strength train, our soft tissues and skeletal system make adaptations, muscles get bigger and stronger, tendons become thicker and more rigid, and our bone density increases.

Here are two of my favourite ways to illustrate the importance of strength training:

1. Studies show that the average decrease in BMD (Bone Mineral Density) during the menopausal transitic 10%. In some cases, women lose as much as 20% in a 5–6-year window around menopause (that's arou year) – **strength training counters this!**

2. Before astronauts used specialist machines to perform high-intensity resistance training in space microgr experienced vast muscle atrophy (muscle wastage). They tended to lose up to 1-2% off bone mass per r evolved to be under the compressive forces of 1G (force per unit mass due to gravity at the earth's surfa we have the bone density we do – **strength training promotes BMD!**

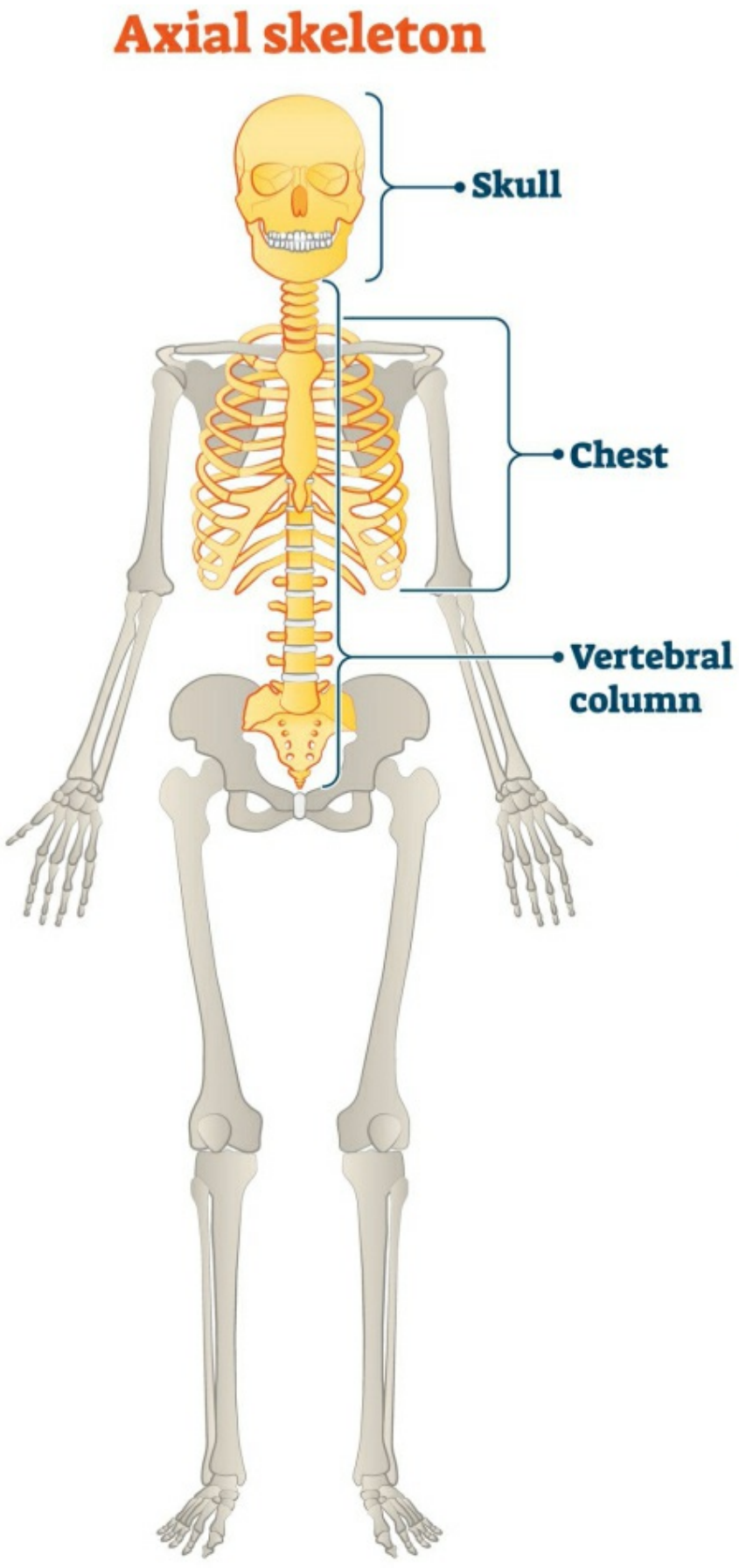


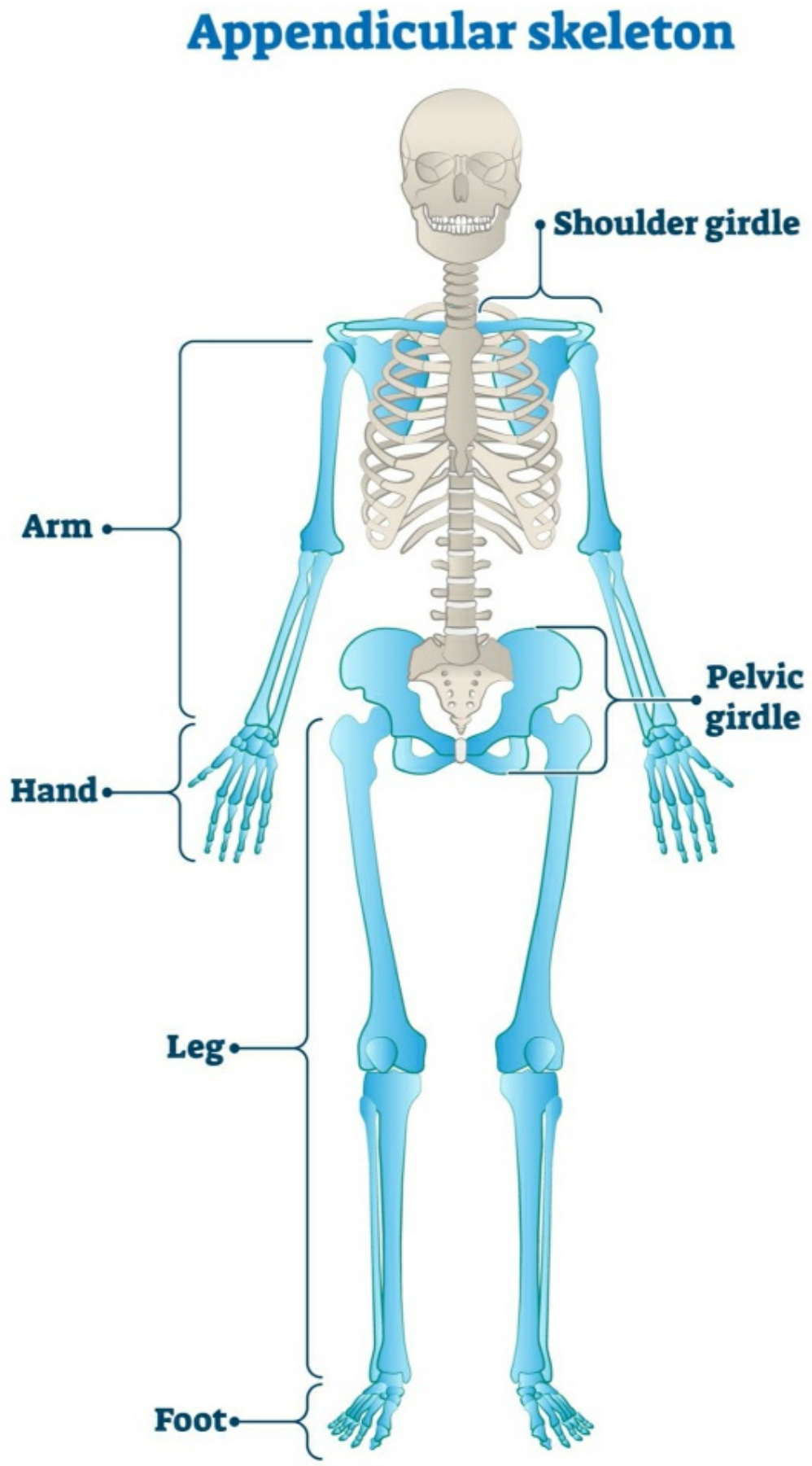
AXIAL AND APPENDICULAR SKELETON

Axial Skeleton: Spine, ribs, sternum and skull.

Appendicular Skeleton: Limbs and anchoring bones.

Of the 206 bones in the body, the axial skeleton is made up of 80, and the appendicular skeleton is made up of 126.





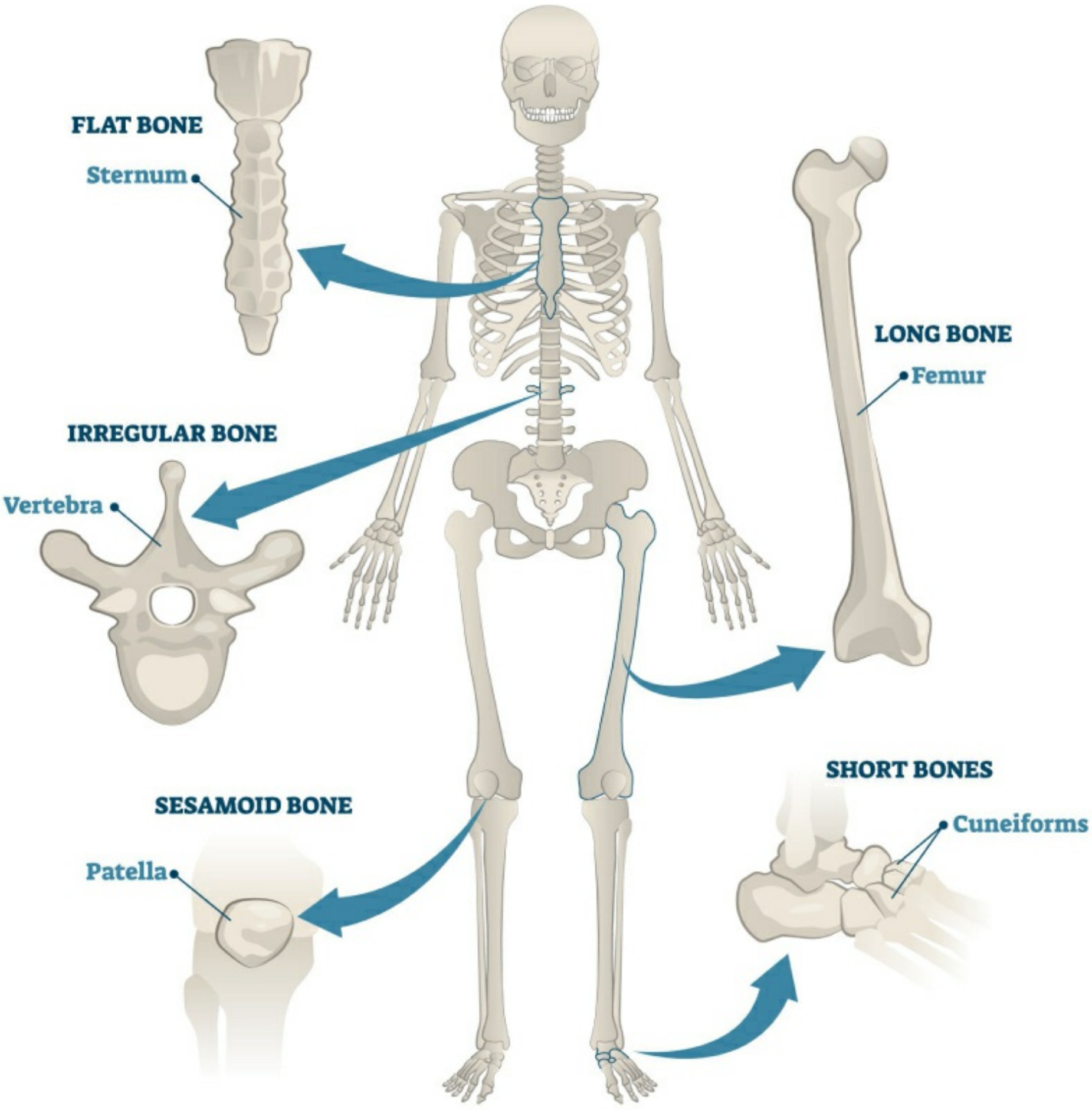
TYPES OF BONES

There are 5 types of bones in the human body:

- Flat.
- Long.
- Short.
- Irregular.
- Sesamoid (seed-like).

Wormian bones, also known as intrasutural bones or sutural bones, are extra bone pieces that can occur within a suture (joint) in the skull.

These are irregular isolated bones that can appear in addition to the usual centers of ossification of the skull and, although unusual, are not rare.


FLAT BONE
Sternum
IRREGULAR BONE
Vertebra
LONG BONE
Femur
SESAMOID BONE
Patella
SHORT BONES
Cuneiforms

STRUCTURE OF A LONG BONE

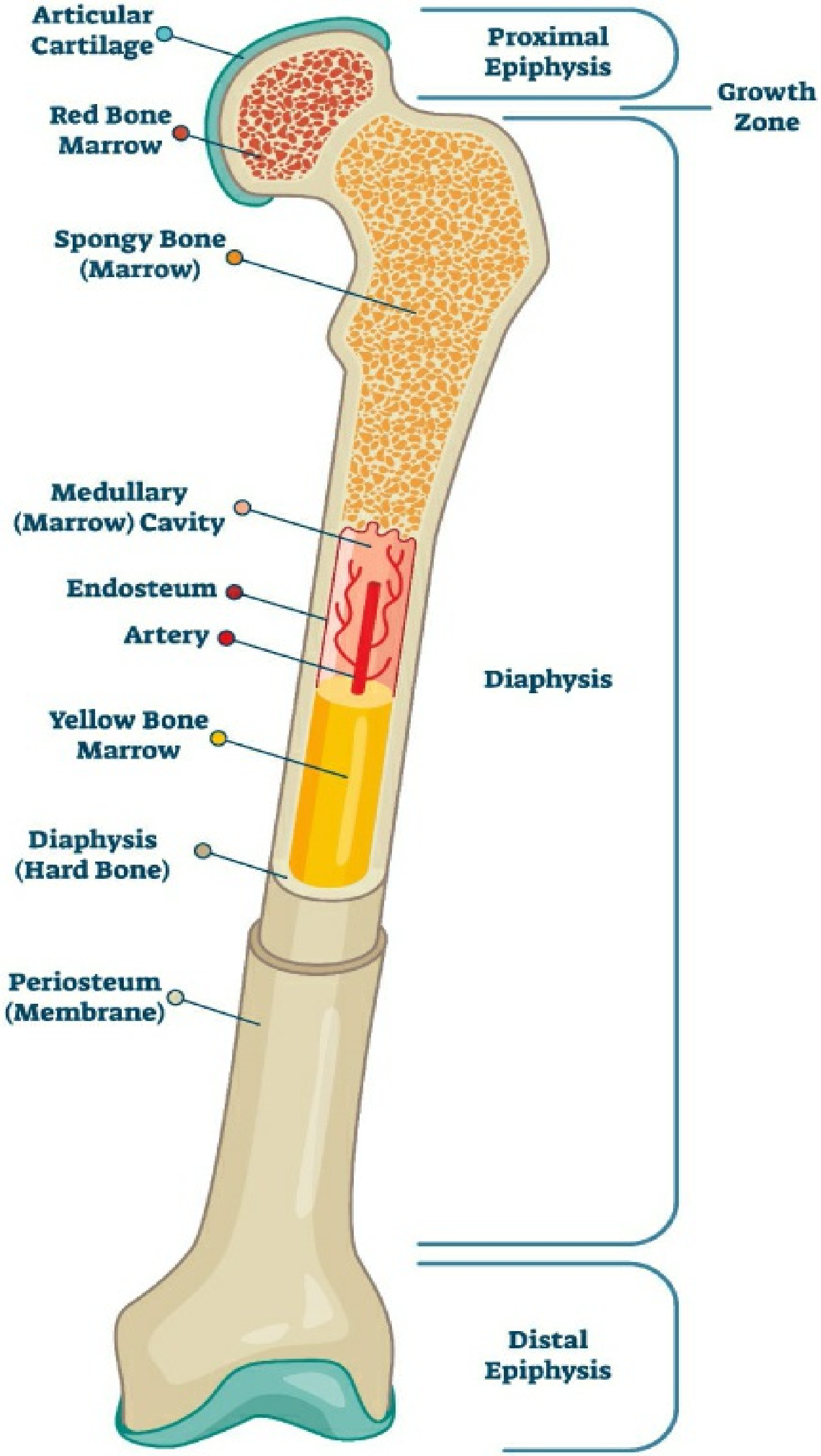
Long bones are capped with wide areas on each end which are called epiphyses. The epiphysis closer to the torso is called the proximal epiphysis, while the distal epiphysis is at the farther end.

Epiphyses are filled with spongy bone (softer) containing red bone marrow, which is red in color because it makes red blood cells. Each epiphysis is capped with articular cartilage that connects the bone to the rest of the body while simultaneously cushioning the end of the bone.

The largest part of any long bone is the long cylindrical middle, called the diaphysis. The diaphysis takes the brunt of the force that long bones must support and is made up primarily of compact bone, also known as cortical bone, which is a denser material used to create much of the hard structure of the skeleton.

The periosteum is a membrane that covers the outer surface of all bones, except at the joints of long bones.

Endosteum lines the inner surface of the medullary cavity of all long bones.

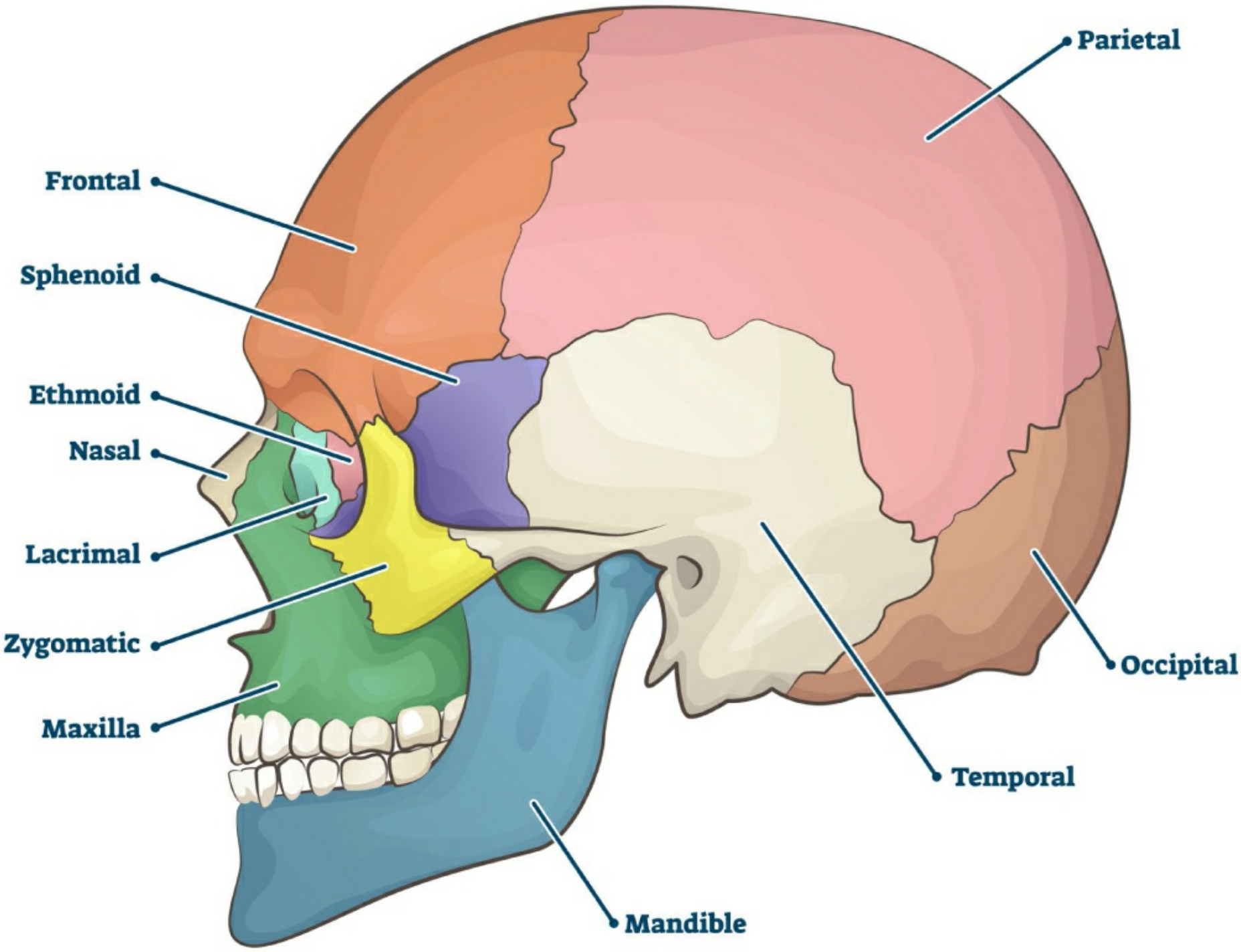

Articular Cartilage
Red Bone Marrow
Spongy Bone (Marrow)
Medullary (Marrow) Cavity
Endosteum
Artery
Yellow Bone Marrow
Diaphysis (Hard Bone)
Periosteum (Membrane)
Proximal Epiphysis
Growth Zone
Diaphysis
Distal Epiphysis

JOINT CLASSIFICATIONS

A joint is where two or more bones meet or join.

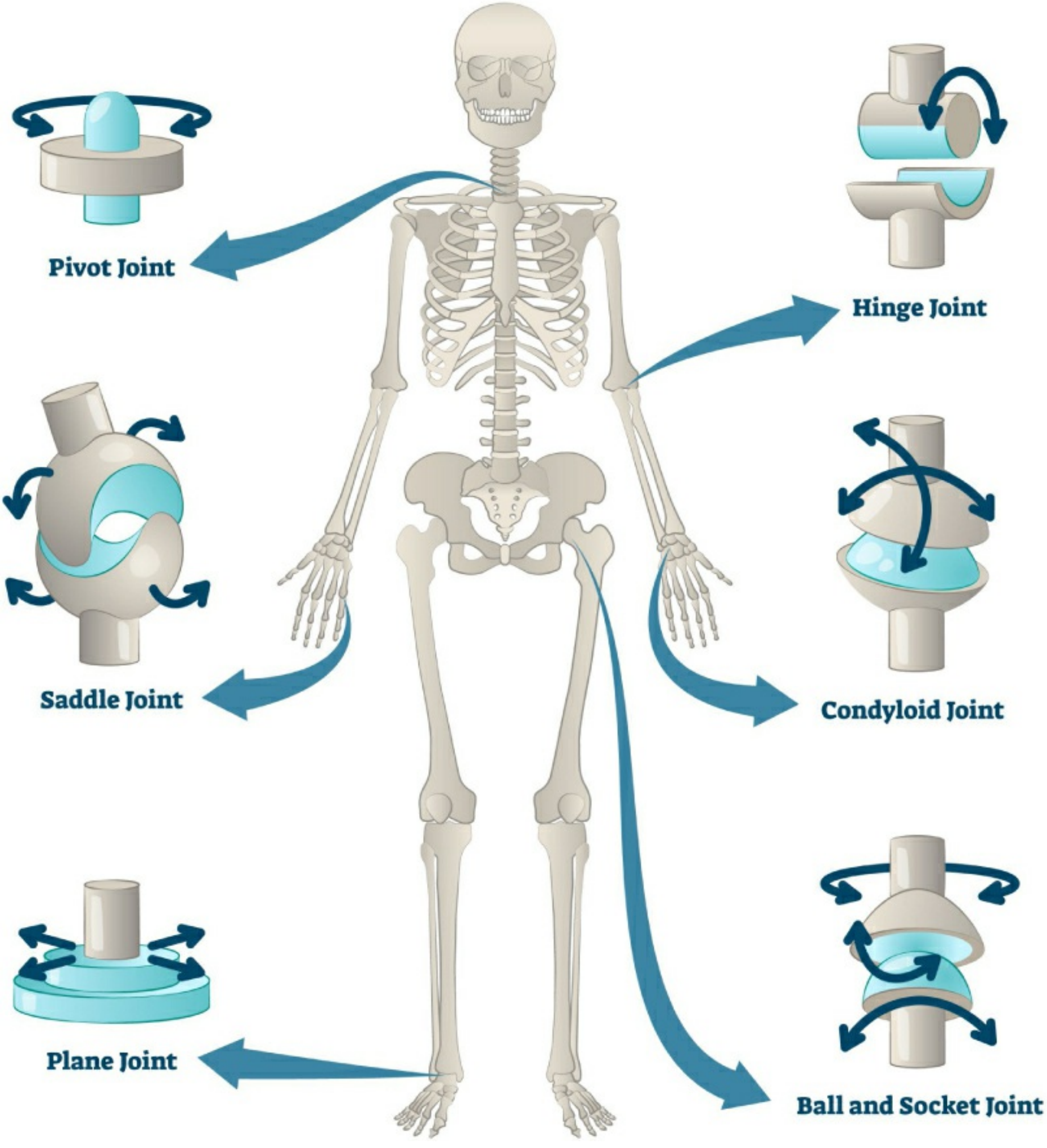
Joints allow you to move parts of your body in specific directions.

- **Fibrous:** Immovable joints, for example, cranium, sacrum, coccyx.
- **Cartilaginous:** Semi-movable joints, for example, vertebrae.
- **Synovial:** Freely movable joints, for example, knee, hip, shoulders and elbows.



TYPES OF JOINTS

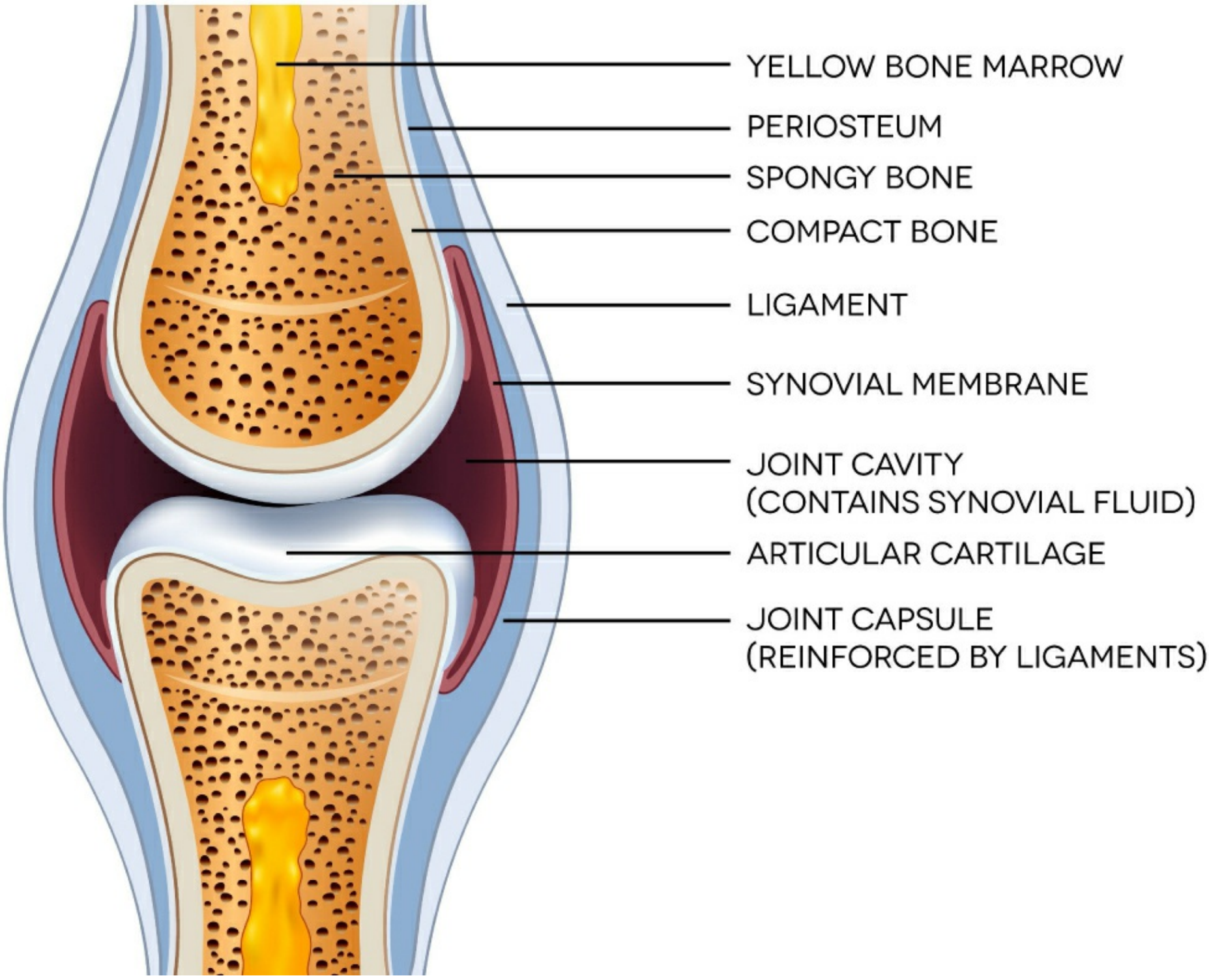
- **Ball and socket:** Shoulders and hips – allows movement in almost any direction.
- **Hinge:** Elbows and knees – allows flexion and extension.
- **Condyloid:** Wrist joint – allows flexion, extension, abduction and adduction.
- **Pivot:** Neck – allows rotation.
- **Saddle:** Thumb – allows flexion, extension, adduction and abduction.
- **Plane / Gliding:** Acromioclavicular joint – allows 2 bones to slide past each other, i.e., Elevation and dep the shoulder girdle.



JOINT ANATOMY

Synovial joints are the joints that muscles cross to create lever systems, i.e., The biceps brachii crosses the elbow joint. Therefore, when it contracts and shortens, it bends the elbow.

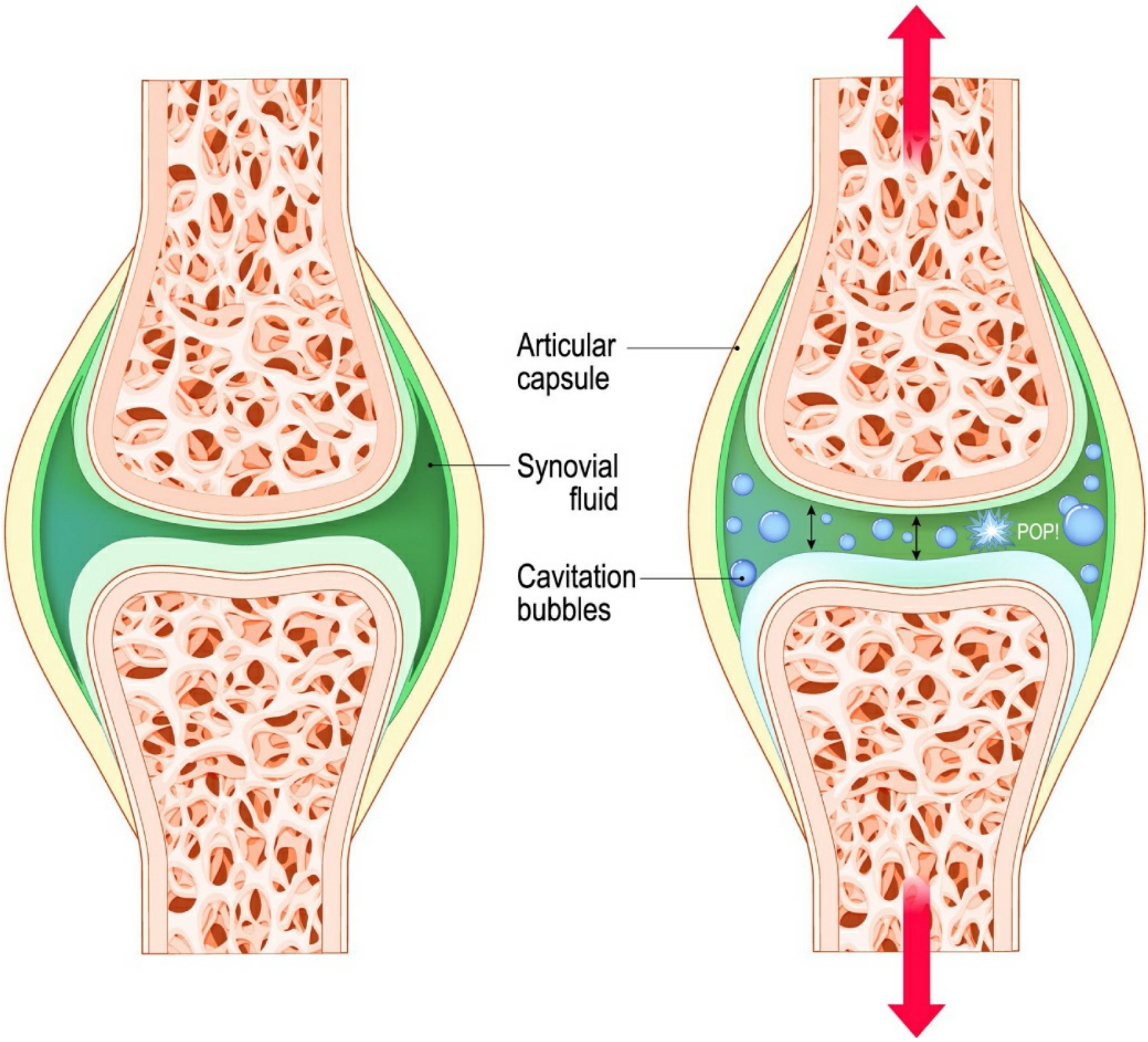
- Ligaments stabilize joints.
- Bone ends are covered with hyaline (articular) cartilage.
- Joints are enclosed within a fibrous capsule.
- The capsule contains a synovial membrane that secretes a lubricating fluid (synovial fluid).



CRACKING JOINTS

Cracking, clicking, clunking and popping noises can be caused by a few things, such as structures rubbing/impinging on each other. However, joint cavitation is often the cause: Synovial joints capsules are filled with synovial fluid.

Just as in any fluid, small partial vacuums can form. Therefore, when the joint is bent or pulled, it can cause a change in pressure and these vacuums collapse producing a sharp sound. This is all absolutely normal, but if it causes pain or discomfort, you should see a professional who can assess the area.



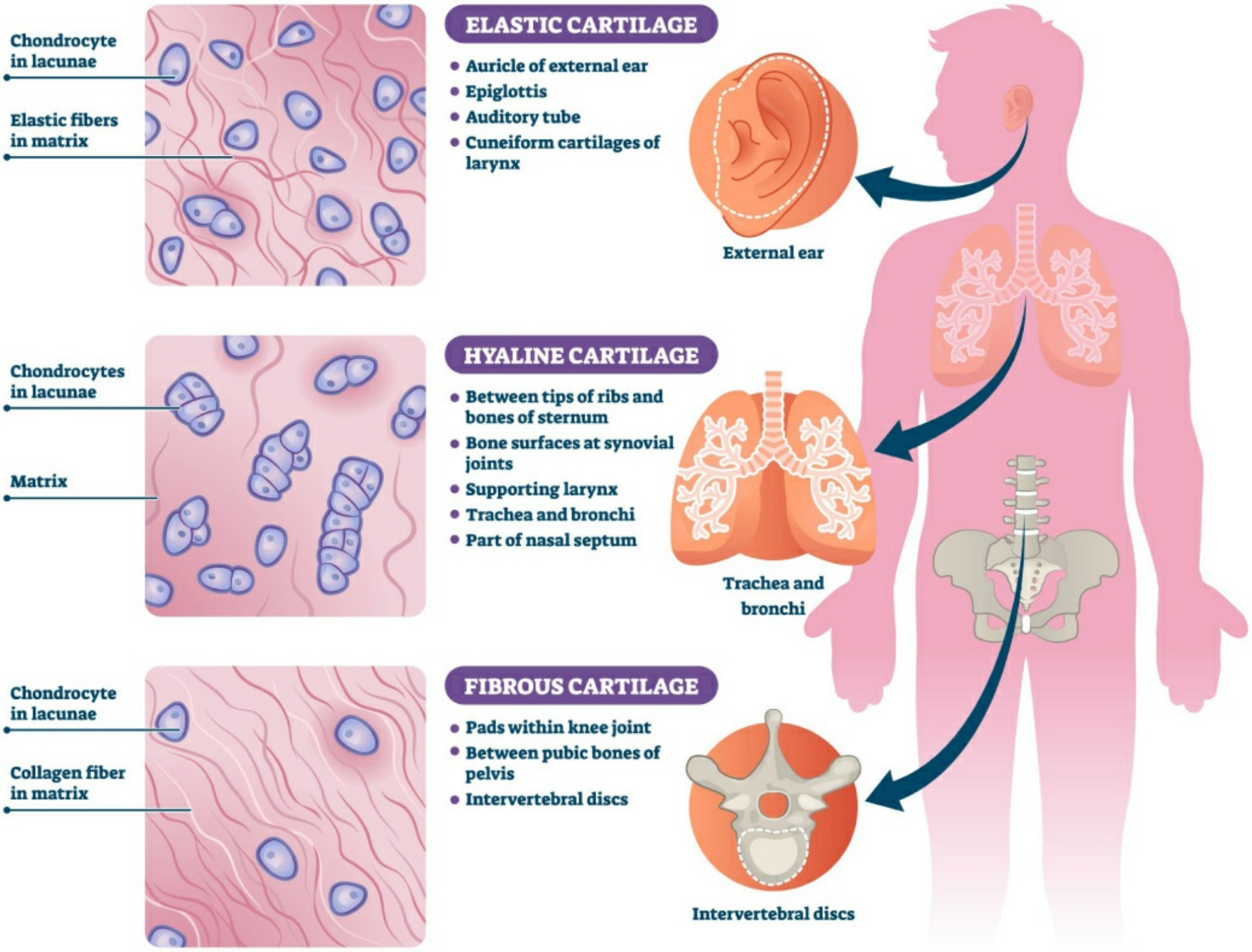
CARTILAGE

Properties:

- It is dense, durable and can withstand compression forces – acts as a shock absorber.
- It is formed from collagen and elastin.
- It has a poor blood supply.

There are three types of cartilage:

- **Hyaline:** Articular cartilage found at the ends of bones.
- **Fibro:** Pads of fibrocartilage between some joints.
- **Elastic:** Found in tubes and areas which need to maintain a shape.



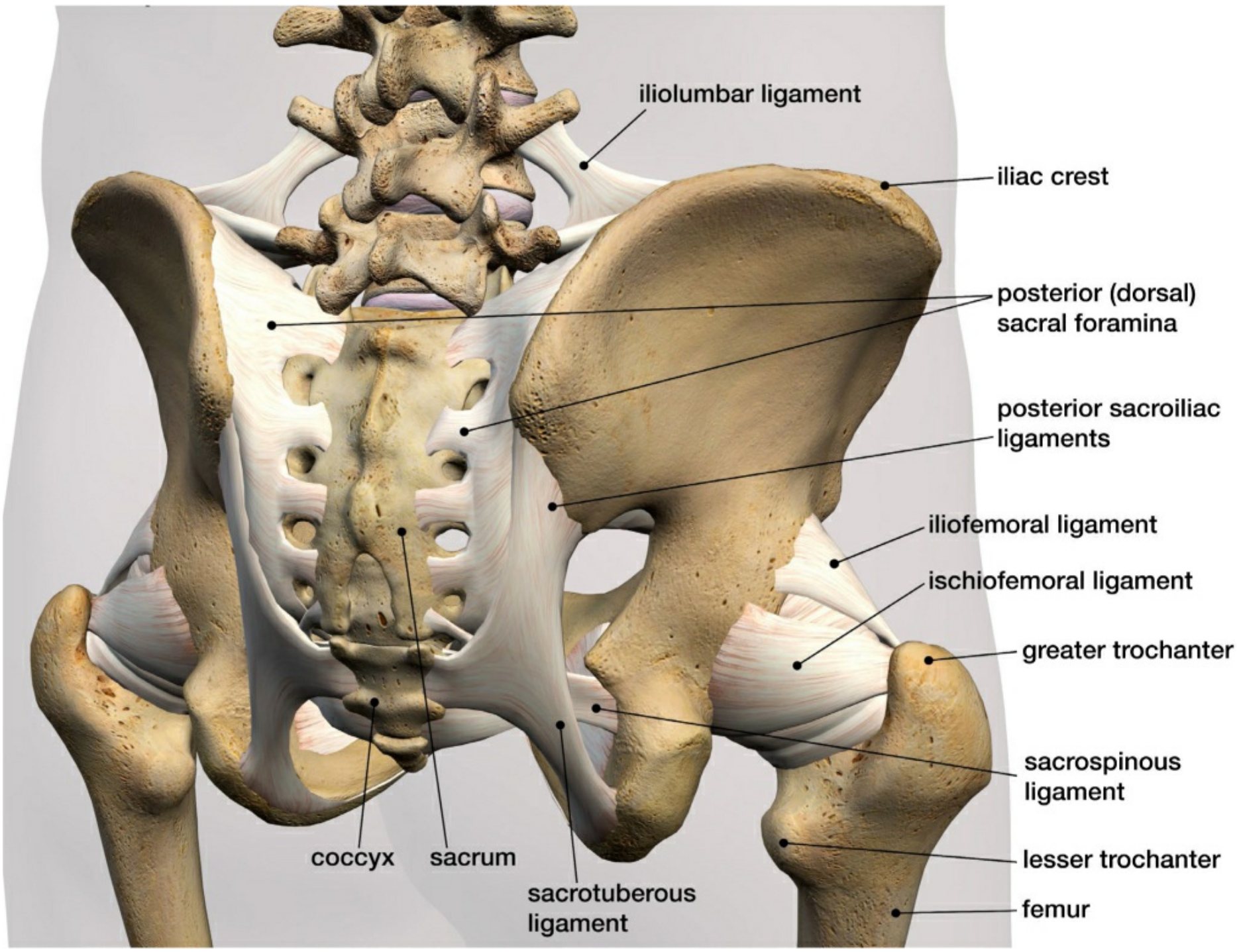
LIGAMENTS

Properties:

- Connect bone to bone.
- Support and add stability to joints.
- Have a poor blood supply.
- Ligaments that are presented as thickening of the articular capsule are called capsular ligaments, ligaments located outside the capsule are called extracapsular and those inside the capsule are called intrac
- Mainly formed by collagen and elastin:

➢ Collagen increases toughness and strength – fibres are resistant to stretch.

➢ Elastin increases elasticity and stretch – fibres allow stretch and return to original shape.



JOINT ACTIONS

Here is a table that illustrates the different joint actions that the body is capable of:

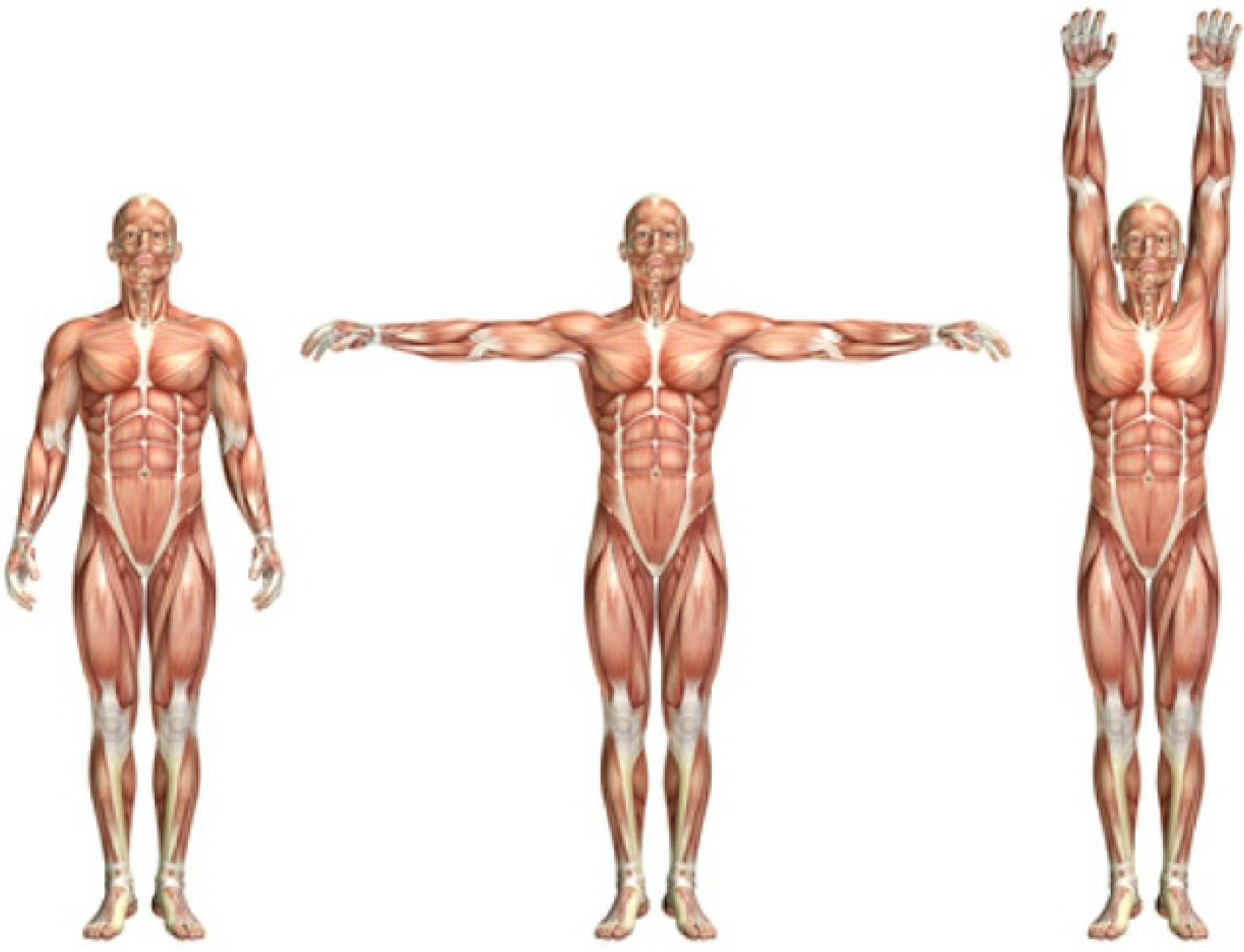
Action	Description	Action	Description
Flexion	Bending a body part.	**Extension**	Straightening a body part
Abduction	Moving a body part away from the midline.	**Adduction**	Moving a body part towards the midline.
Rotation	Circular movement around a bone.	**Circumduction**	Cone-shaped movement.
Lateral Flexion	Bending to the side.	**Lateral Extension**	Returning straight from a side bend position.
Horizontal Flexion	Moving a body part horizontally towards the midline.	**Horizontal extension**	Moving a body part horizontally away from the midline.
Elevation	Upwards movement of a body part.	**Depression**	Downwards movement of a body part.
Protraction	Forwards movement of a body part.	**Retraction**	Backwards movement of a body part.
Plantarflexion	Pointing the toes downwards.	**Dorsiflexion**	Pointing the toes upwards.
Pronation	Rotation of the forearm, so the palm faces downwards.	**Supination**	Rotation of the forearm, so the palm faces upwards.
Inversion	Moving the sole of the foot to face inwards.	**Eversion**	Moving the sole of the foot to face outwards.

Notes:

- Rotation is split into two categories, internal (medial) and external (lateral) rotation.
- Horizontal flexion and extension are also referred to as horizontal adduction and abduction.
- Pronation and supination can also be used to describe the action at the ankle. Pronation is often de eversion and supination is often described as inversion – when someone is described as “over-pronat usually show a flat arch with more weight placed onto the inner side of the ball of the foot.

Typical ranges of motion:

Joint Action	Degrees of Motion	Joint Action	Degrees of Motion
Shoulder:			
Flexion	160	Extension	50
Internal Rotation	45	External Rotation	90
Abduction	180		
Elbow:			
Flexion	160	Extension	0
Hip:			
Flexion	120	Extension	0-10
Abduction	40	Adduction	15
Internal Rotation	45	External Rotation	45
Knee:			
Flexion	140	Extension	0
Ankle:			
Plantarflexion	45	Dorsiflexion	20



PLANES OF MOTION

When we describe movement, we often use planes. A multiplanar movement would involve working through multiple planes. For example, a lunge with a torso rotation works through the sagittal and transverse plane.

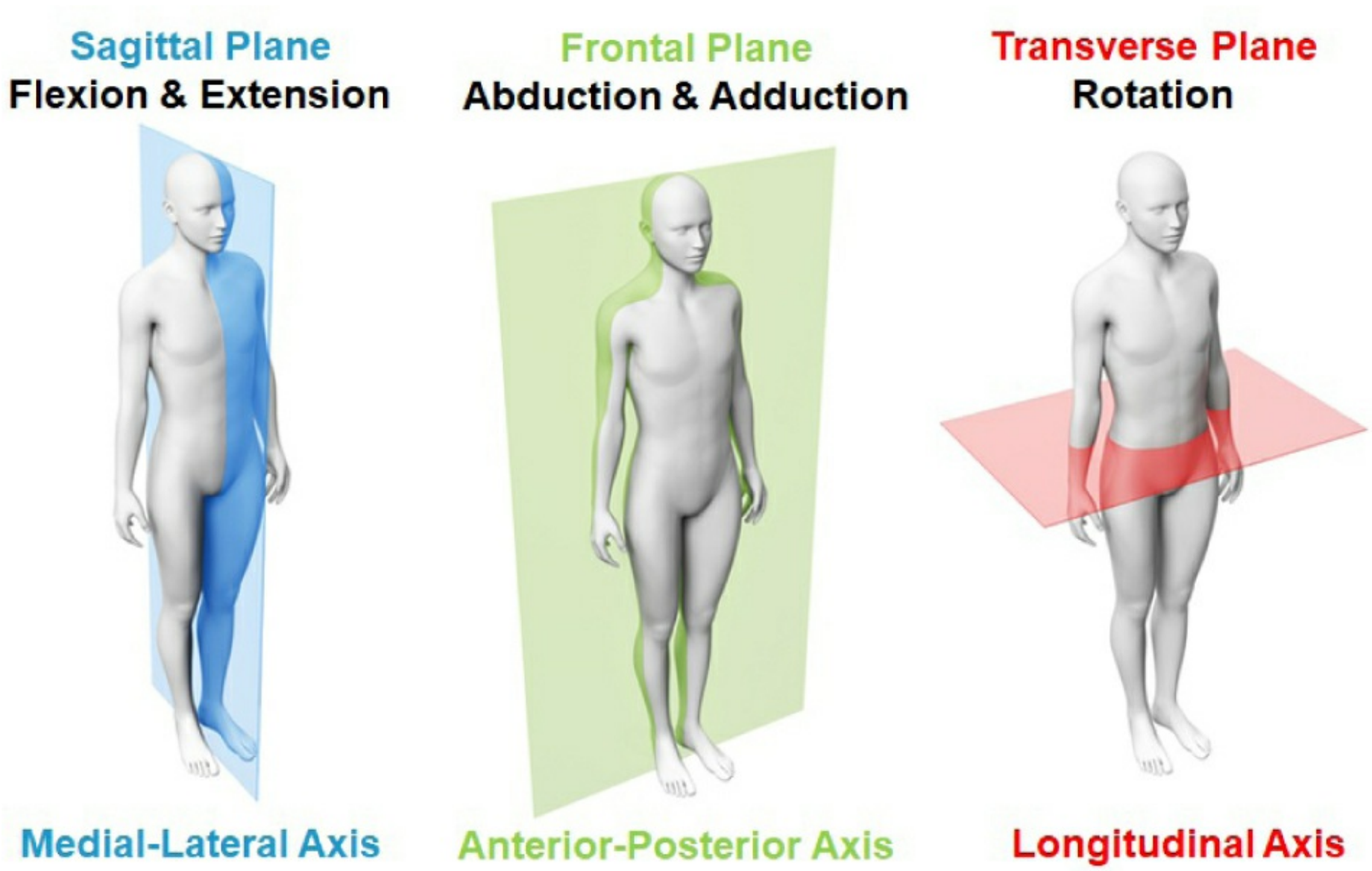
Note: The frontal plane is also known as the coronal plane.

It is easiest to think of each plane as an imaginary pane of glass that divides the body into opposing segments.

Movement through the sagittal plane can also be illustrated with an axis – imagine pole traveling through the side of the body from left to right.

Movement through the frontal plane can also be illustrated with the anterior-posterior axis – imagine a pole traveling from the front to the back of the body.

Movement through the transverse plane can also be illustrated with the longitudinal axis – imagine a pole traveling from the head to the feet.



POSTURE

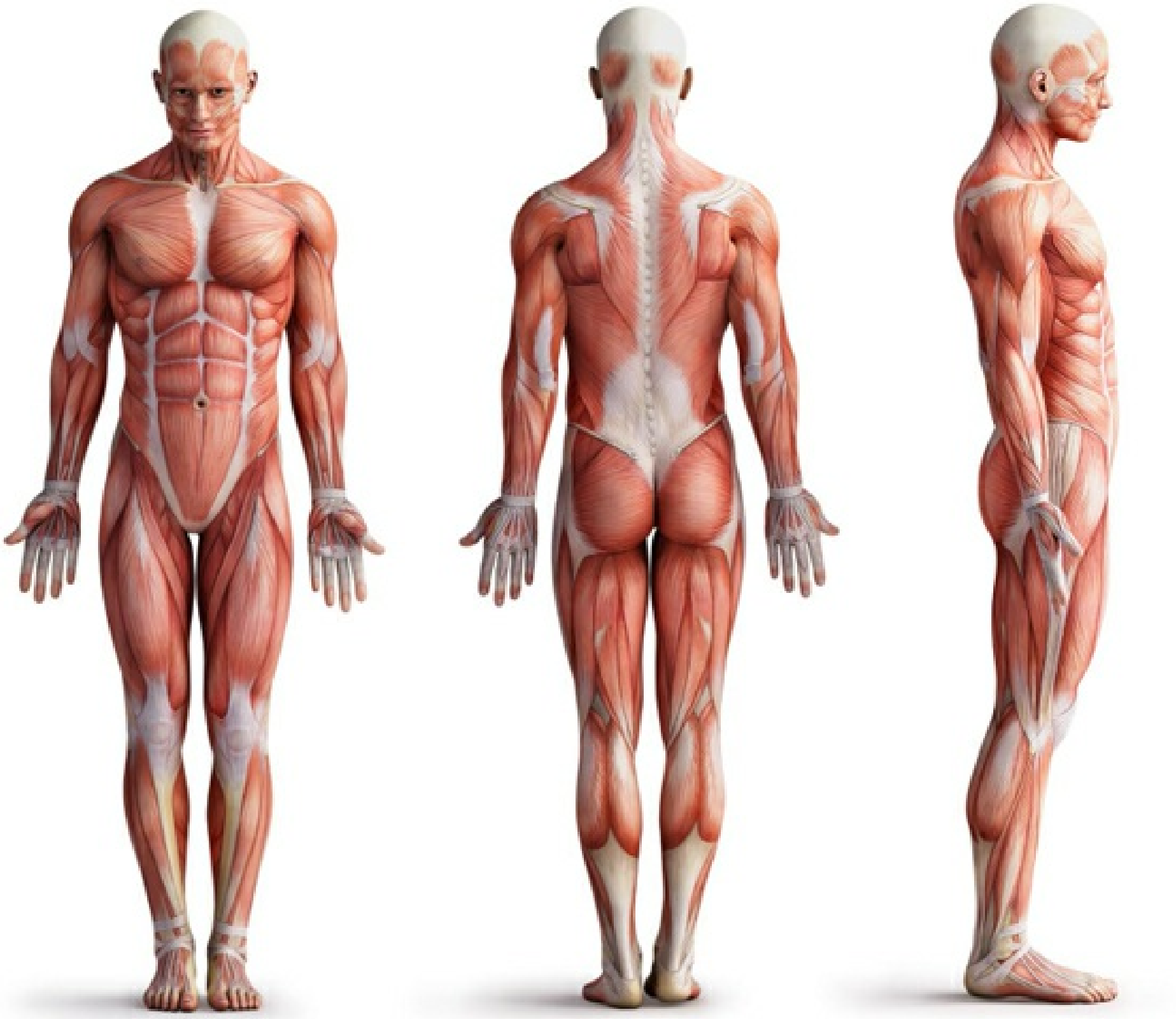
Static posture is the position someone holds their body in while standing, sitting or lying, but is most commonly assessed in a standing position. Dynamic posture refers to your positioning while performing movements.

For many years, some health and fitness professionals have promoted the utterly unrealistic notion that we should be in what is classed as “good posture” at all times, with our head and shoulders retracted, chest proud and our spine neutral (unbent and untwisted). However, it is key to understand that it is fine to bend, twist and slouch. Ultimately the best posture is the next posture – spending hours in even the most ergonomic (efficiency and comfort) position will get sore and uncomfortable.

Although a draconian level of maintaining “good” posture is a little silly, there are clearly optimal positions for someone to take while static (standing in line) or performing an action (a deadlift) – optimal posture is often described as the “neutral” position where the least stress is placed on the joints and surrounding structures.

An imbalance can affect:

- Muscular length-tension relationships.
- Joint range of motion.
- Forces placed on the body.
- Nervous input (sensory information) and output (motor responses).



ASSESSING POSTURE

An individual's posture can be observed as soon as they walk through the door. How do they hold themselves; do they look confident or worried? Do they slouch and hold their head down?

We should also be observing both static and dynamic postures throughout a session to ensure optimal positioning. However, a static assessment of posture during a consultation or the start of a session is often used.

What's the first thing you are going to do when I tell you I am going to assess your posture?

Probably stand up straight and pull your head and shoulders back. Therefore, to get a more accurate reading, tell the individual to jog on the spot for a few seconds before telling them to "stop." From there, they will usually fall into their natural posture.

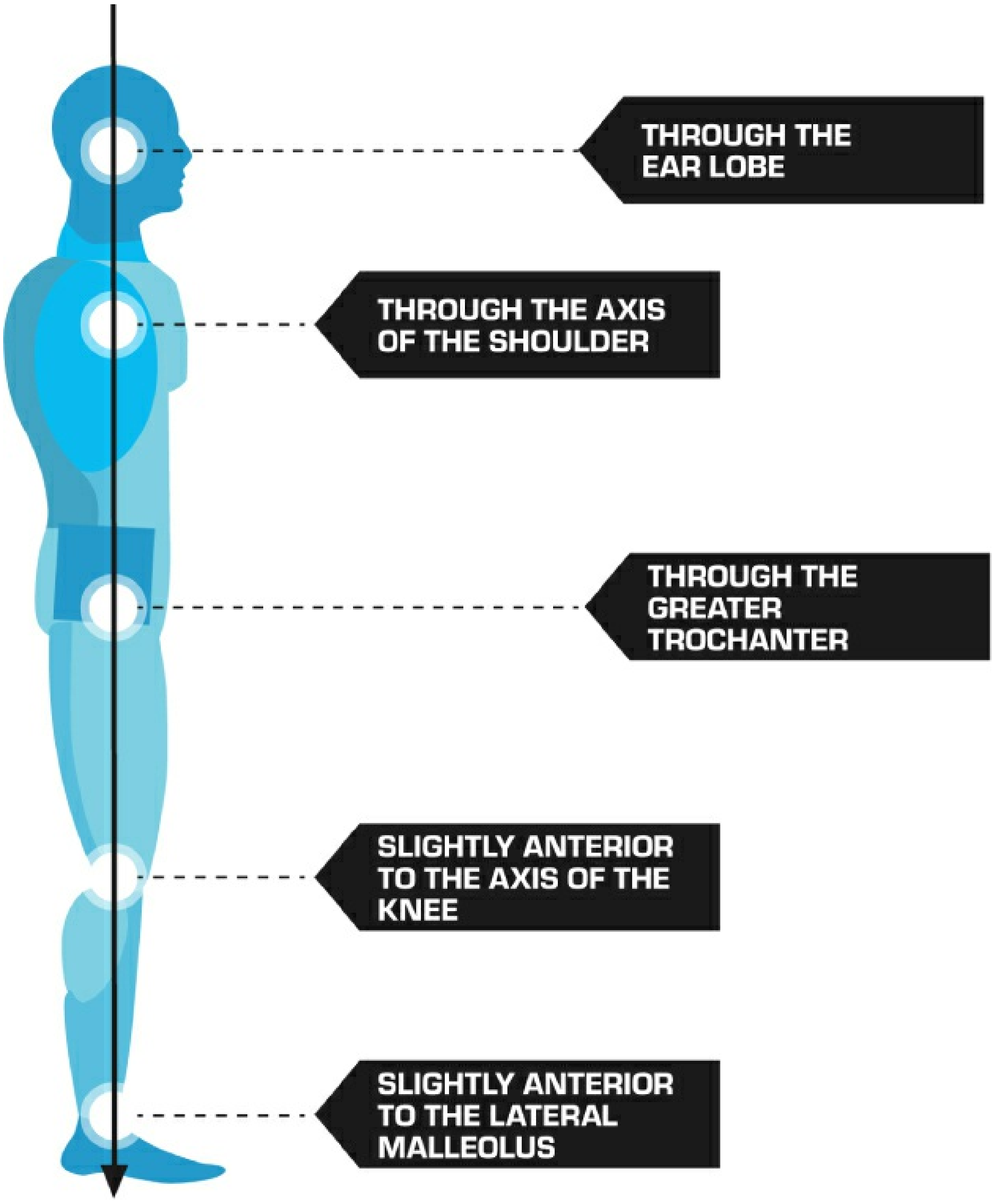
We can assess posture from the side and from the front and back.

We can also use a specific movement screen to assess someone's overall movement capabilities. For example, the overhead squat assessment (OHSA).

SIDE-ON VIEW

From a side-on view, we imagine a plumb line that should drop through:

- The earlobe.
- The centre of the shoulder.
- The centre of the hip.
- Slightly anterior to the midline of the knee.
- Slightly anterior to the ankle bone (malleolus).
- This allows us to clearly see if an individual has forward head posture or rounded shoulders.


THROUGH THE EAR LOBE
THROUGH THE AXIS OF THE SHOULDER
THROUGH THE GREATER TROCHANTER
SLIGHTLY ANTERIOR TO THE AXIS OF THE KNEE
SLIGHTLY ANTERIOR TO THE LATERAL MALLEOLUS

FRONT/BACK VIEW

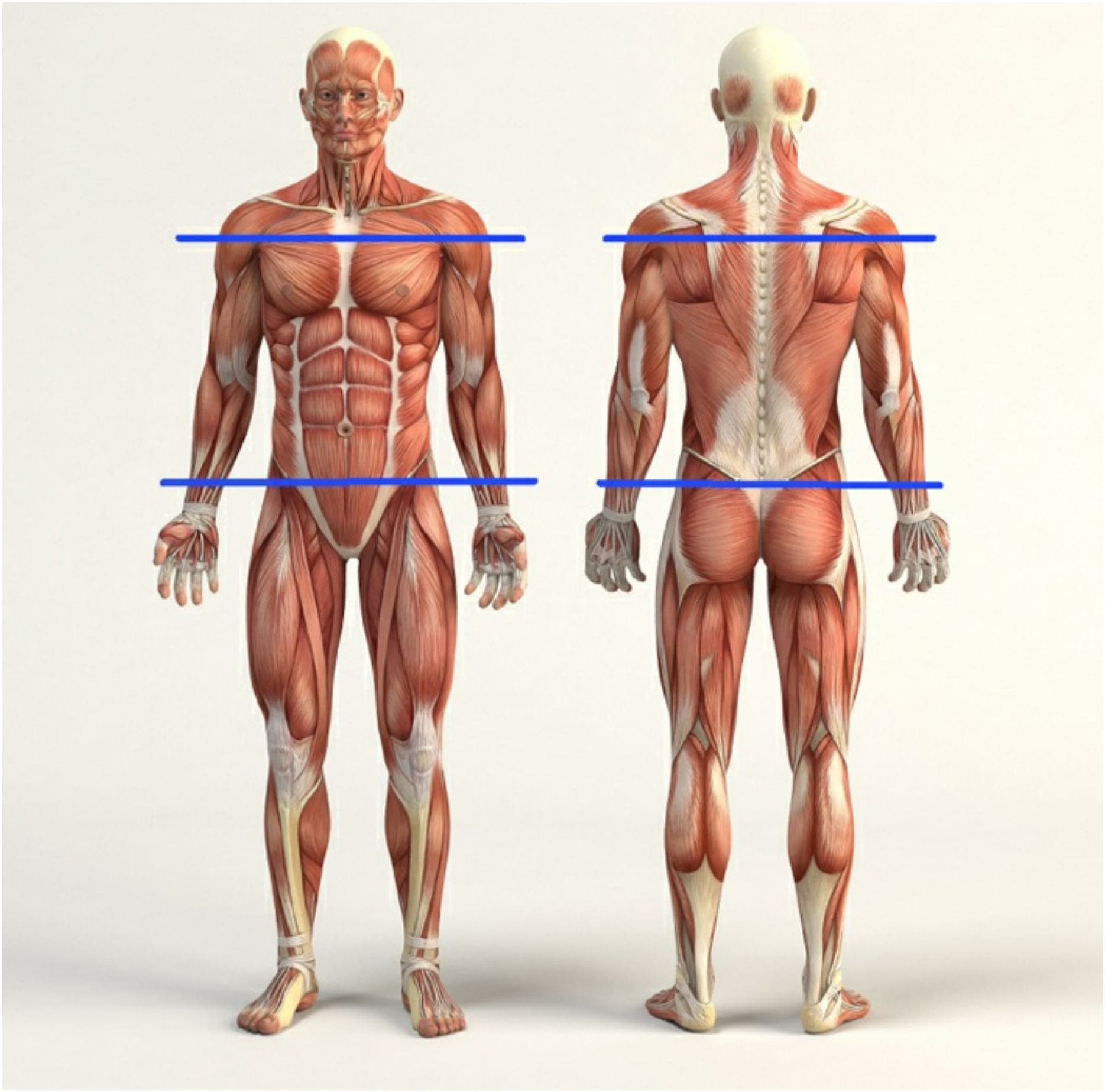
When viewing posture from the front or back, we imagine two horizontal lines parallel to the floor:

- Between the shoulders.
- Between the hips.

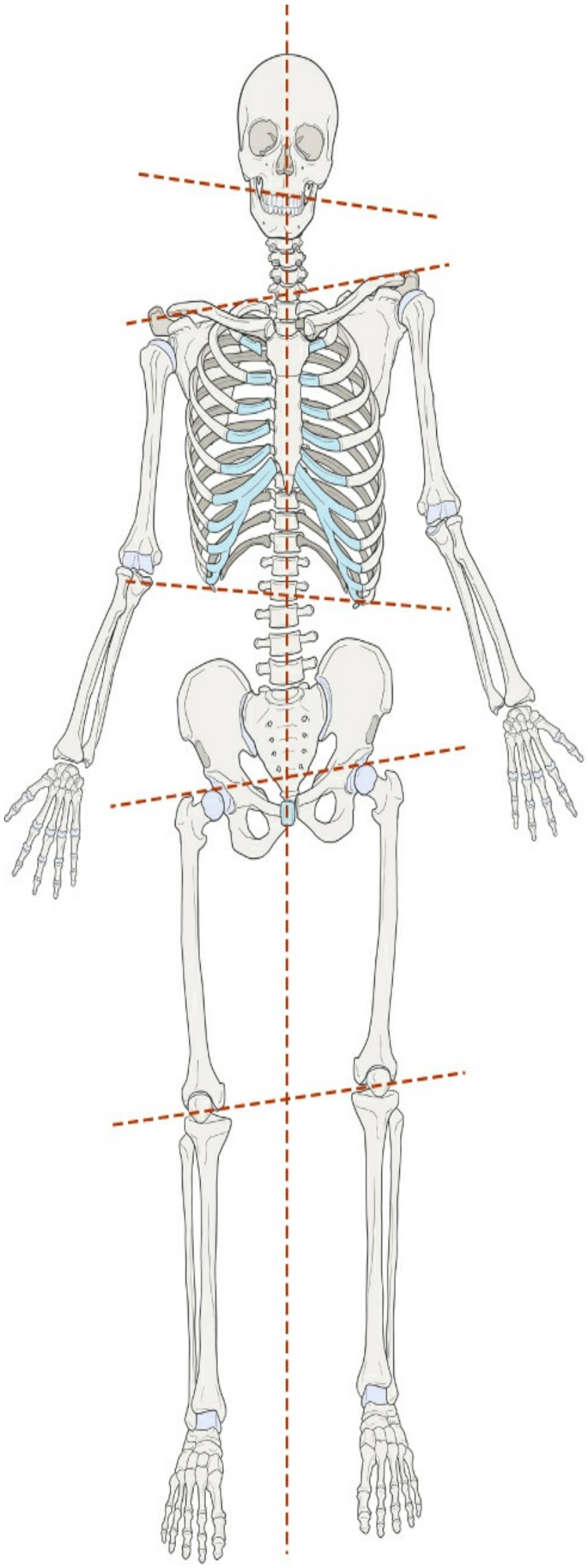
This allows us to clearly see whether one shoulder or hip is higher than the other.

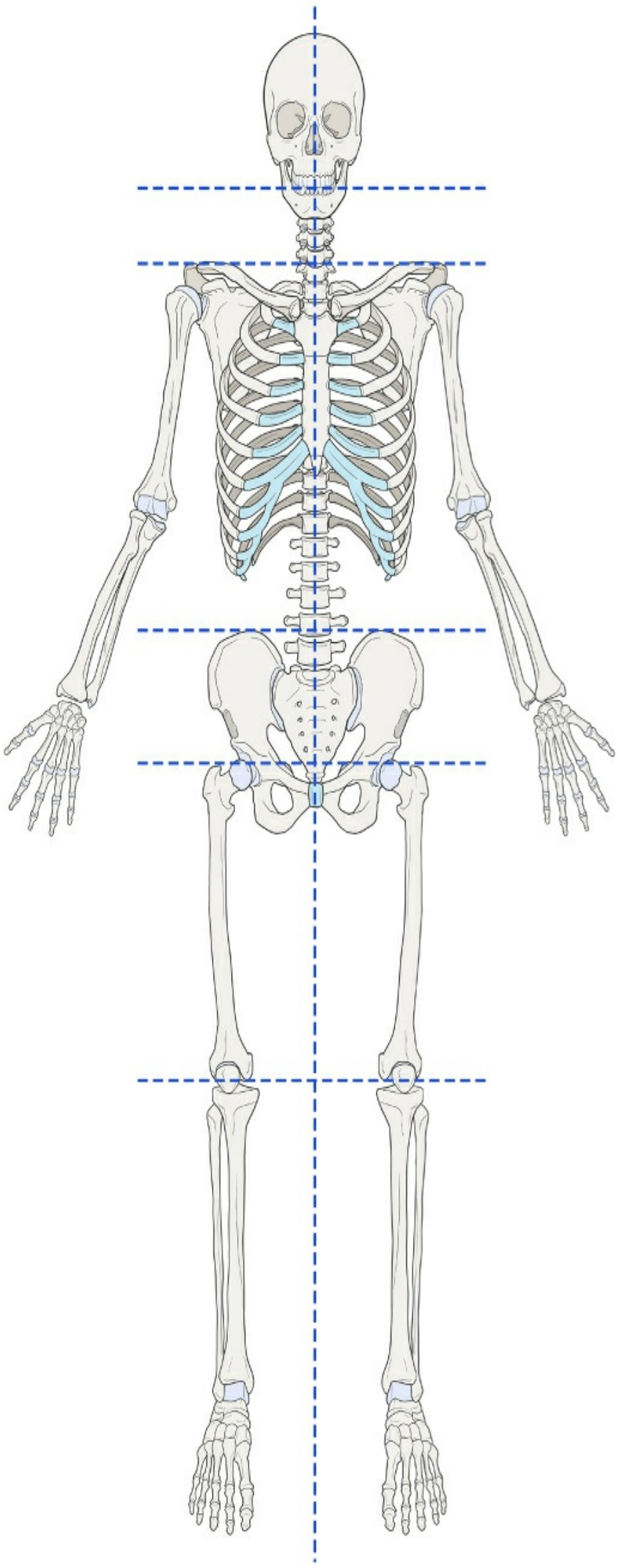
Although an asymmetry can be quite clear, it is not always as clear what the root cause is. The right trapezius might be considerably more developed, causing a higher shoulder, but it could also be caused by scoliosis or an imbalance at the hips.

It is essential that we have a deep understanding of how an individual muscle may impact a structure and how the muscles and structures of the body work together as one big kinetic chain.

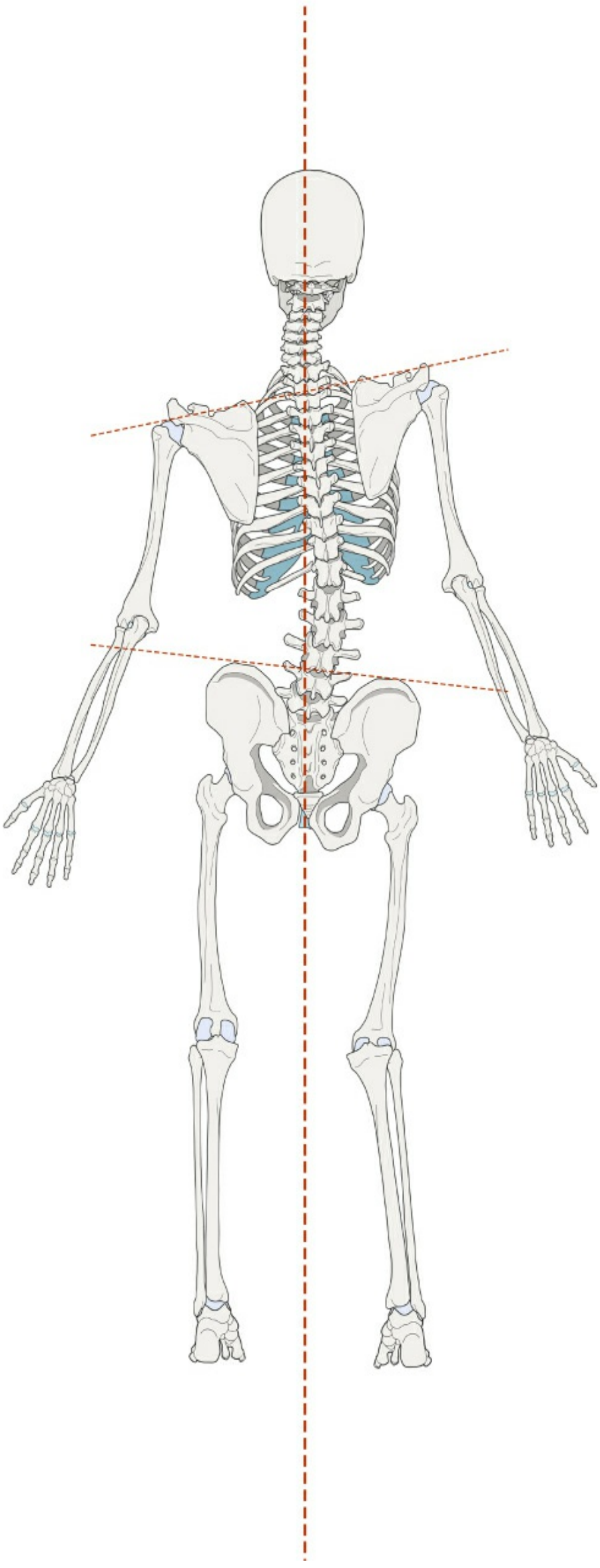


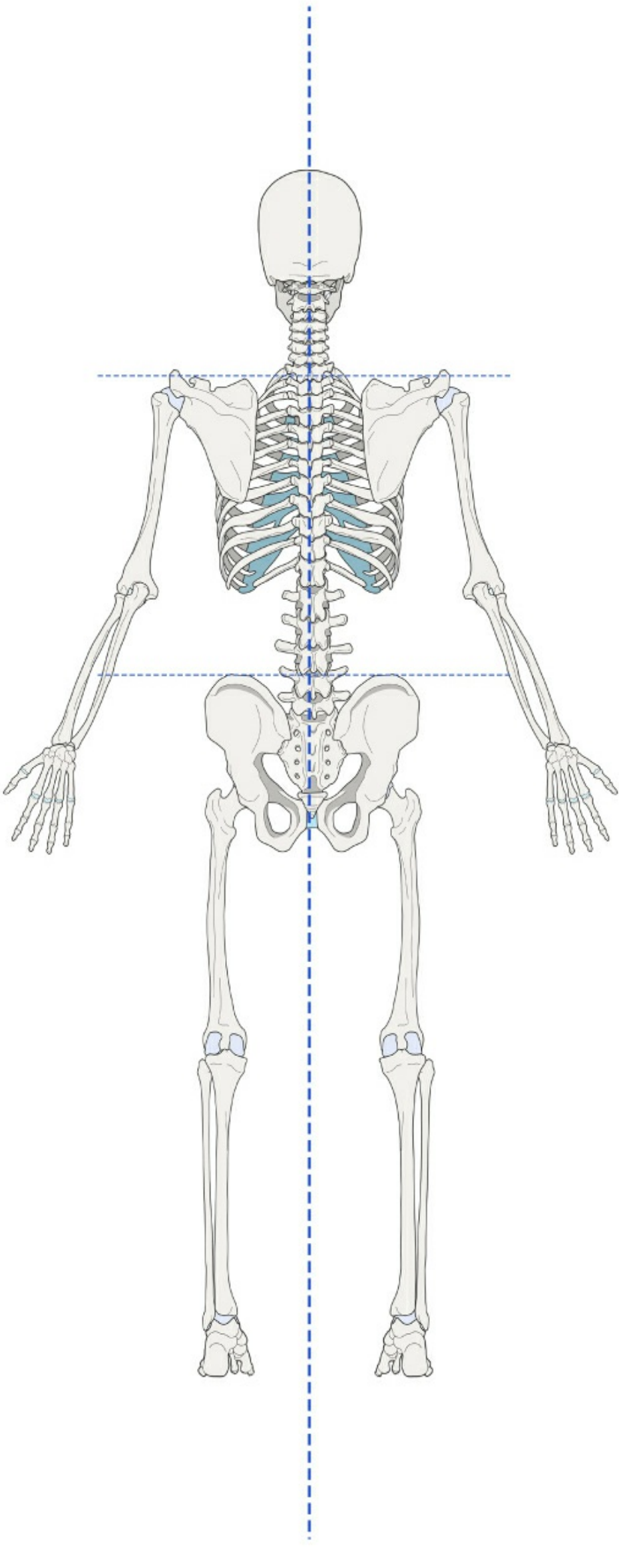
DETAILED FRONT (ANTERIOR) VIEW





DETAILED BACK (POSTERIOR) VIEW





THE SPINE

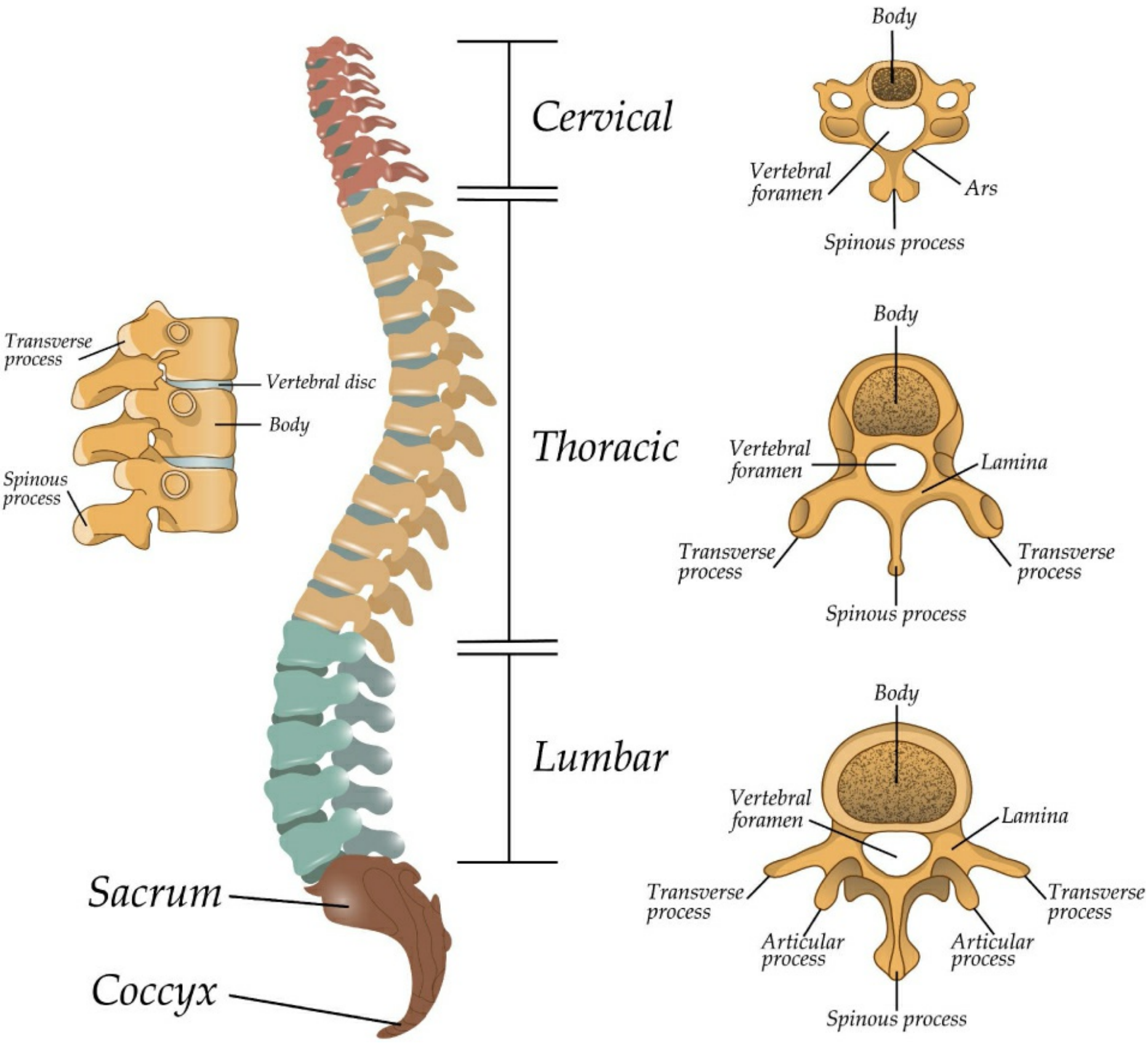
The spine is made up of 5 regions which create 4 curves – these curves help us to absorb impact.

The curves of the spine are described as kyphotic, which is a convex curve as we look from the side and lordotic, which is a concave curve as we look from the side.

It is normal for people to have varying degrees of curvature in their spine. However, when these curves become excessive, we refer to them as hyper-kyphosis and hyper-lordosis.

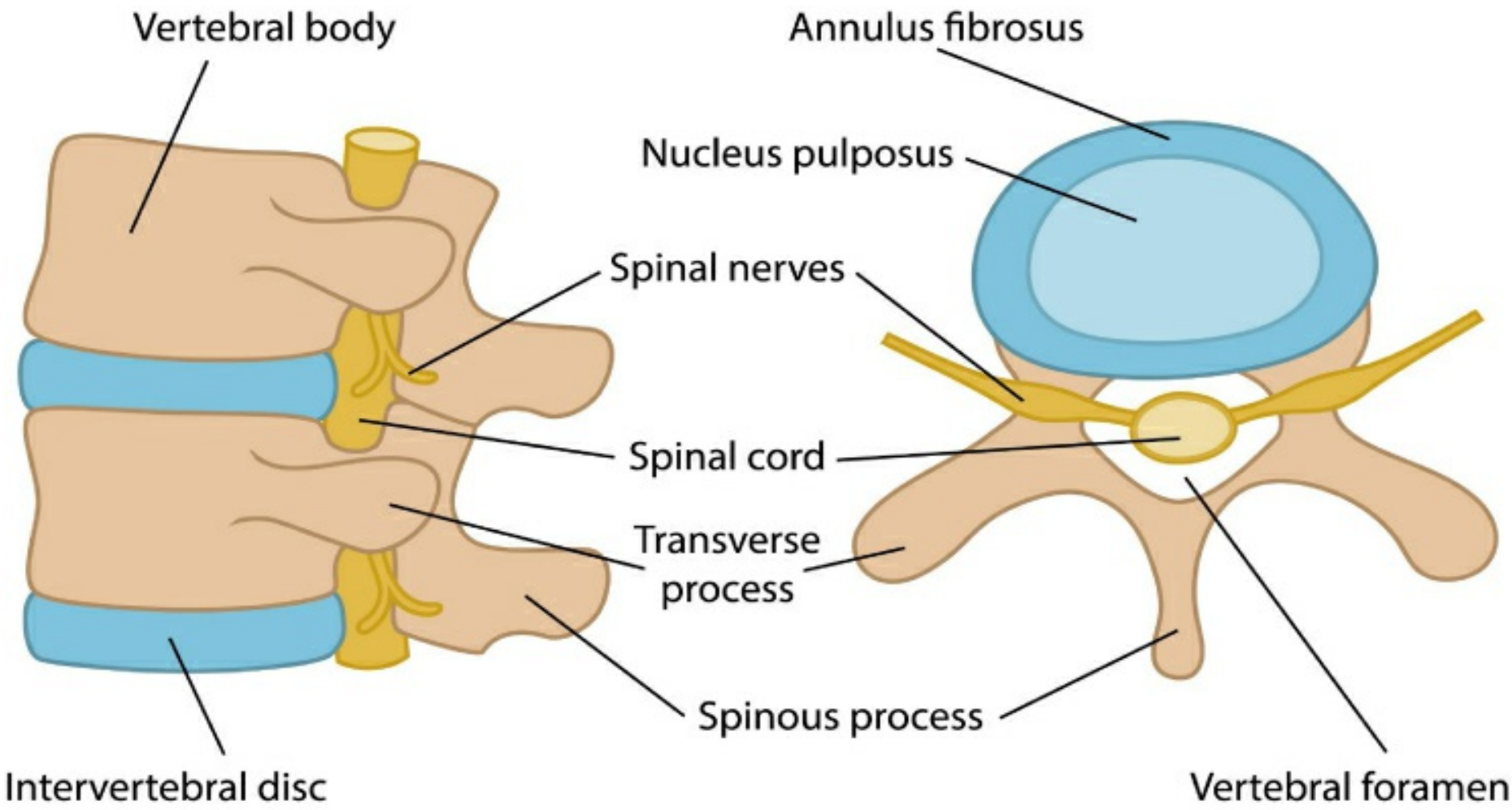
Note: The terms lordosis and kyphosis (without "hyper) are often used to describe an excessive range.

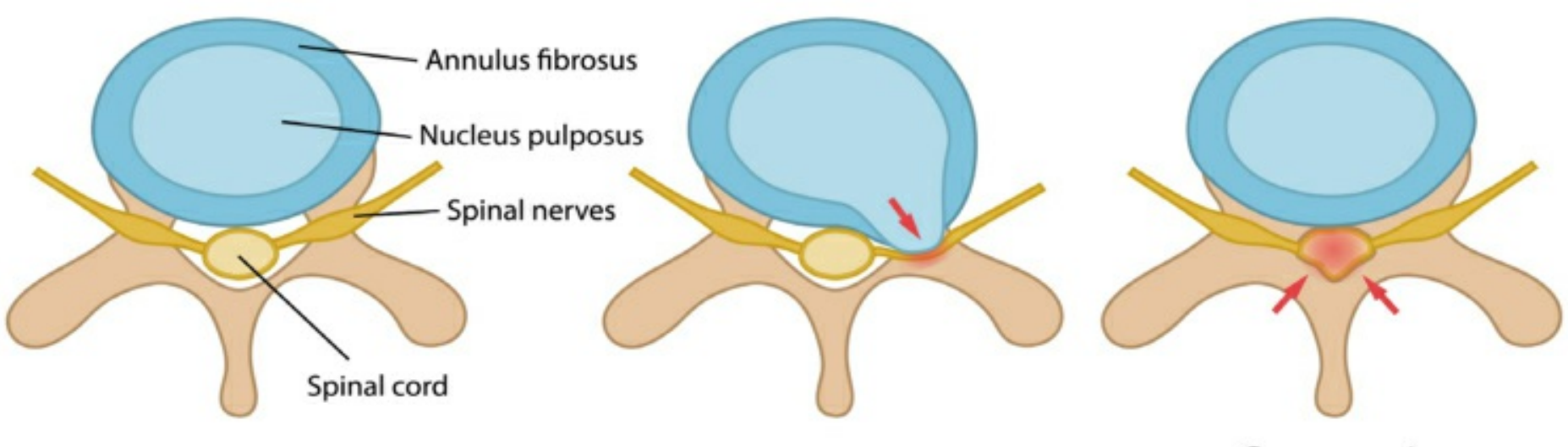
As you can see from the diagram, the vertebrae from each section of the spine are different. Therefore, they function in different ways (sacrum and coccyx are fused). For example, rotation of the torso is primarily performed through the thoracic spine rather than the lumbar spine.



VERTEBRAE

On this page, we can see the relationship between the vertebral body, discs and spinal cord, and the exiting nerve roots.


Vertebral body
Annulus fibrosus
Nucleus pulposus
Spinal nerves
Spinal cord
Transverse process
Spinous process
Intervertebral disc
Vertebral foramen
Lateral view
Superior view

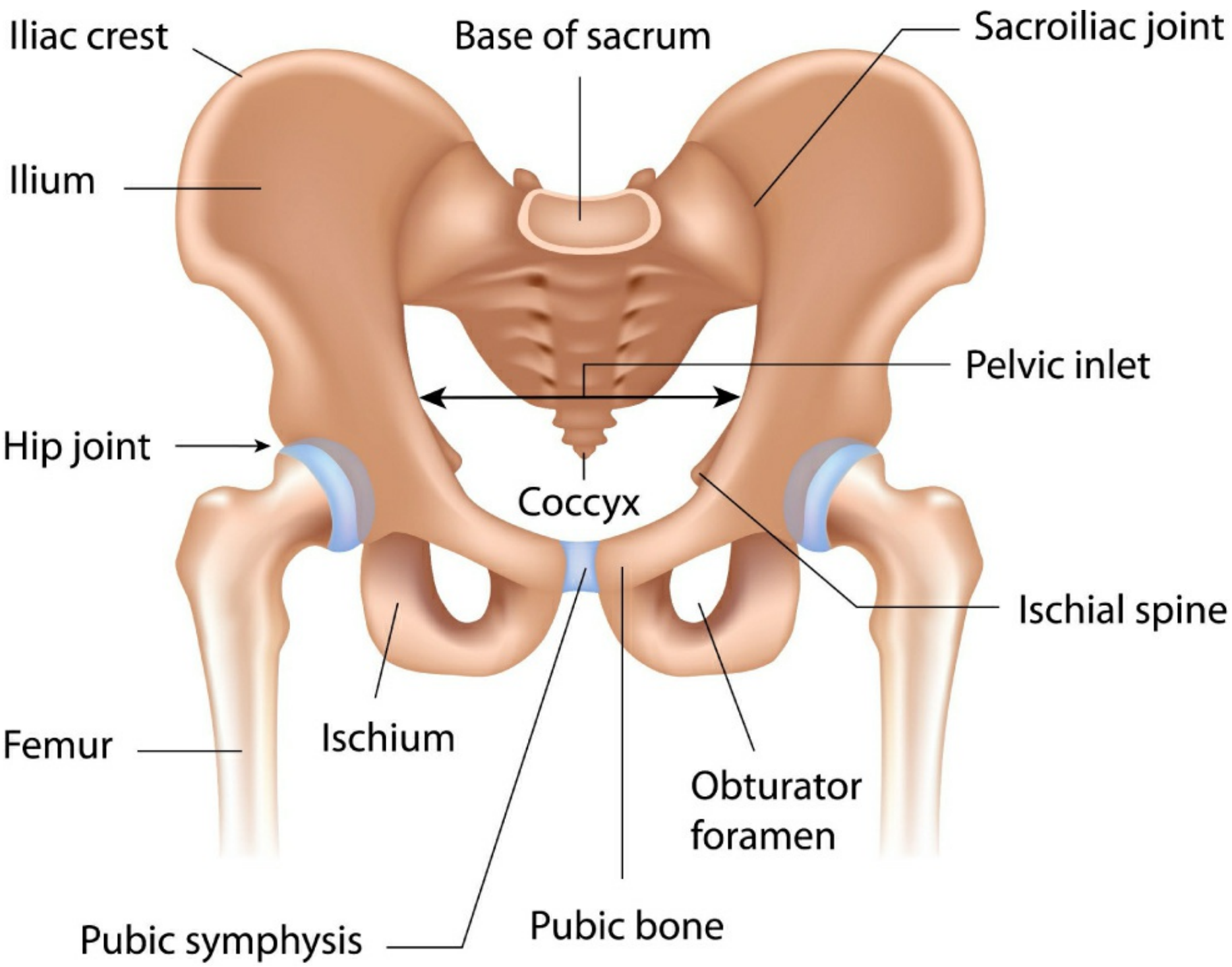

Normal
Intervertebral hernia
Stenosis
Annulus fibrosus
Nucleus pulposus
Spinal nerves
Spinal cord
Superior view
Flattening nerve endings
Compression of the spinal cord
Spinal cord
Spinal nerves
Intervertebral disc
Lateral view
Pulposus nucleus goes into the spinal canal
Degenerative bones narrow the spinal canal

THE PELVIS

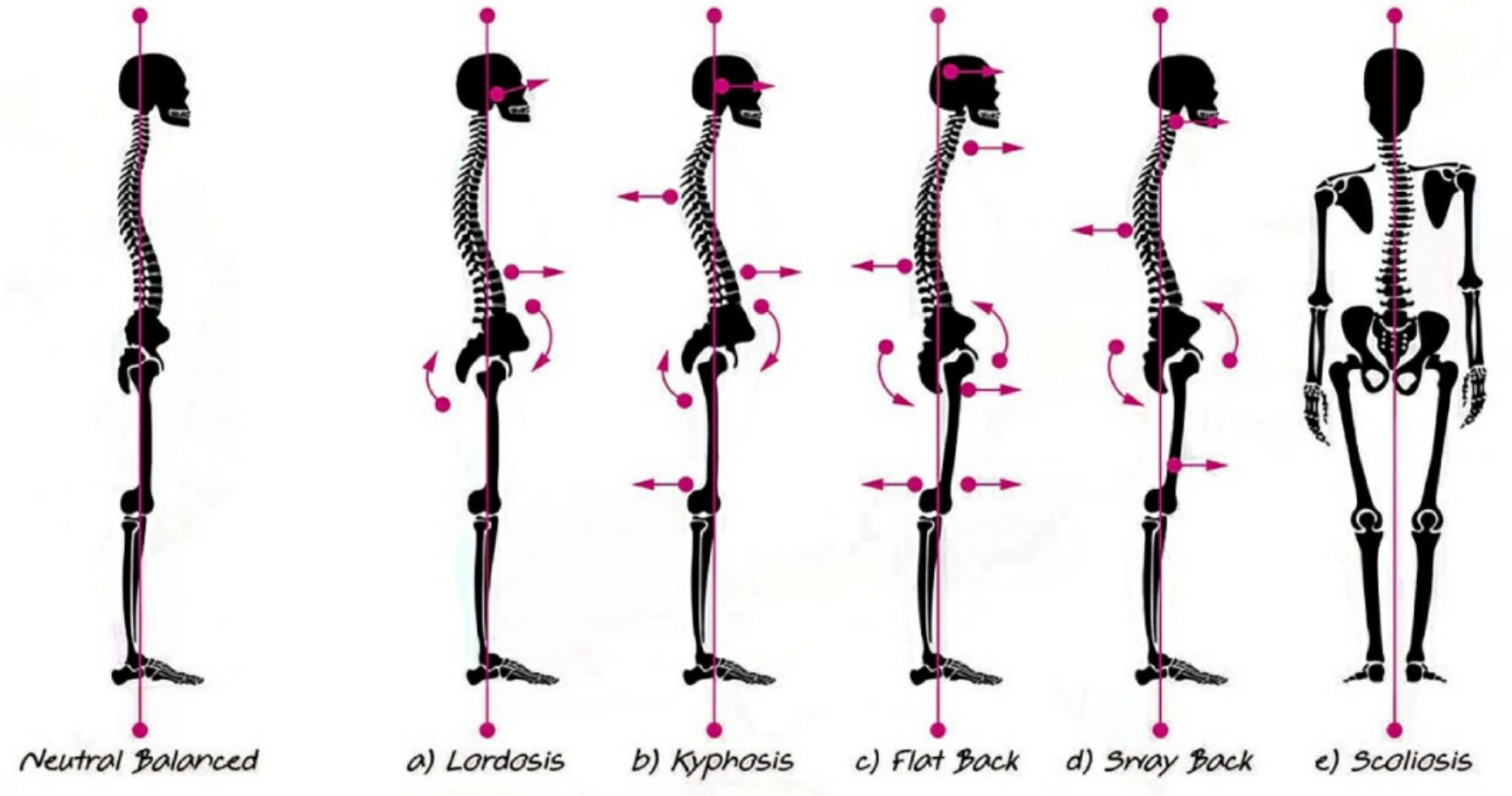
The pelvis is made up between the sacrum and the ilium, creating the sacroiliac joints at either side of the sacrum. Therefore, pelvic positioning will impact the spine. Specifically, the lumbar spine – an anterior (forward) tilt will exaggerate the lordotic curve.

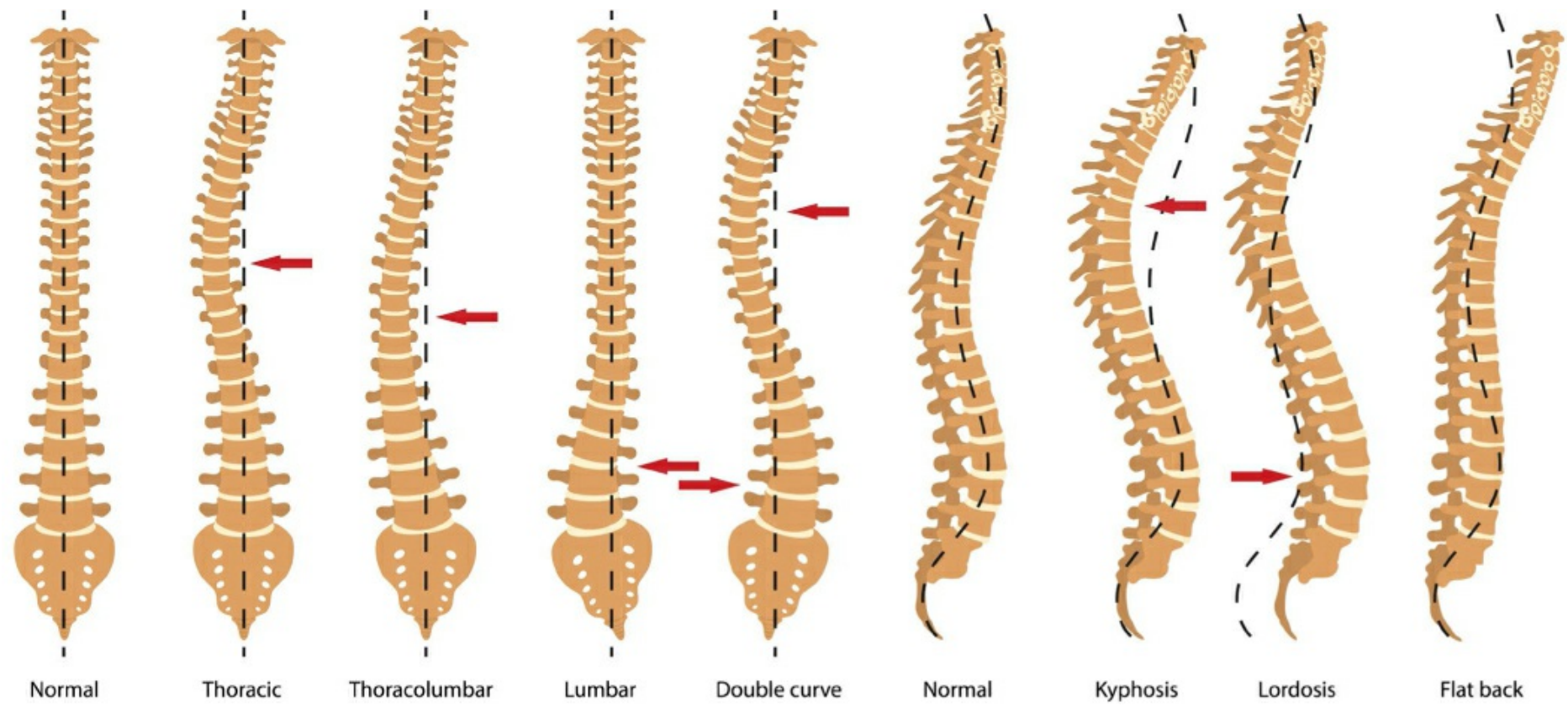
The pelvis naturally tilts forward slightly. However, there are 3 common ways in which the pelvis may tilt excessively:

- **Anterior tilt:** Tilted forwards – increases lumbar lordosis (a common sight in gyms and athletes).
- **Posterior tilt:** Tilted backwards – causes the lumbar spine to flatten.
- **Lateral tilt:** Tilted to one side with one ilium being higher than the other.



STANDING POSTURES





HYPER-LORDOSIS

Hyper-lordosis is usually characterized by an anteriorly tilted pelvis and an exaggerated curve of the lower spine.

The relationship between the muscles that surround these areas is often referred to as lower crossed syndrome:

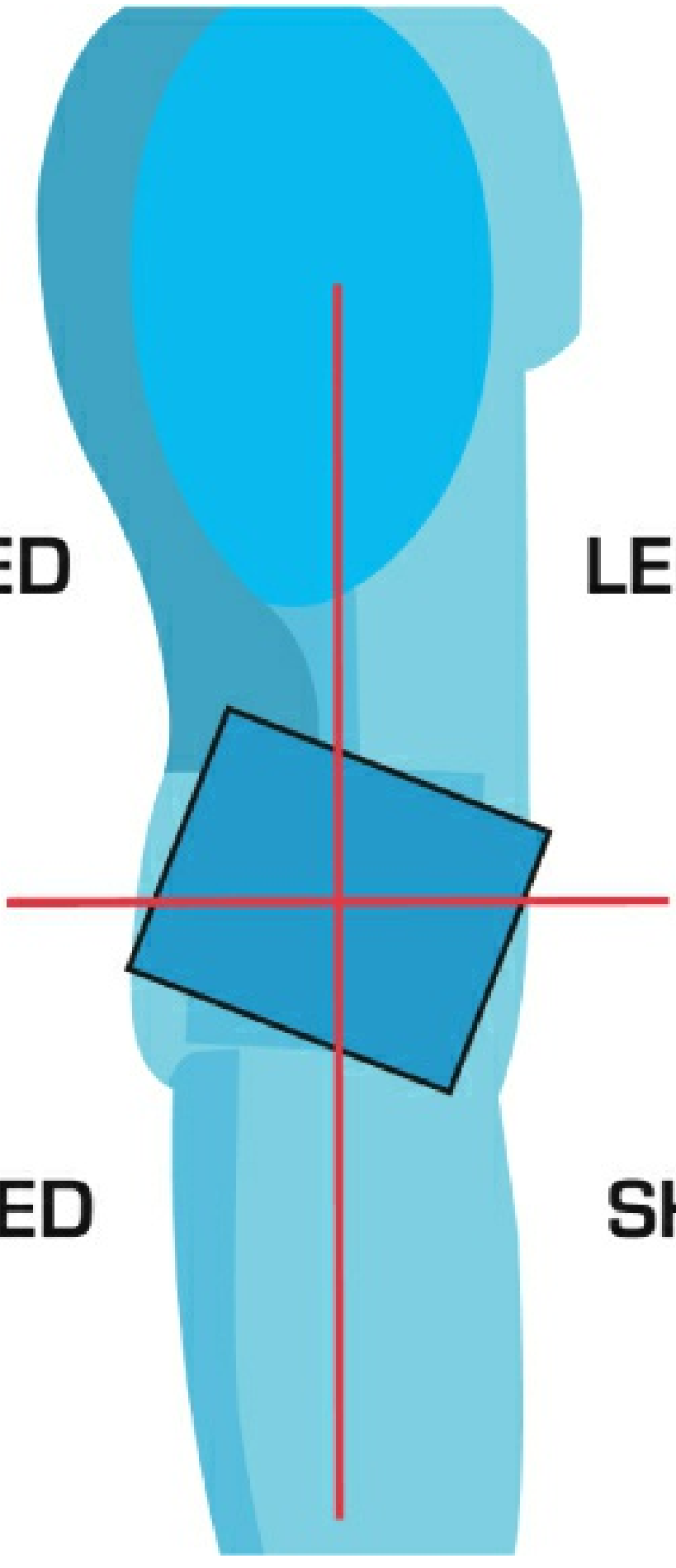
- Tight / Shortened erector spinae and quadratus lumborum (QL's)
- Tight / shortened iliopsoas (psoas major and iliacus).
- Weak / lengthened abdominals.
- Weak / lengthened gluteals and hamstrings.

We can help correct these issues with:

- Quadratus lumborum and lowe erector spinae release and stretches.
- Quadriceps and hip flexor release and stretches.
- Glute Bridges and Hamstring Curls.
- Abdominal Crunches.

SHORTENED

LENGTHENED



LENGTHENED

SHORTENED

HYPER-KYPHOSIS

Hyper-kyphosis is usually characterized by a rounded upper back, rounded shoulders, and forward head posture.

The relationship between the muscles that surround these areas is often referred to as upper crossed syndrome:

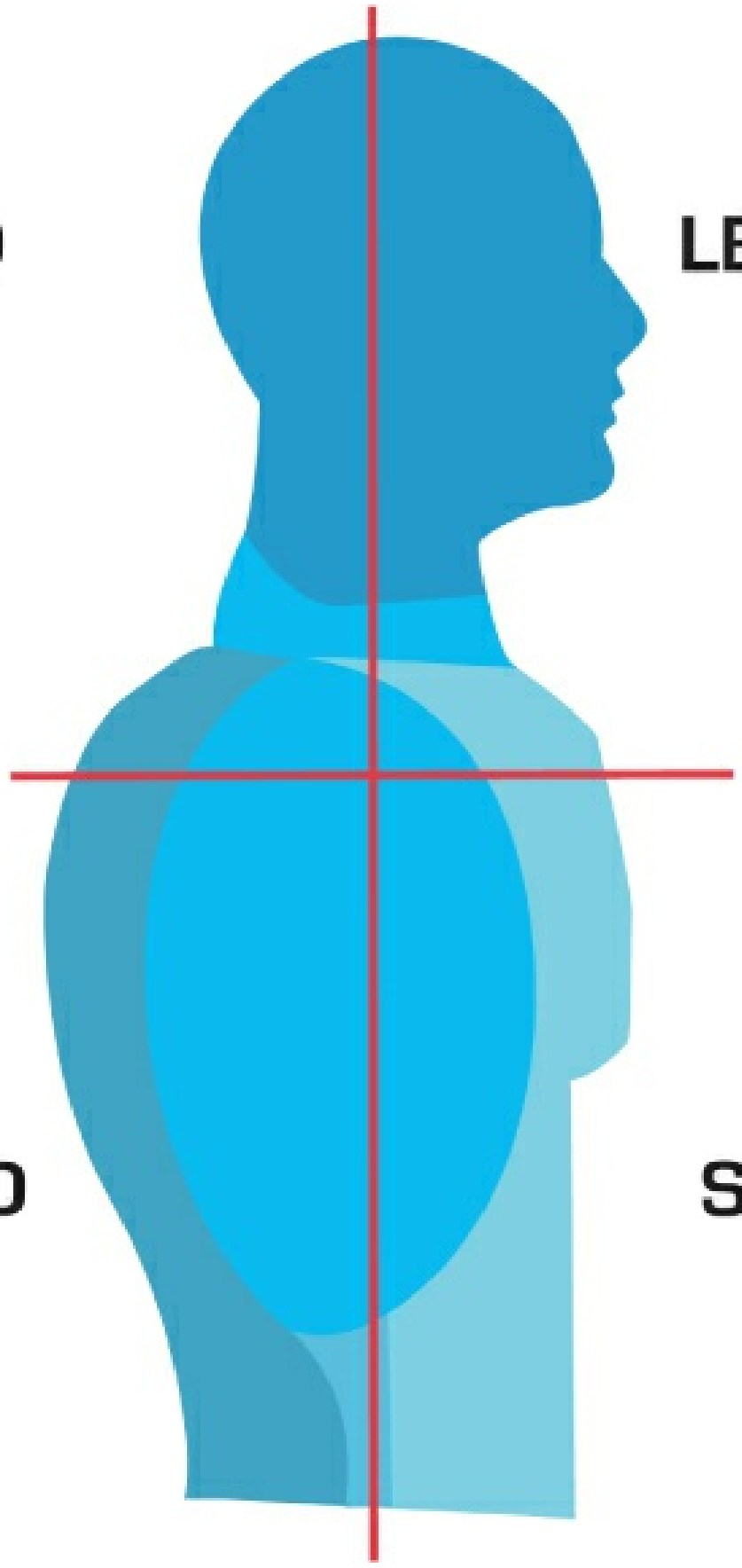
- Tight / shortened pectorals.
- Tight / shortened upper trapezius and levator scapula.
- Weak / lengthened deep neck flexors.
- Weak / lengthened lower trapezius, rhomboids and serratus anterior.

We can help correct these issues with:

- Pectoralis minor release and stretches.
- Trap and levator scapula release and stretches.
- Neck flexor strength exercises.
- Band horizontal Pulls.
- Palms forward bent-over lateral raises.

SHORTENED

LENGTHENED



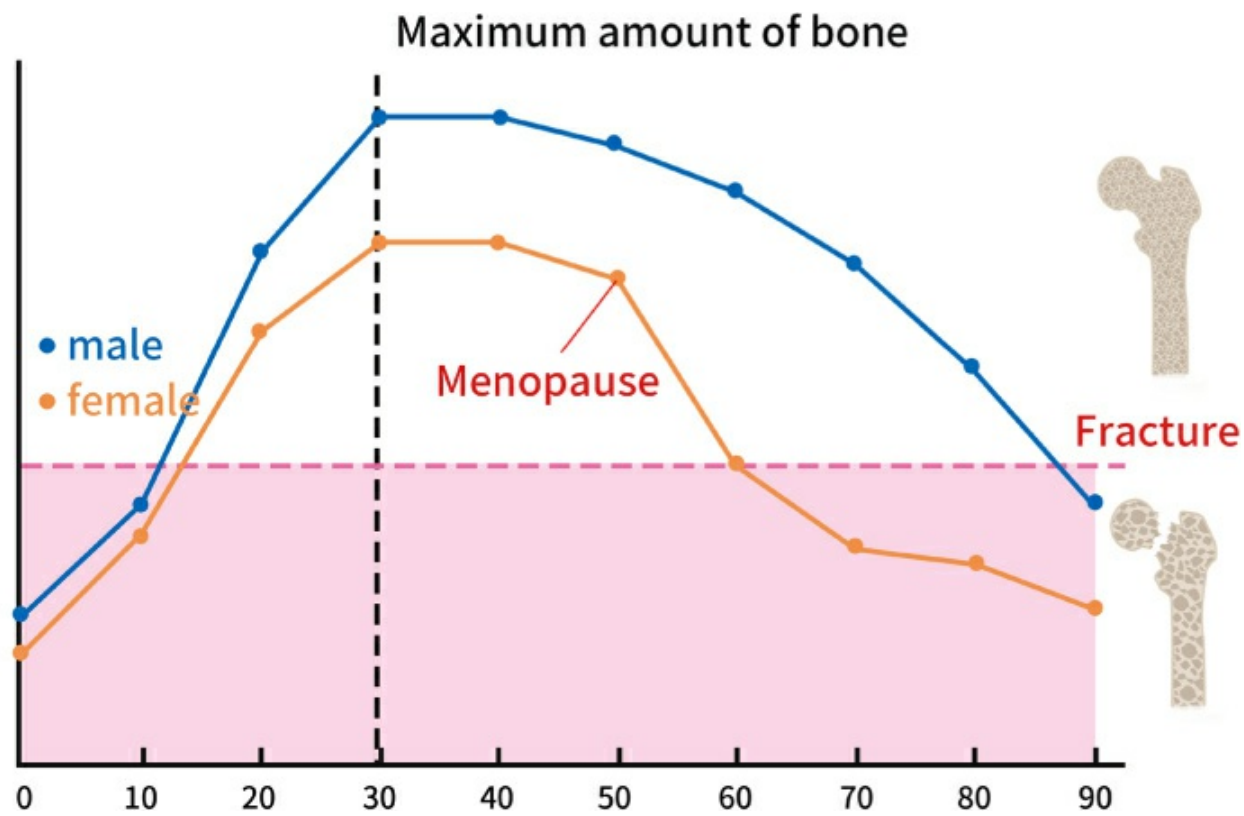
LENGTHENED

SHORTENED

EFFECTS OF EXERCISE ON THE SKELETAL SYSTEM

Immediate Effects	Long-Term Effects
Increased secretion of synovial fluid in joints, which reduces wear-and-tear.	Increased bone mineral density and strength.
Increase in blood flow and nutrients to bones and joints.	Increased joint stability due to stronger ligaments and tendons.
Muscles pull on bones to increase ROM.	Improved cartilage health.
	Increased ROM, leading to improved flexibility and mobility.
	Reduced risk of osteoporosis (brittle-bone disease).
	Reduced risk of fractures.
	Improved posture.

Normal



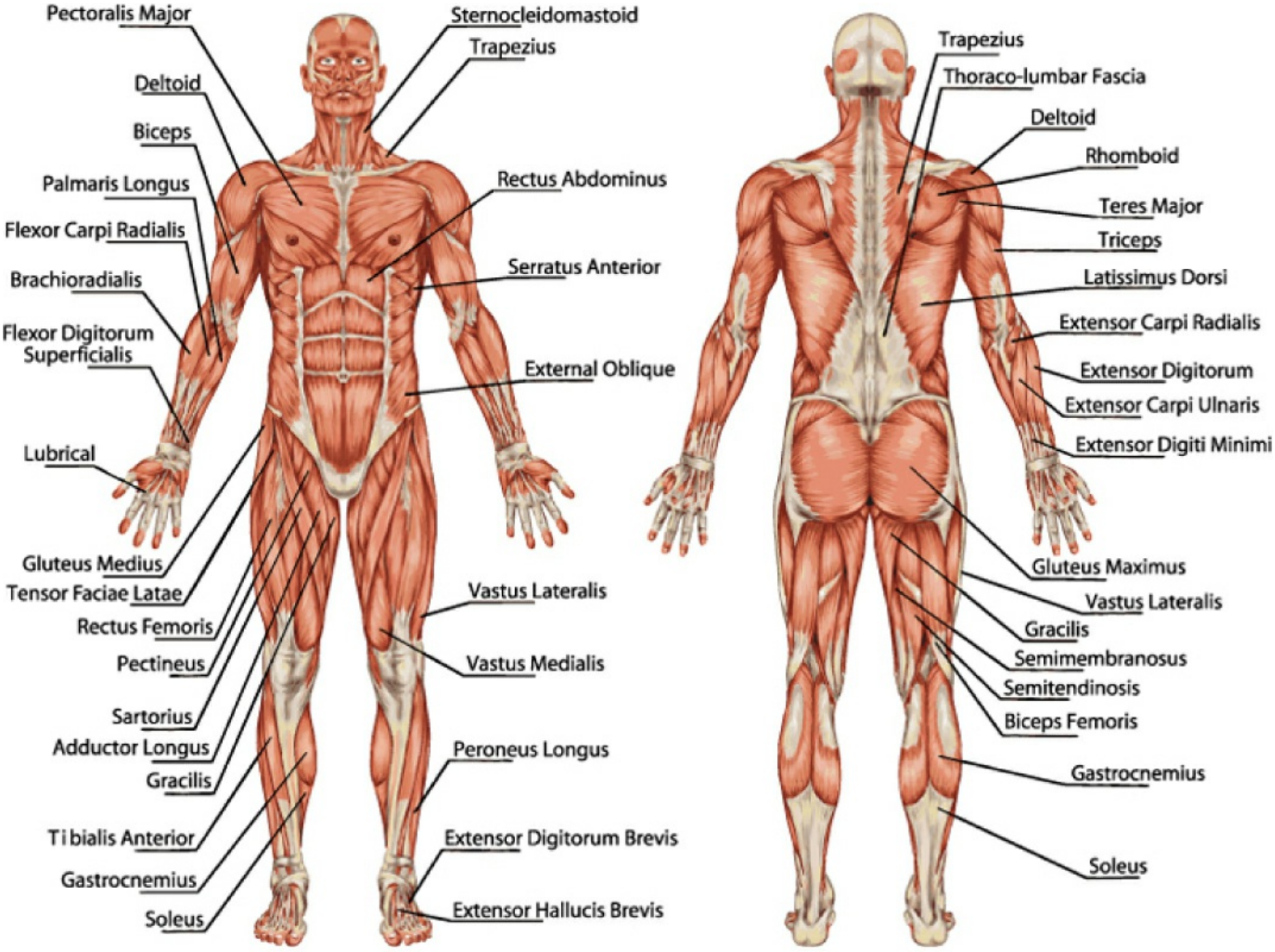
THE MUSCULAR SYSTEM

The simplest example of how a muscle facilitates movement is to think of a basic hinge joint like the elbow or knee.

The biceps brachii muscle on the front of the upper arm crosses the elbow (attaches below the elbow). Therefore, when the biceps contract and shorten (concentric contraction), the tendon pulls on the forearm bone it attaches to and pulls it towards the upper arm (the insertion is being brought towards the origin), i.e., Your elbow bends (performing a biceps curl).

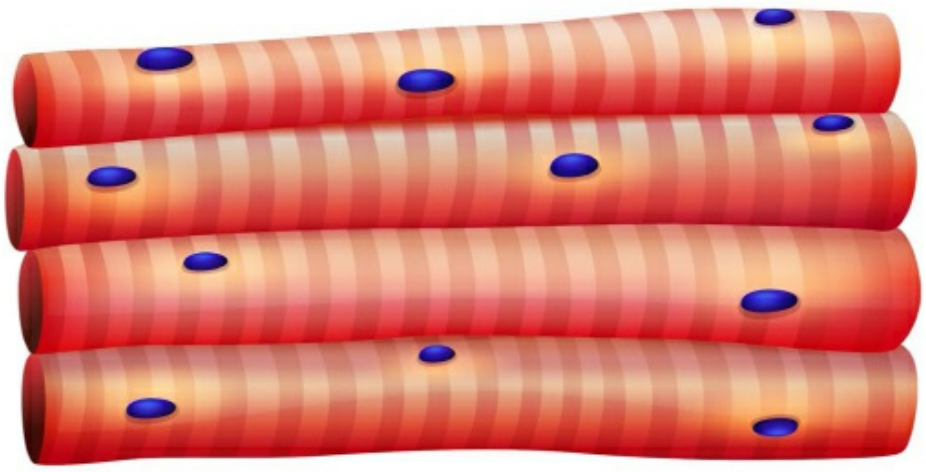
When a muscle contracts and shortens, the opposing muscle lengthens, and this is referred to as reciprocal inhibition. We refer to the major muscle performing the action as the agonist or prime mover and the opposing muscle as the antagonist.

We can also refer to other muscles that assist the actions as synergists and ones that stabilize the action as fixators.

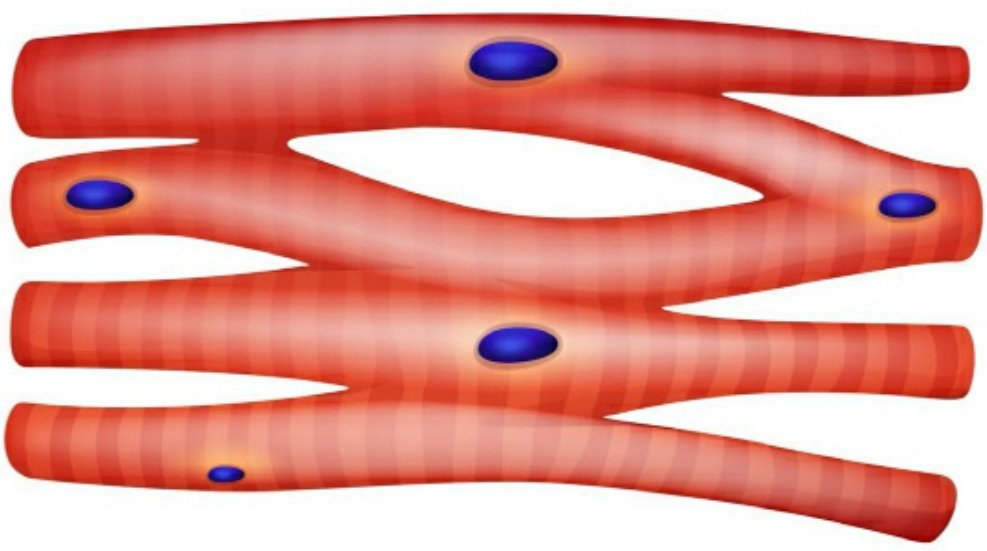


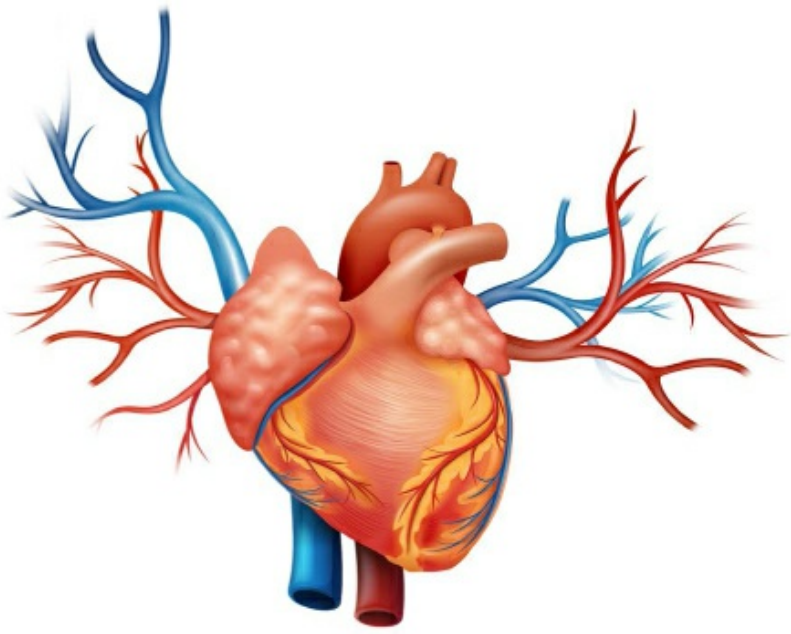
TYPES OF MUSCLE

There are three types of muscle shown below.

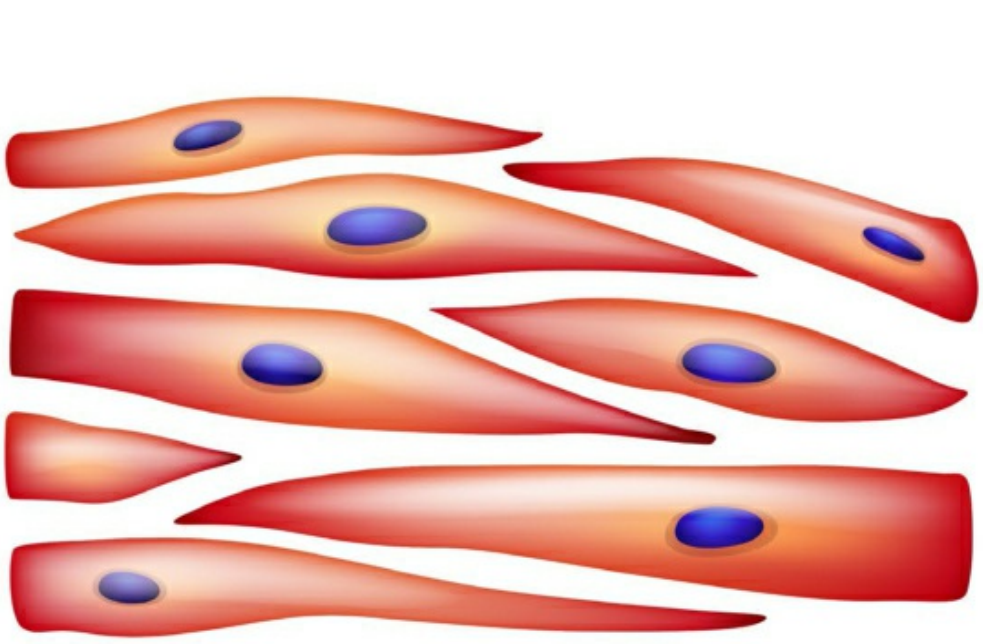


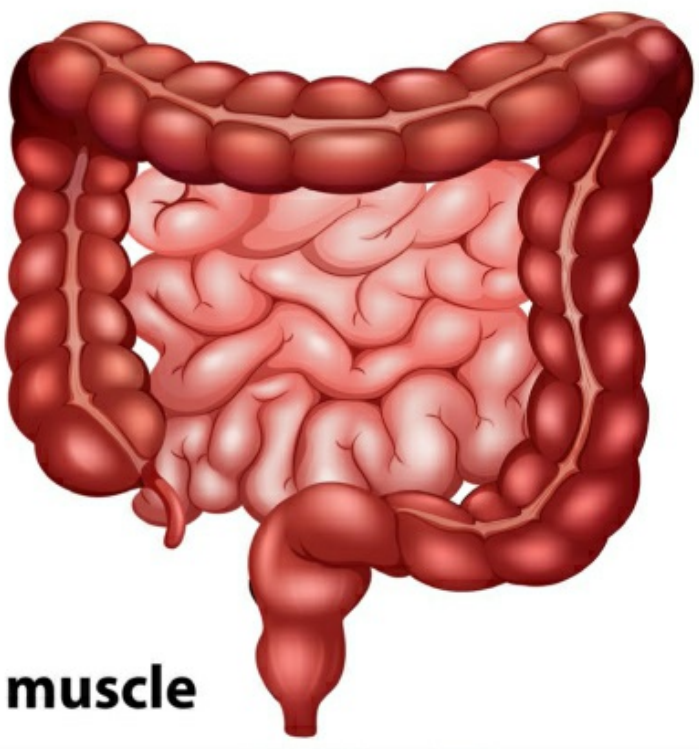
skeletal muscle





cardiac muscle



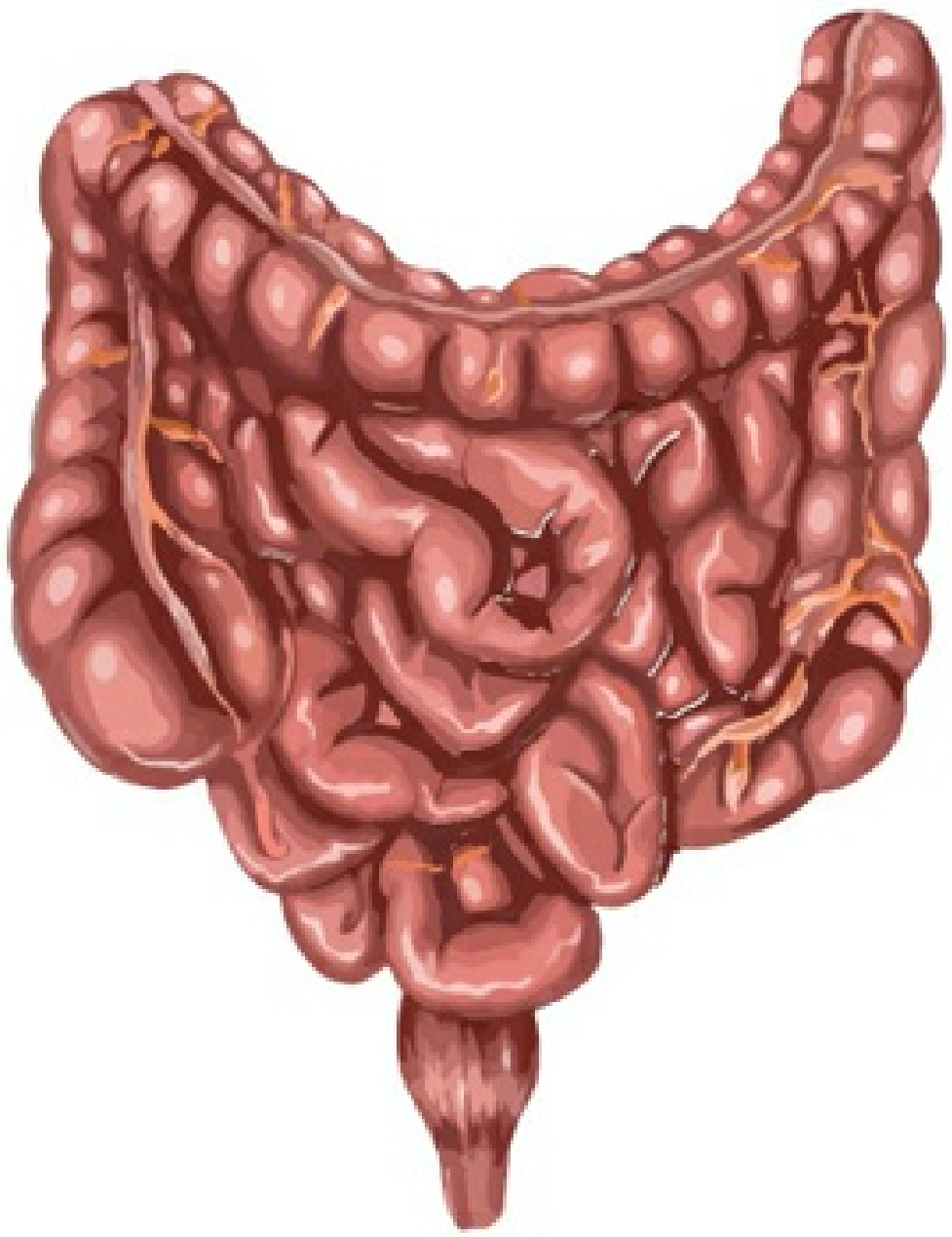


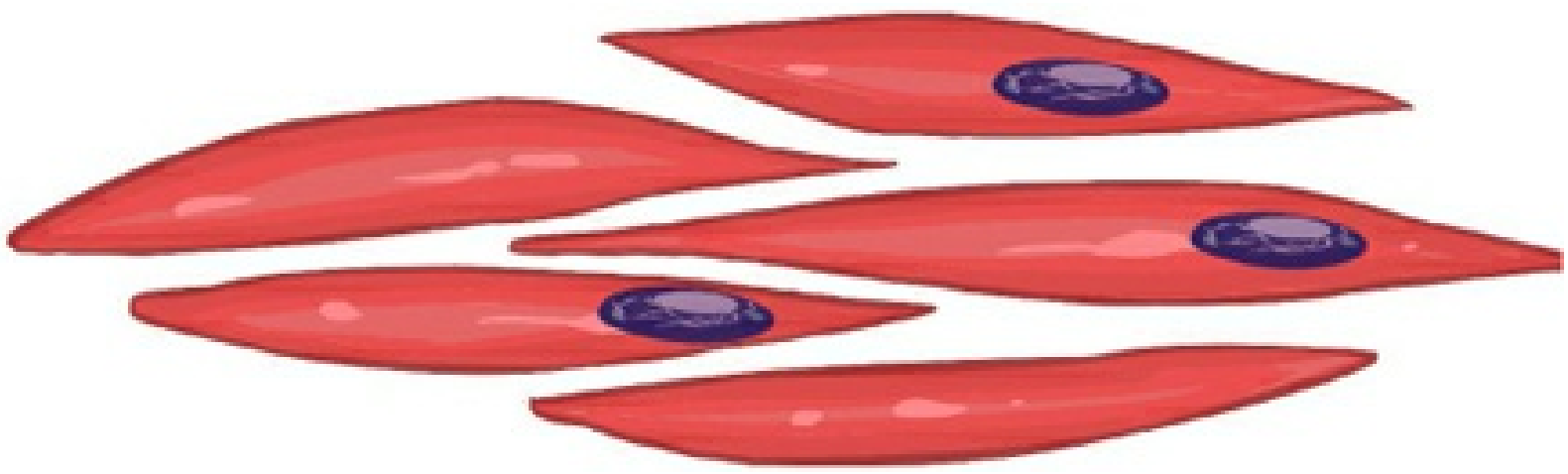
smooth muscle

SMOOTH MUSCLE

Smooth muscle, for example, the digestive system:

- Controlled by the autonomic nervous system.
- Smooth, spindle-shaped.
- Involuntary – not under conscious control.
- Found in the digestive system, blood vessels, urinary and reproductive systems. For example, the musc digestive tract contract to move food through the body (peristalsis).
- They are used in all processes that maintain the body's internal environment.

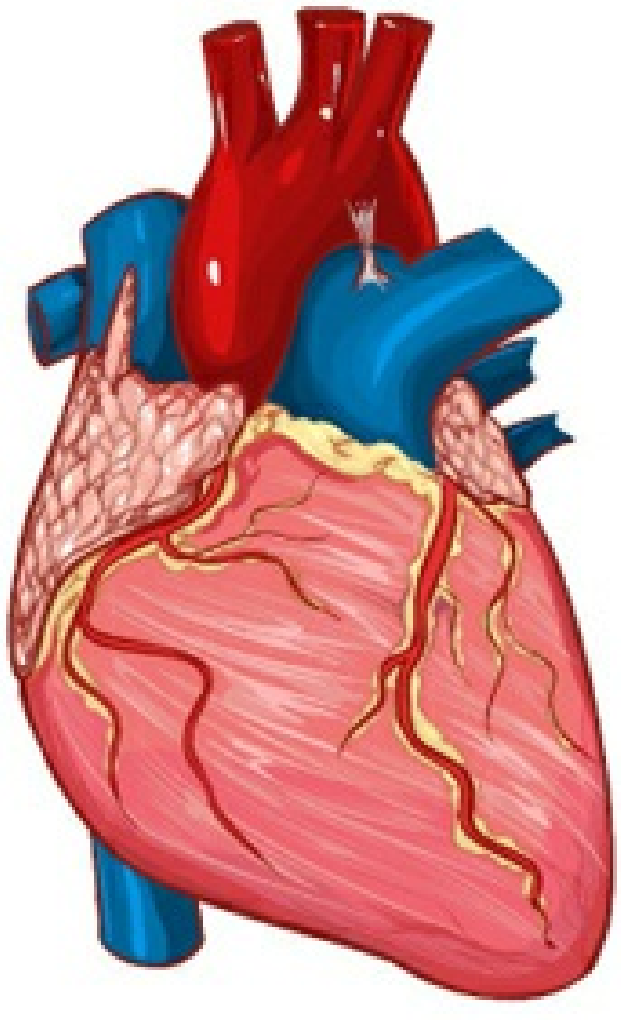


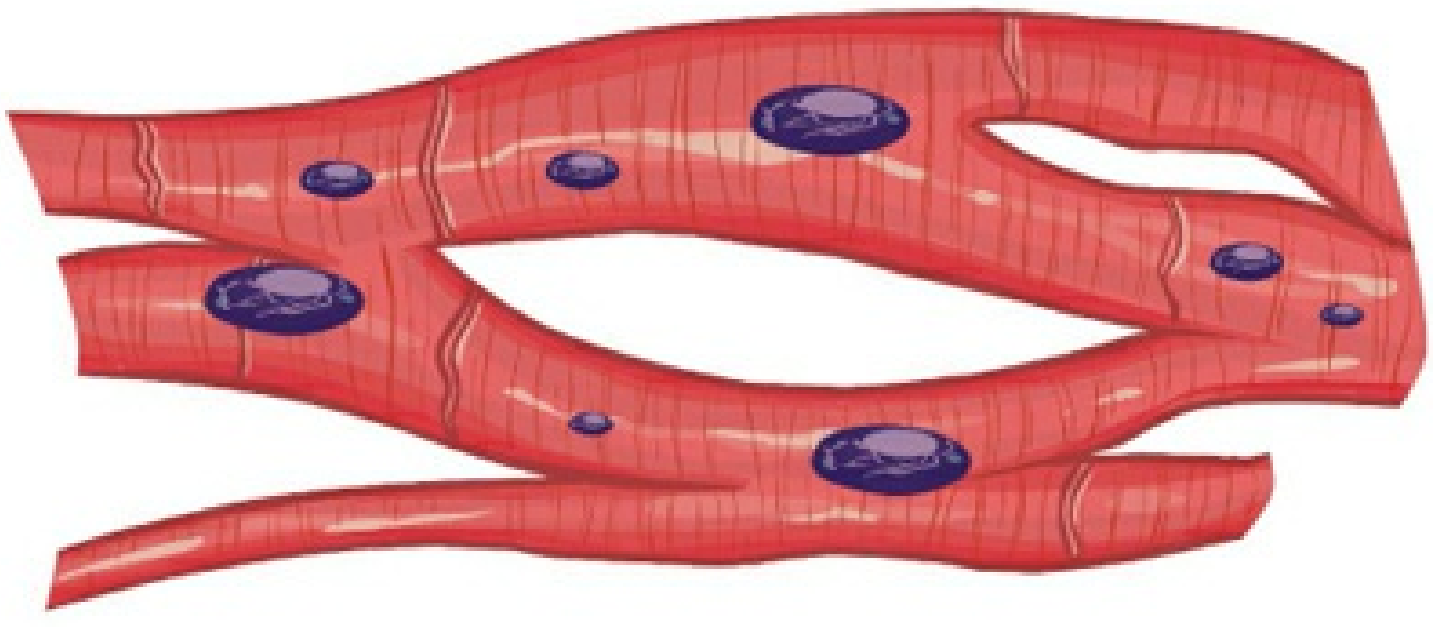


CARDIAC MUSCLE

Cardiac muscle (myocardium). The only example is the heart.

- Found in the heart (the chamber walls).
- Striated (striped or streaked).
- Main function is to pump blood around the body.
- Works continuously.
- Involuntary – not under conscious control.
- Contraction of the heart is controlled by the sinoatrial node (SAN).

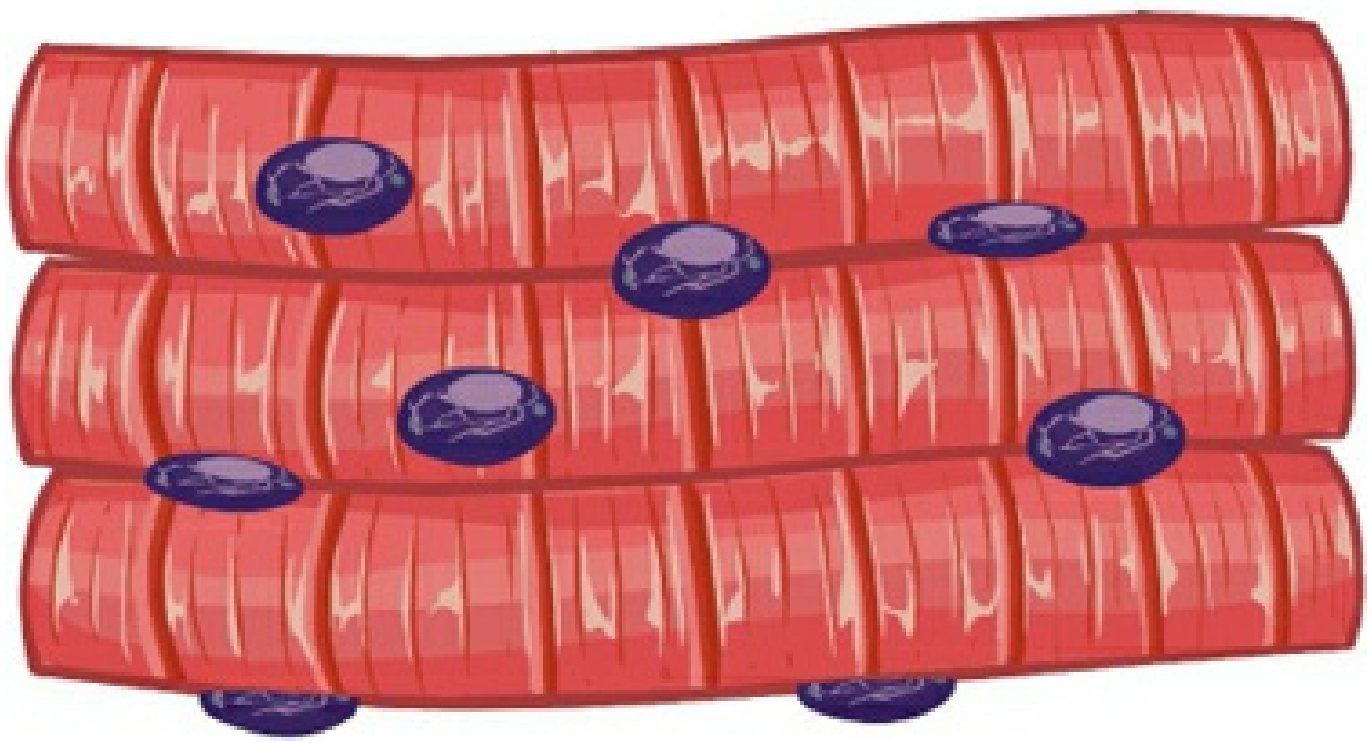




SKELETAL MUSCLE

Skeletal muscle, for example, the hamstrings or triceps.

- Attaches to bones across joints via tendons.
- Striated (striped or streaked).
- Controlled by the somatic nervous system.
- Works under conscious or voluntary control.
- Contracts and pulls on the bones to produce movement and locomotion.
- Resists the force of gravity to hold the body upright.



CHARACTERISTICS OF SKELETAL MUSCLE

Characteristic	Explanation
Contractility	Ability to shorten.
Extensibility	Ability to stretch and lengthen.
Elasticity	Ability to return to its original length.
Excitability	Ability to respond to stimuli from the nervous system.

SHAPES OF SKELETAL MUSCLE

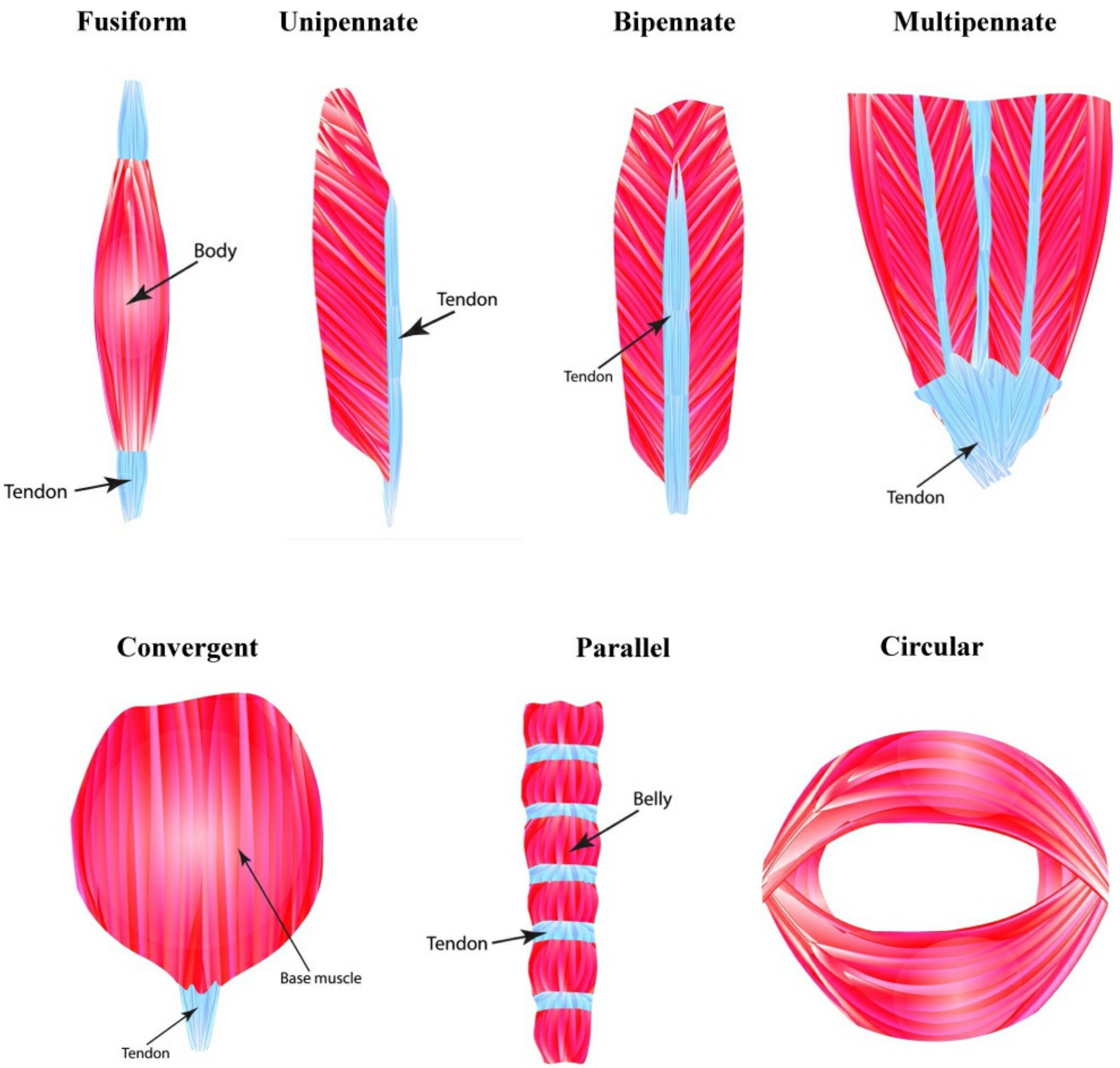
There are four distinct muscle shapes: Parallel, Convergent, Pennate and Circular.

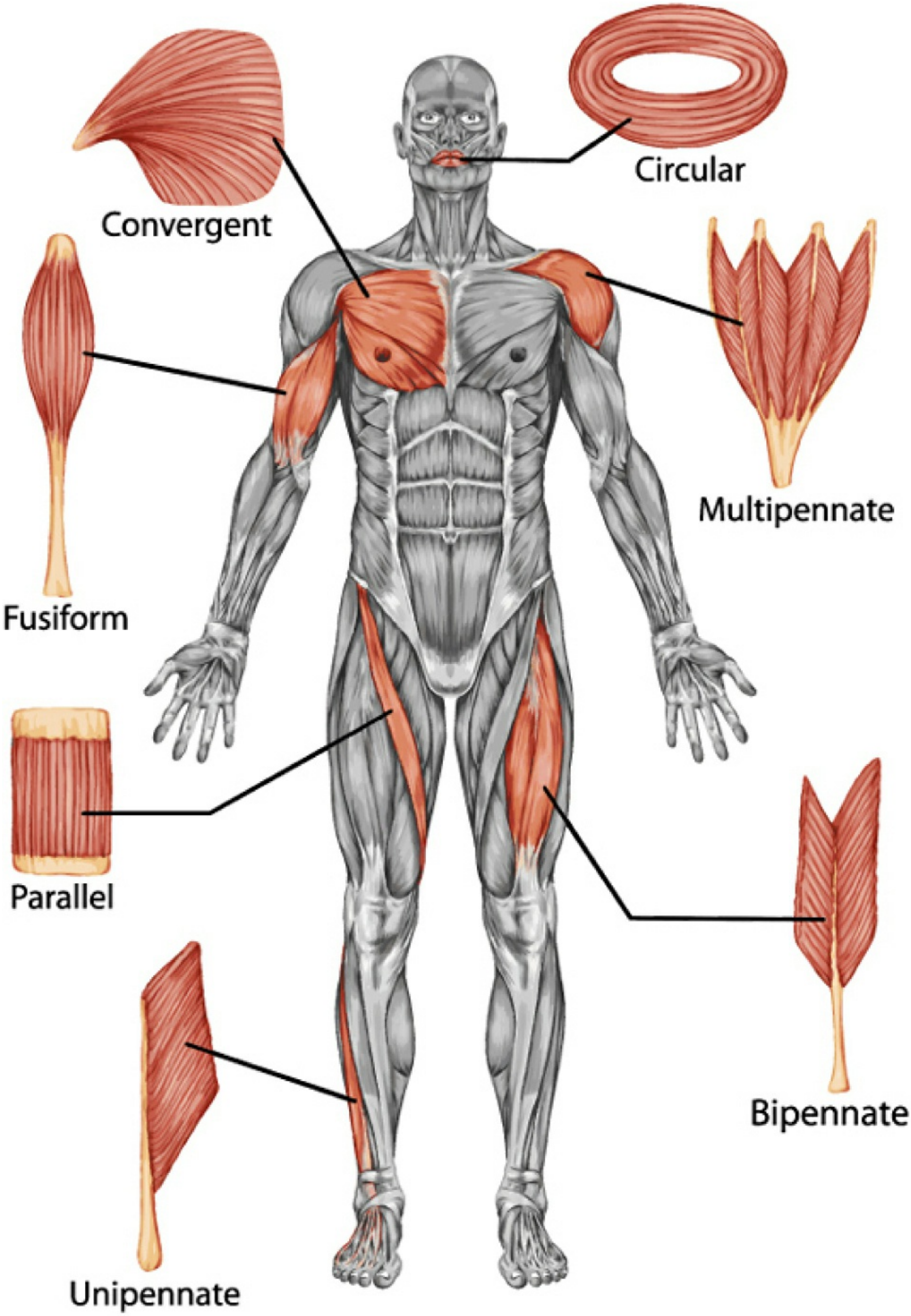
Parallel fascicles (bundle of muscle fibres) lie parallel to one another along the longitudinal axis of the muscle. If the muscles narrow towards the tendon on each end, it is called a fusiform muscle. Or they can remain parallel with wide tendons like the rectus abdominis.

Fascicles in a pennate pattern are attached like plumes of a feather (oblique) to long tendons and can be split into three categories: Unipennate, bipennate and multipennate.

Convergent muscles have an origin that is wider than the insertion, for example, the pectoralis major.

Circular muscles are circular shaped, for example, sphincter muscles and around the mouth.




Convergent
Circular
Fusiform
Multipennate
Parallel
Unipennate
Bipennate

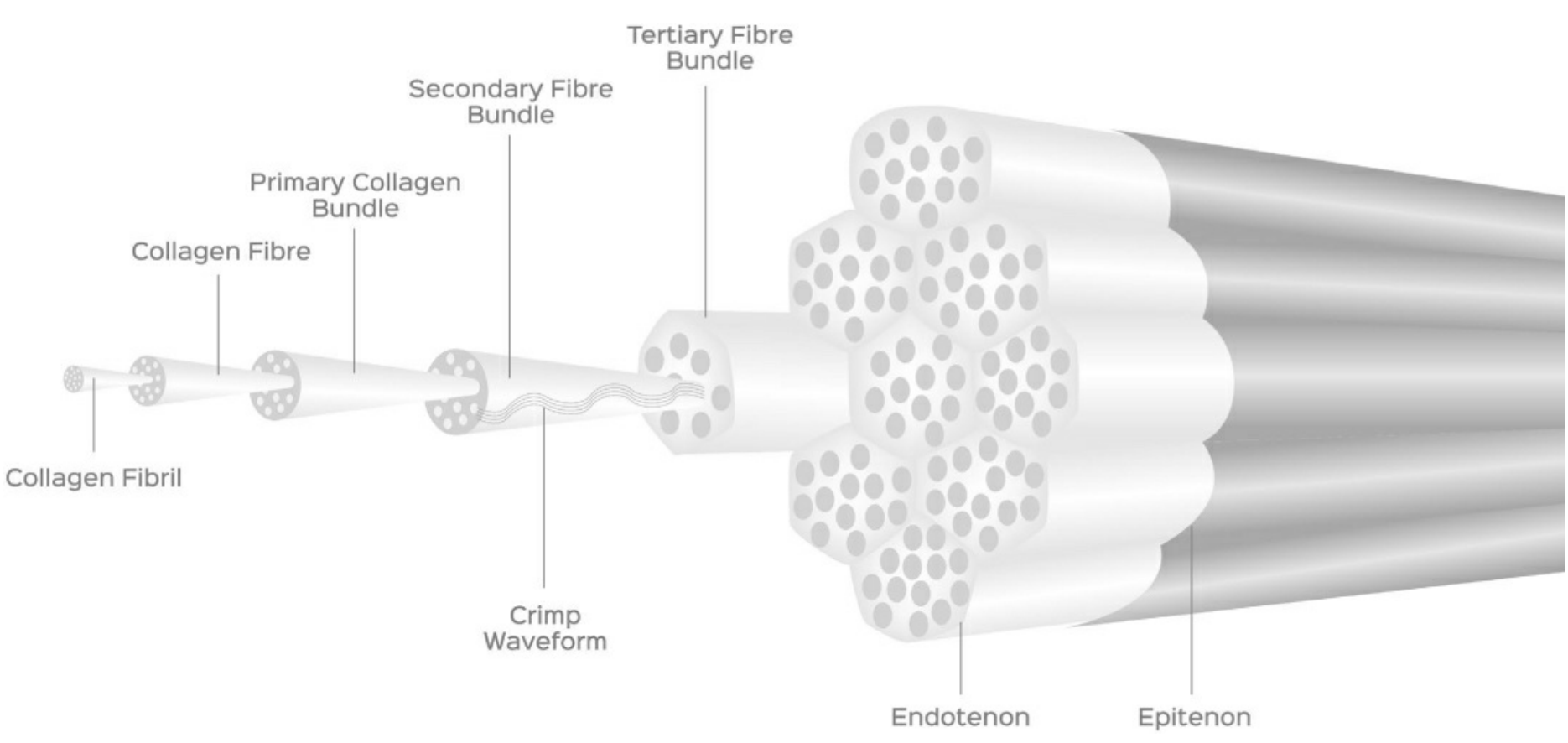
TENDONS

Properties:

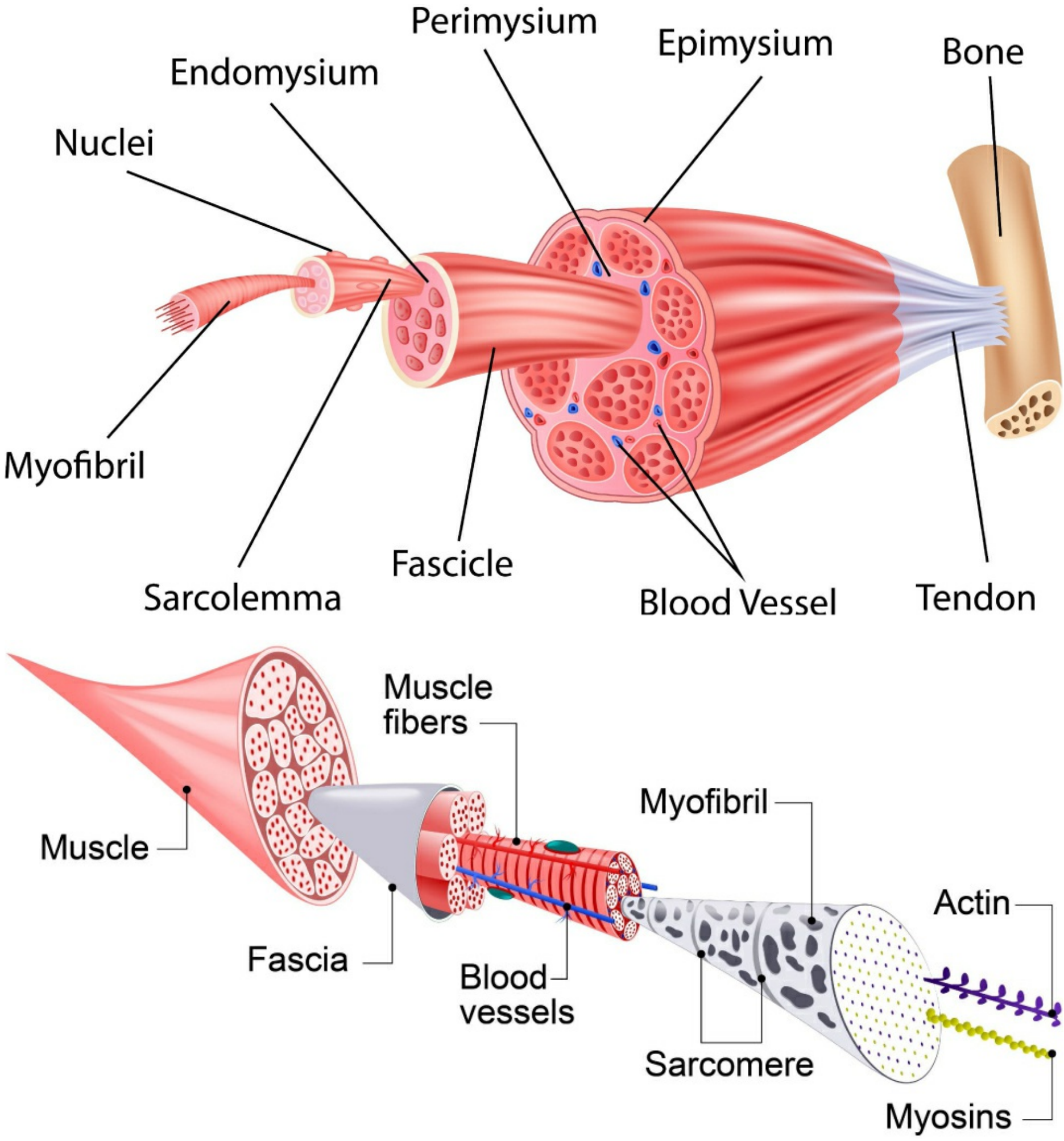
- Connect muscle to bone.
- Emerge from the muscle's connective tissue and insert onto bone via the periosteum.
- Have a shiny, white appearance.
- Have a poor blood supply.
- They are formed mainly from collagen with some elastin:

➢ Collagen increases toughness and strength – fibres are resistant to stretch.

➢ Elastin increases elasticity and stretch – fibres allow stretch and return to original shape.



STRUCTURE OF SKELETAL MUSCLE



STRUCTURE OF A MYOFIBRIL

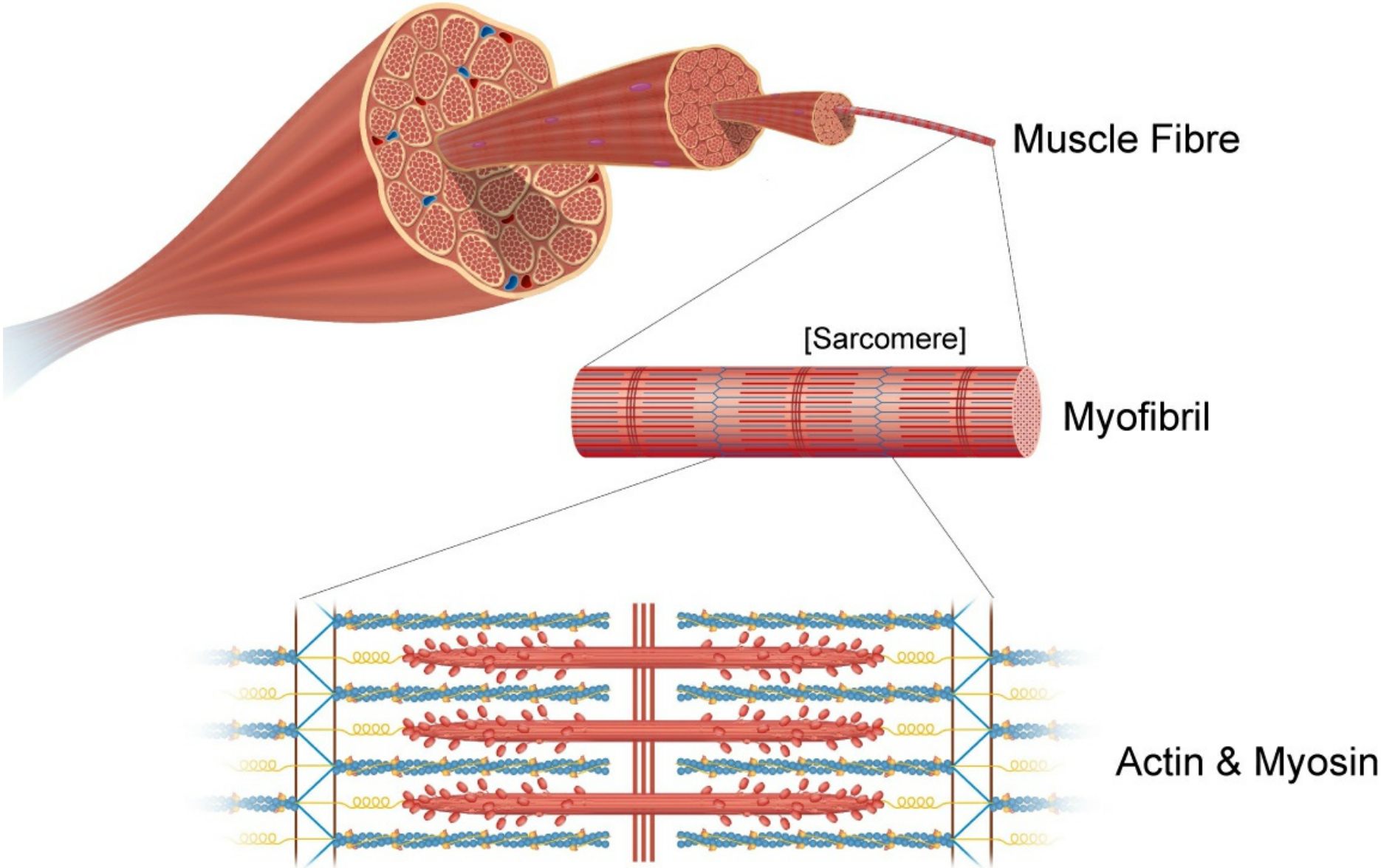
A myofibril has sections called sarcomeres.

The sarcomere is the contractile unit of a muscle, and within the sarcomere, we find actin and myosin, which are proteins found in every type of muscle tissue.

- **Actin is the thin filament (blue/green colour on the diagram).**
- **Myosin is the thick filament (red on the diagram).**

Actin and myosin filaments work together to generate muscle contractions and, in turn, movement.

Myosin converts chemical energy from ATP (discussed in the energy systems section) and turns it into mechanical energy, which is used to pull the actin filaments along, causing muscle contractions.



SARCOMERE

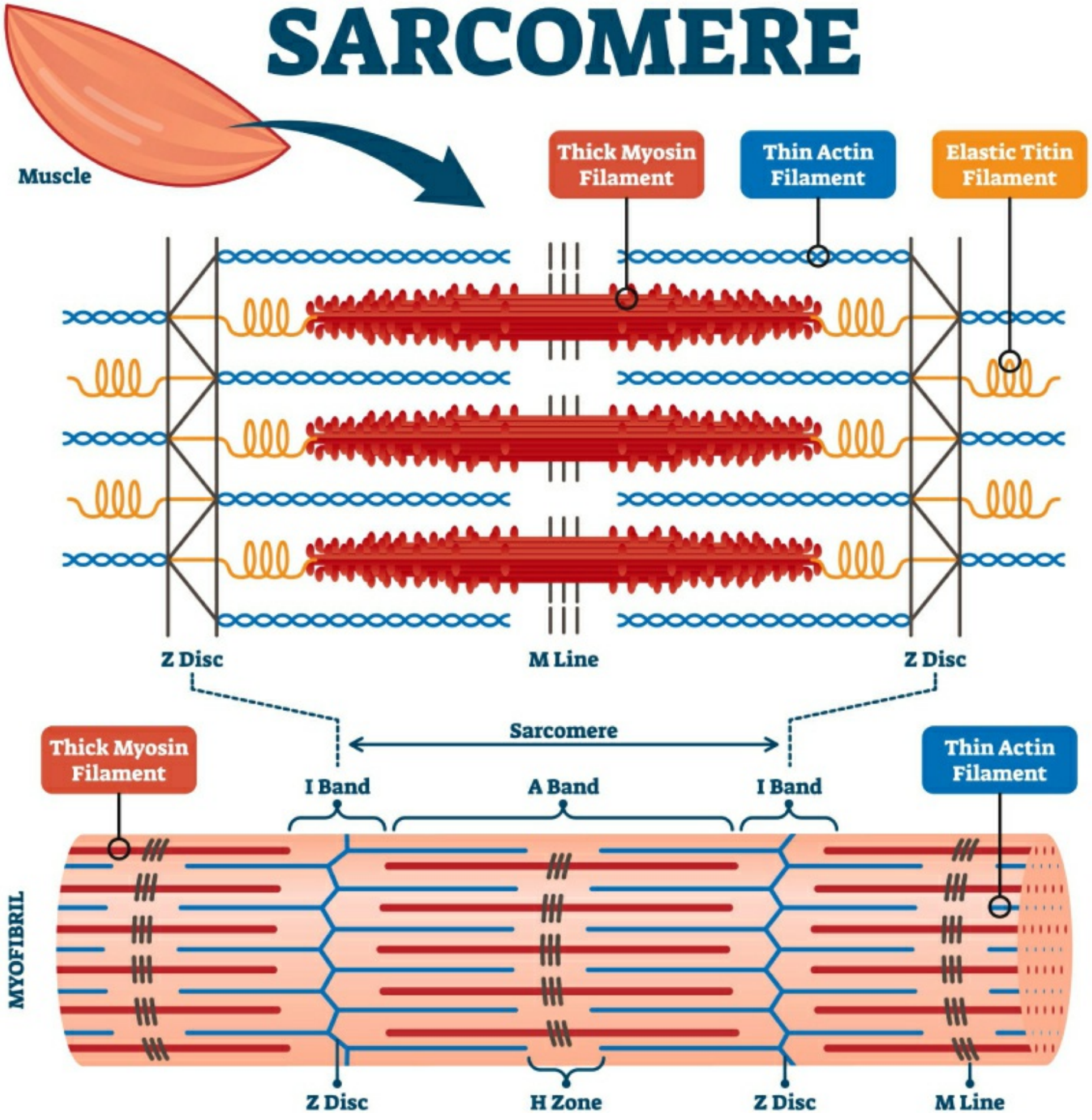
The sarcomeres give skeletal and cardiac muscle their striated appearance. The myofibrils of smooth muscle cells are not arranged into sarcomeres.

The Z disk (or Z line) defines the boundaries of a muscle sarcomere. Two adjacent Z disks along the myofibril mark the boundaries of a single sarcomere.

The I band is a light line on each side of the Z line – the region of the sarcomere where thin (actin) filaments are not overlapped by thick (myosin) filaments.

The H zone is in the center of the A band, where there is no overlap between the thick and the thin filaments. Therefore, in the H zone, the filaments consist only of the thick filament. The H zone becomes smaller as the muscle contracts and the sarcomere shortens – M line is the dark line in the center of the H zone.

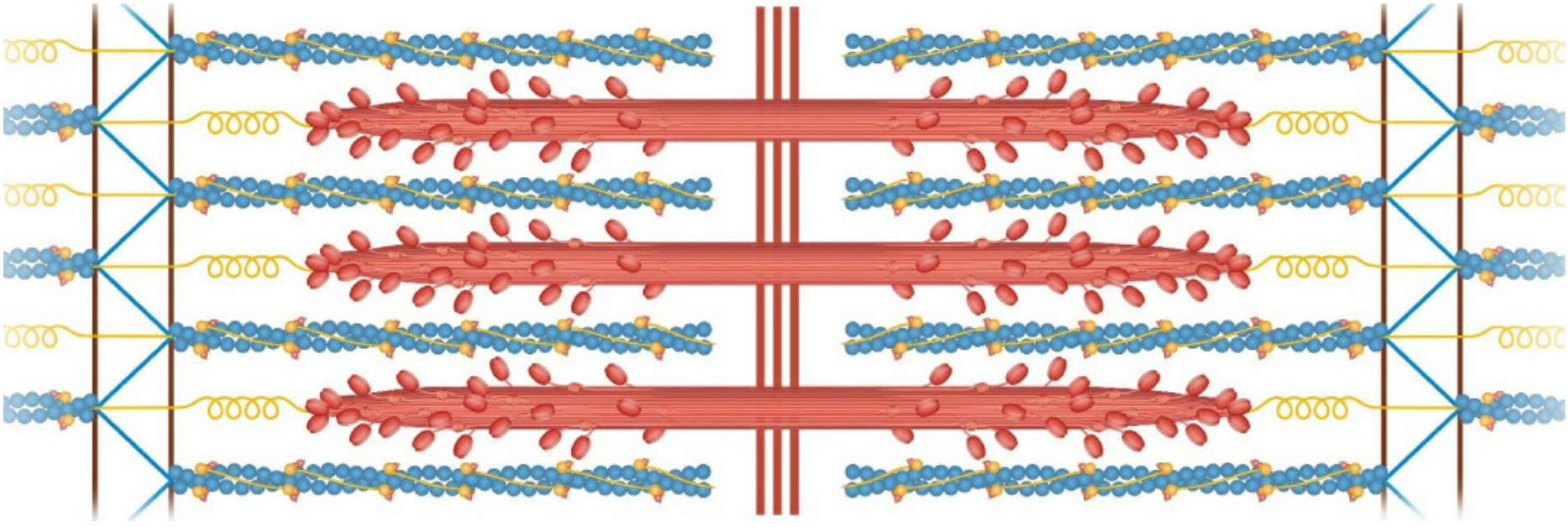
The A band is the region of a striated muscle sarcomere that contains myosin thick filaments.



SLIDING FILAMENT THEORY

The table below shows the phases of the sliding filament theory.

Phase	Explanation
Cocking Phase	ATP primes the myosin head.
Binding Phase	Calcium ions are released from the sarcoplasmic reticulum. Troponin and tropomyosin move away from the actin-binding sites. Myosin binds to actin.
Power Stroke	ATP becomes ADP. Energy is released to make the myosin heads nod and rotate. Sarcomere shortens/contracts as the actin is drawn over the myosin.
Resetting	ATP binds to myosin heads, releasing them from the actin-binding site.



SKELETAL MUSCLE FIBRES

There are 3 types of muscle fibres, Type 1 (slow), Type 2a (intermediate), and Type 2b (fast). However, muscle fibres are often described as slow or fast.

The type 2a fibres are classed as fast-twitch fibres but are also known as intermediate fibres because they contain many blood capillaries, myoglobin, and mitochondria.

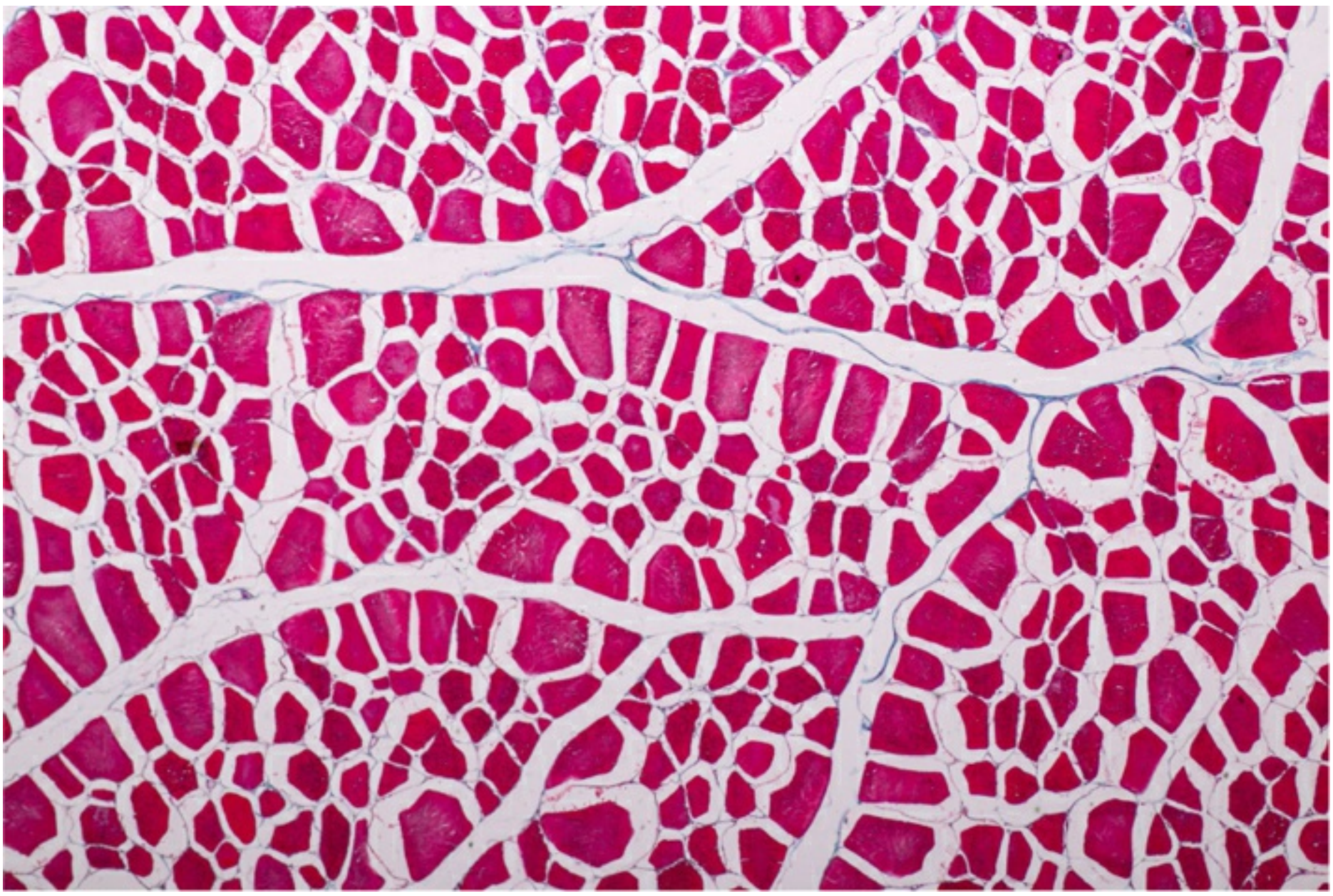
Myoglobin is an iron-containing protein in muscles that receives oxygen from the red blood cells and transports it to muscle cells' mitochondria.

Mitochondria are rod-shaped organelles that are considered the power generators of the cell, converting oxygen and nutrients into adenosine triphosphate (ATP).

These attributes mean type 2a muscle fibres can respire aerobically, making them relatively resistant to fatigue. However, they can also hydrolyze (breakdown) ATP quickly, using both aerobic and anaerobic metabolism, allowing them to contract much faster than type 1 fibres.

Genetics dictates the ratios of the fast and slow-twitch fibres we have. Hence certain individuals are suited to specific sports. If an athlete partakes in predominately endurance-based training. In that case, their muscle fibres will make adaptations to support this, and the same applies to athletes who participate in predominant strength and power-based training.

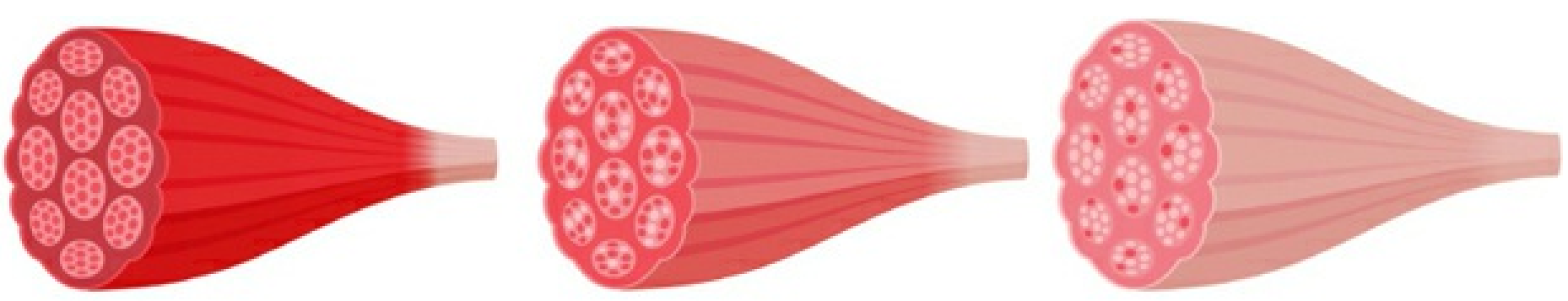
However, to what extent this can happen is not fully understood. For example, slow-twitch fibres do not merely turn into fast-twitch fibres. Still, intermediate fibres will develop their resistance to fatigue or their ability to contract fast and hard depending on the training being practiced – SAID principle (Specific Adaptation to Imposed Demands).



MUSCLE FIBRE TYPES

The table below shows the characteristics of each muscle fibre type.

Characteristic	Type 1 Slow	Type 2a Fast Oxidative	Type 2b Fast Glycolytic
Colour	Red	Red	White
Muscle Fibre Size	Small	Large	Large
Force Production	Low	High	Very High
Contractile Speed	Slow	Fast	Very Fast
Resistance to Fatigue	High	Medium	Low
Capillaries	High	Medium	Low
Mitochondria	High	Medium	Low
Myoglobin	High	Medium	Low
ATPase	Low	Medium	High
Oxidative Capacity	High	Medium	Low
Glycolytic Capacity	Low	High	High

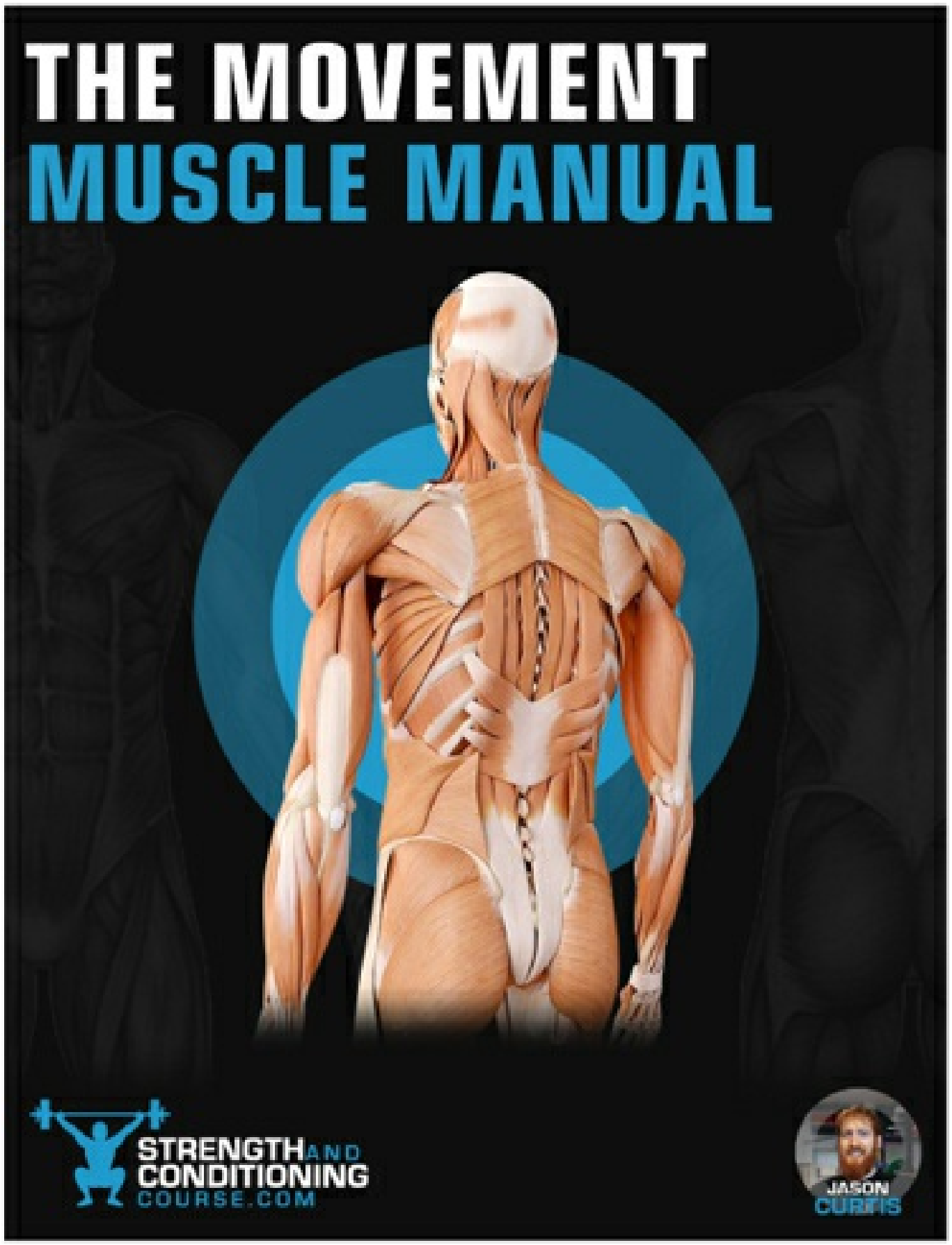


ORIGINS AND INSERTIONS

- **Origin:** The origin is attached to a fixed bone that usually does not move during contraction. It is often de the proximal attachment, meaning it is closer to the centre or midline of the body – muscles may have one origin. For example, the triceps have three and the biceps have 2.

- **Insertion:** The insertion is the attachment to a bone that usually moves during contraction. It is often de the distal attachment, meaning further from the centre or midline of the body.

FREE MUSCLE MANUALS



This unique muscle manual categorizes muscles by their movements, giving you a much better understanding of how muscles assist and oppose each other to perform actions.

You also get a FREE second version of the muscle manual, which lists:

- Origin.
- Insertion.
- Action.
- Antagonist.
- Innervation.
- Blood Supply.
- Daily Use.

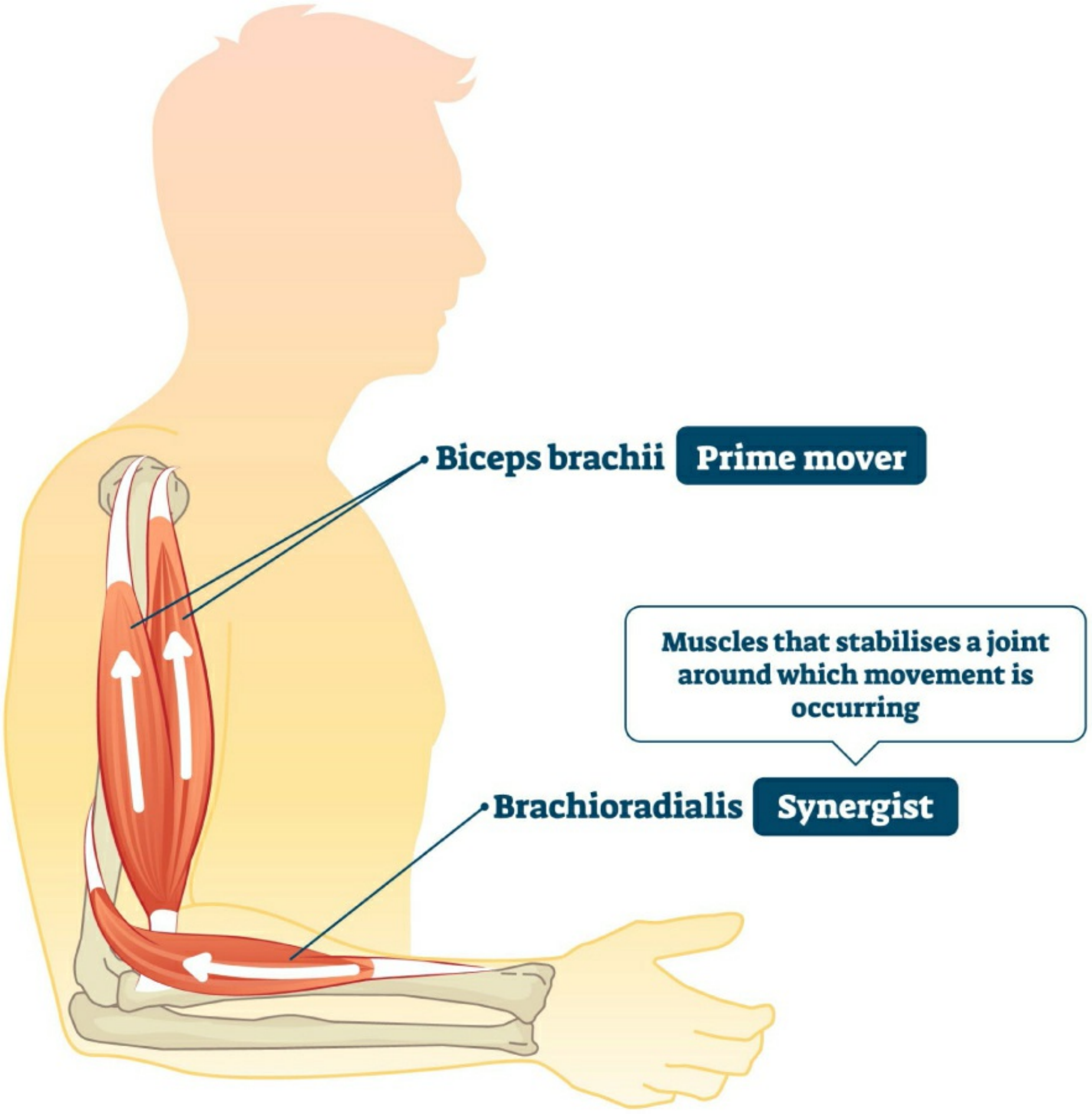
- Gym Use.

Scan the QR Code to download your copies:

You can also purchase a paperback copy on Amazon: mybook.to/musclemanual

MUSCLE ROLES

- **Prime Movers / Agonists:** These are the muscles that perform the desired action. For example, the bice during a biceps curl.
- **Antagonists:** These are the muscles that oppose the agonist. For example, the triceps brachii during a bice
- **Synergists:** These are the muscles that assist the agonist. For example, the brachioradialis.
- **Fixators:** These are the muscles that stabilize the body during the movement. For example, the deltoi biceps curl.



TYPES OF CONTRACTIONS

There are 2 types of muscle contraction:

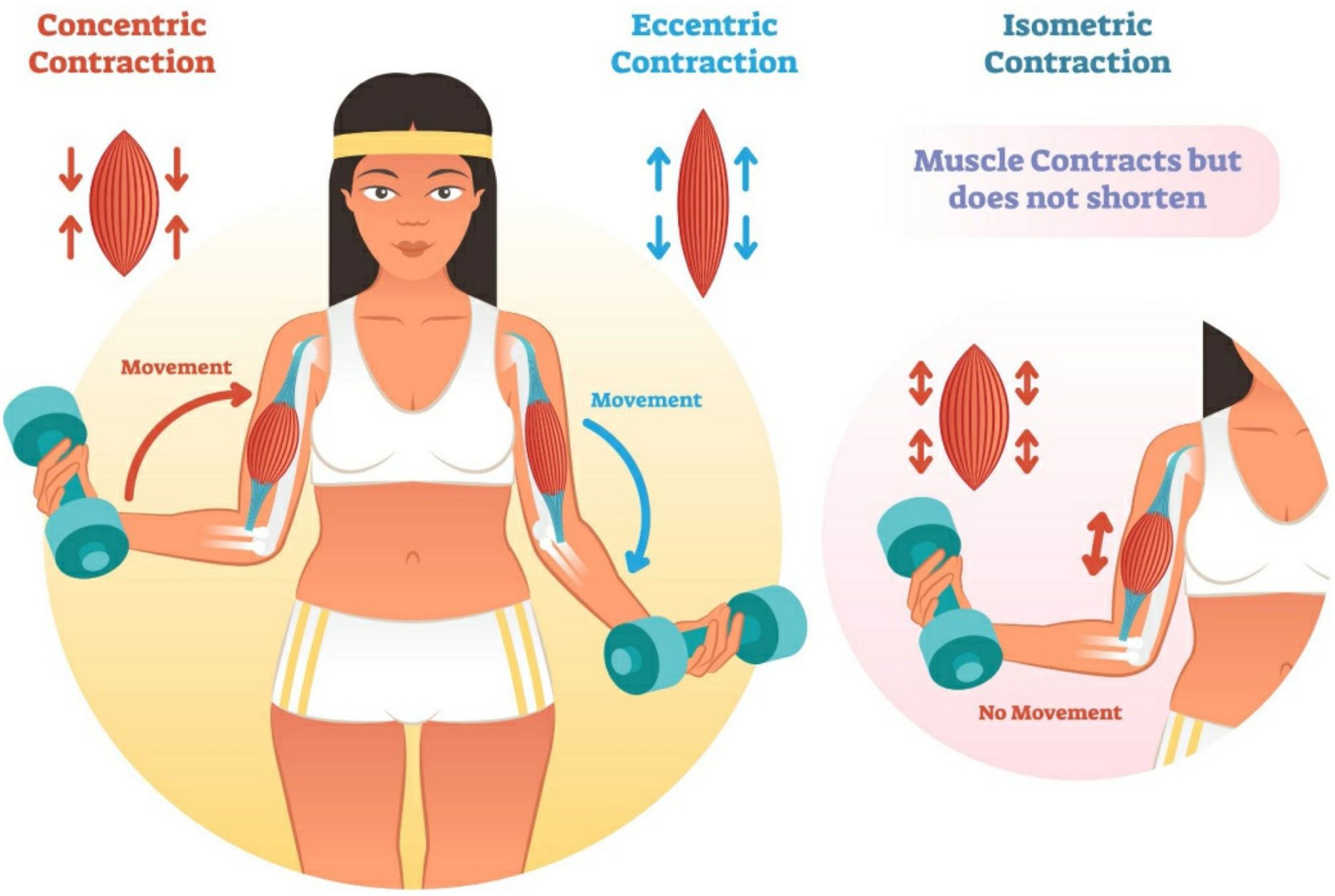
- **Isotonic:** Where there IS a change in muscle length.
- **Isometric:** Where there is NO change in muscle length.

Isotonic contractions can be split down into 2 categories:

- **Concentric:** Where the muscle shortens.
- **Eccentric:** Where the muscle lengthens.

The eccentric phase is much stronger than the concentric phase – you might be able to lower a weight with control during a squat but are unable to come back up.

The eccentric phase is also responsible for most of the delayed onset muscle soreness (DOMS) we experience days after training.



LEVER SYSTEMS

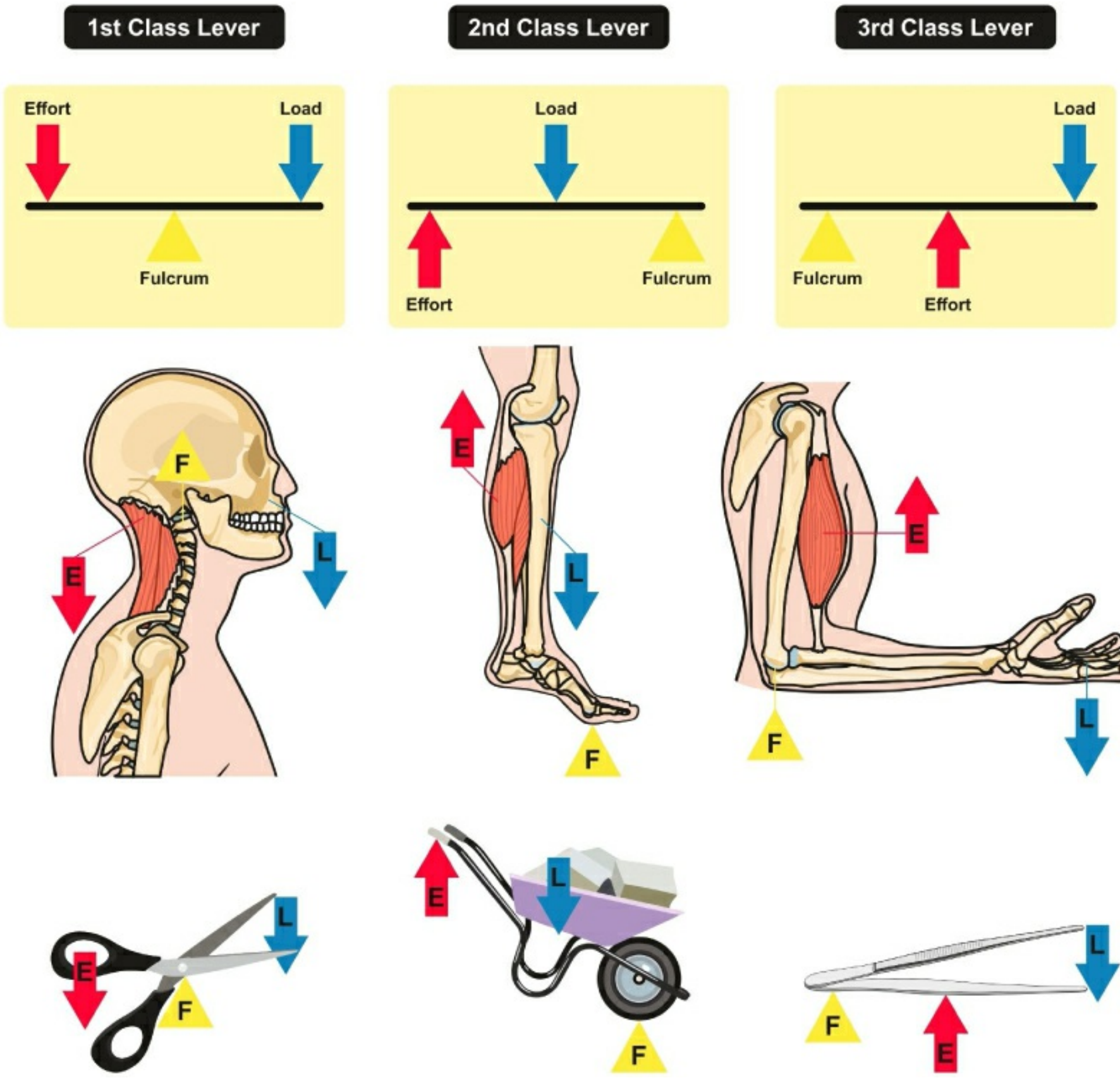
As mentioned previously, when muscles cross joints, they create lever systems.

Terminology:

- **Fulcrum:** The point at which a lever is placed to get purchase, or on which it turns or is supported.
- **Effort:** The muscles contracting to produce force.
- **Load:** The weight that needs to be moved.

The 3 Lever Types:

- **1st Class Lever:** Like a seesaw or a pair of scissors. The fulcrum is in the middle with the effort a opposite ends.
- **2nd Class Lever:** Like a wheelbarrow. The fulcrum is at one end, the load is in the middle and the effo other end.
- **3rd Class Lever:** Like a pair of tweezers. This is the most common type of lever in the body and is where is between the fulcrum and the load.



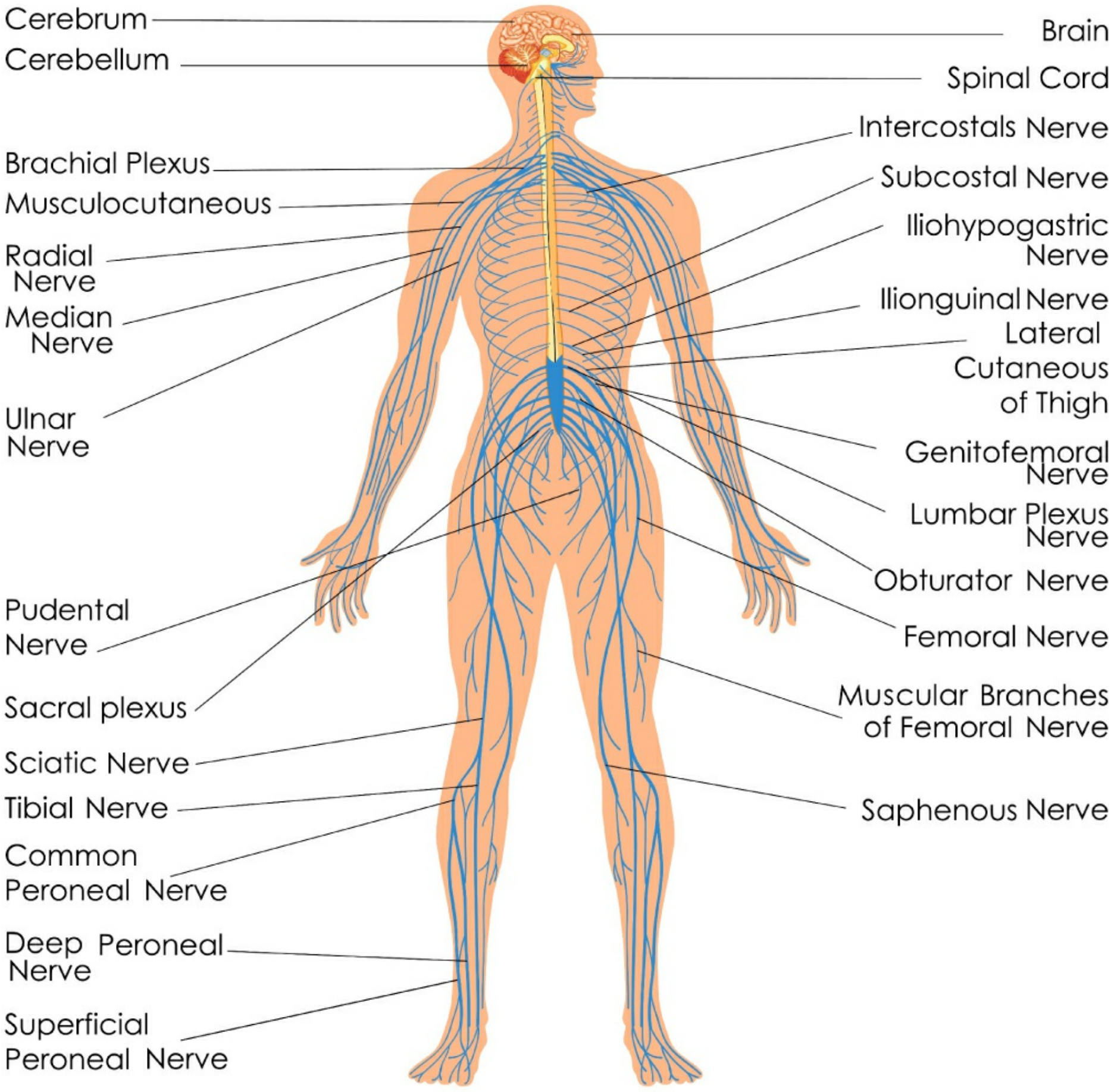
DELAYED ONSET MUSCLE SORENESS (DOMS)

- Pain/discomfort and stiffness felt in the muscles several hours or days after exercise - the soreness is strongly 24-72 hours after exercise.
- Eccentric contractions are known to cause greater DOMS.
- The key to preventing DOMS is progressive training and good training frequency – DOMS increases wh a spike in volume/intensity or a sudden change in the type of stressors included in the session.
- DOMS should not be chased – muscle soreness is NOT an accurate indicator of a "good session."

Coming from a prolonged rest period to even moderate training is essentially a spike in stress, and it is not uncommon for an athlete to suffer from notable DOMS even after a short period of inactivity. However, DOMS can have a negative impact on the training plan and therefore, should be limited – build resilience progressively.

THE NERVOUS SYSTEM

The nervous system is a complex collection of nerve cells (neurons) and fibres which transmit nerve impulses between parts of the body.



LIFECYCLE OF THE NEUROMUSCULAR SYSTEM

Early Years:

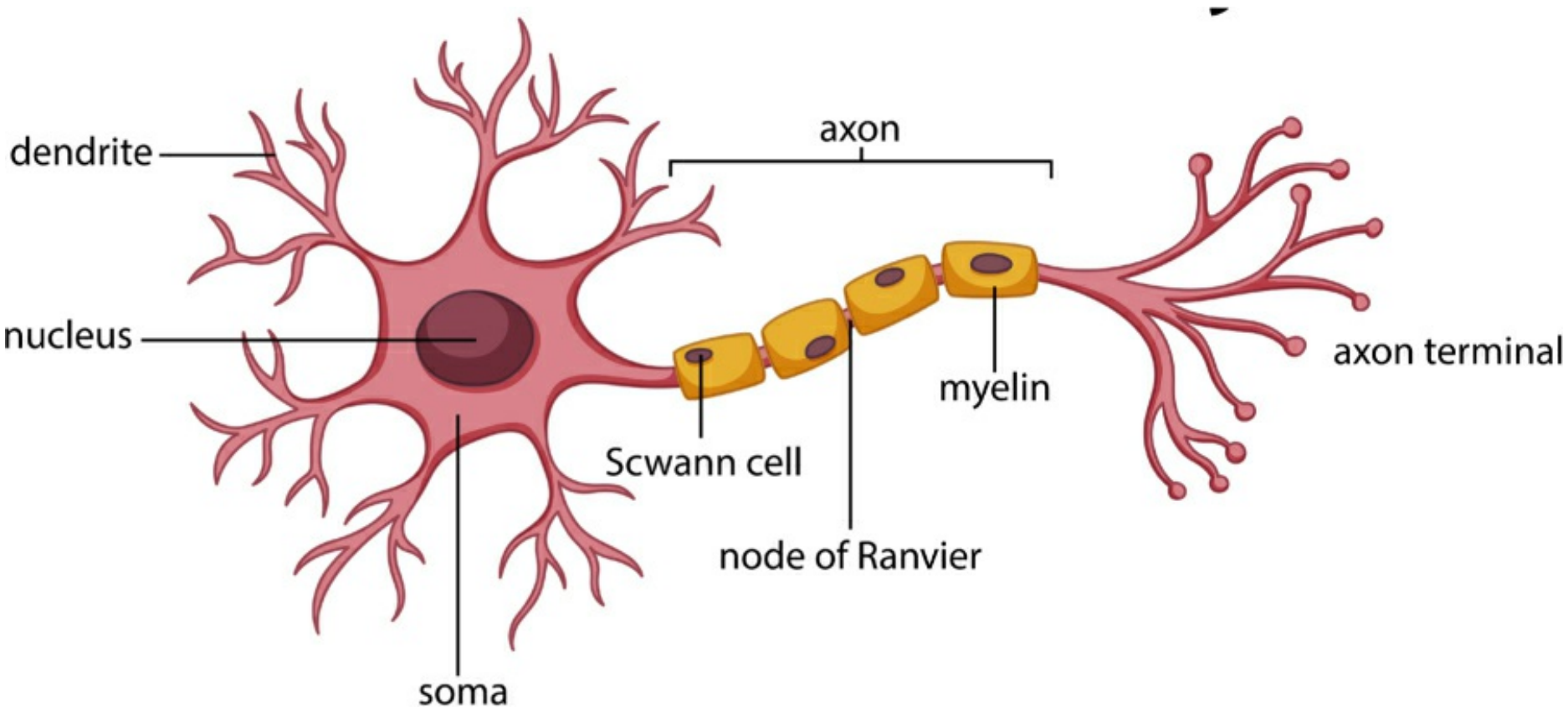
- Neural pathways increase rapidly in number to develop coordination, etc.
- Postural and stabilizing muscles also develop quickly (think of a baby that cannot hold its head up, to be walk within approximately 12 months).
- Genetics and environment strongly influence the potential for neuromuscular development during this stag

Pubescent Years:

- No significant gender difference until this stage.
- Influence of testosterone in boys, which stimulates muscle growth and estrogen in girls, which stimula muscle and fat tissue development.

Adulthood and Later Years:

- Neuromuscular development typically ends in our mid-20s.
- With training, this can continue beyond this stage.
- By the age of 30, the brain begins to lose thousands of neurons each day, which leads to the pro information becoming slower.
- From the age of 60, muscular strength has an annual reduction of 1–2%, on average.
- Exercise and strength training can help combat the effects of aging.



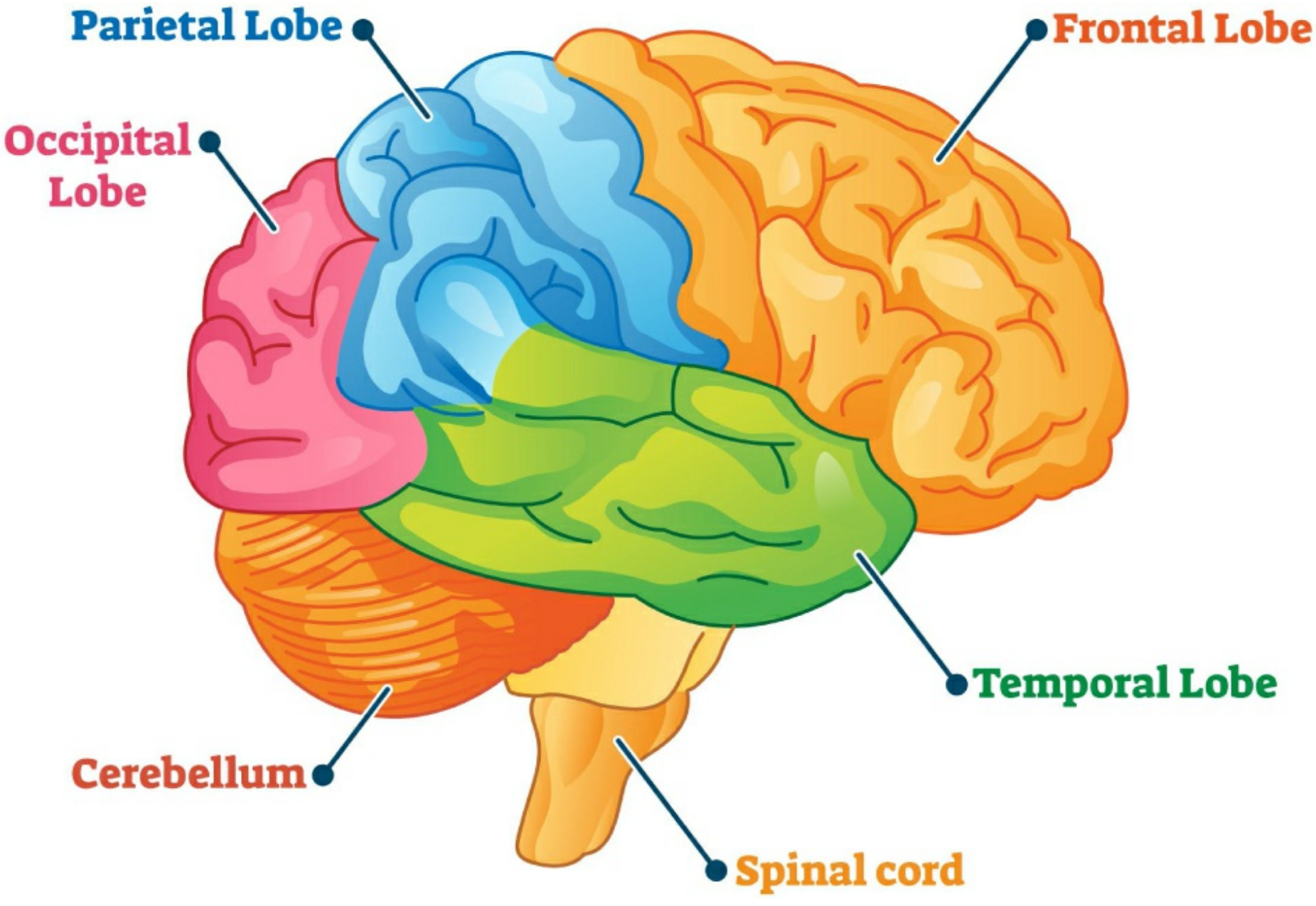
CENTRAL NERVOUS SYSTEM

The CNS consists of:

- The brain.
- The spinal cord.

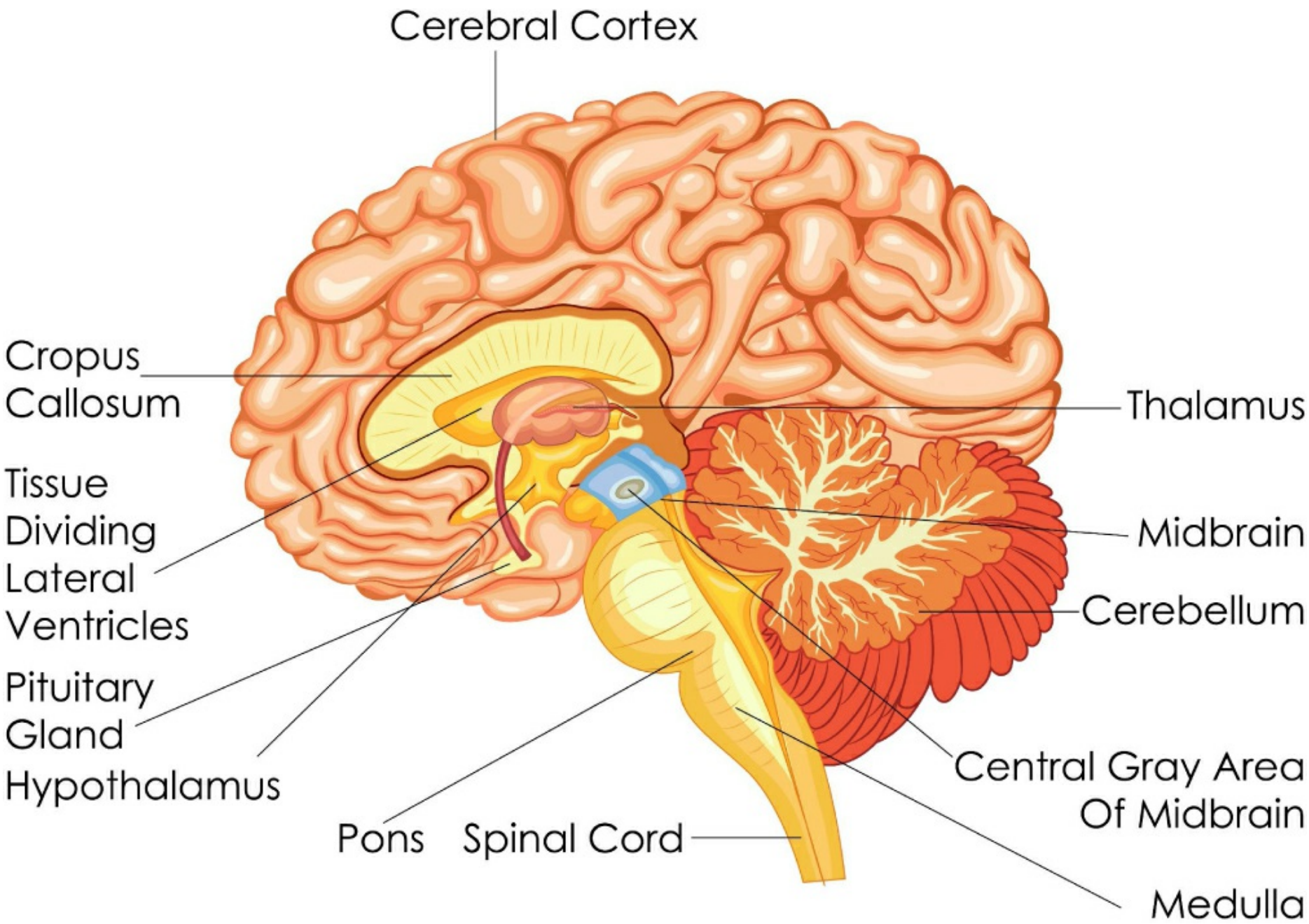
The neurons of the CNS are:

- Interneurons (pass signals from one nerve to another).



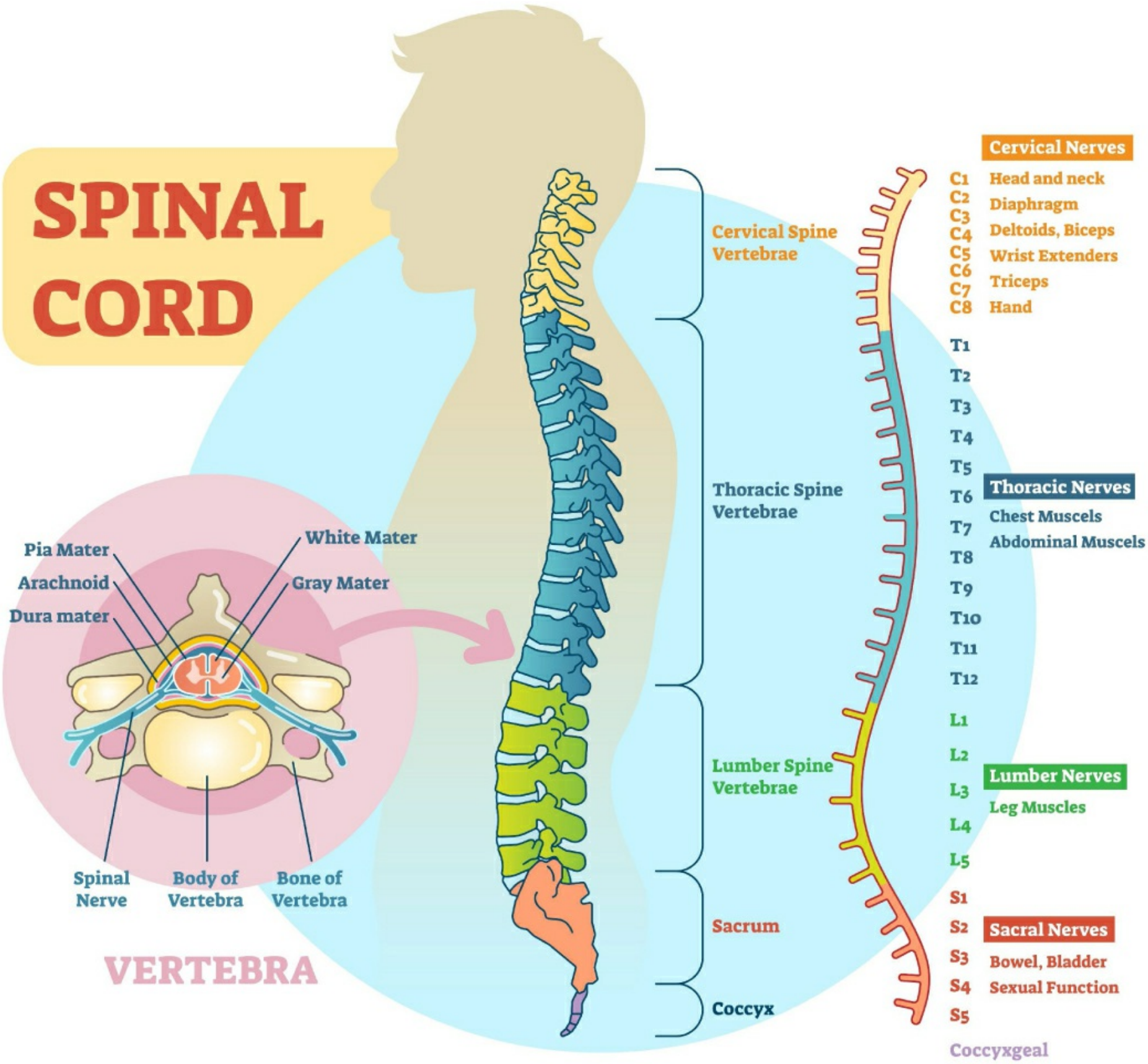
THE BRAIN

Simply put, the brain is an organ of soft nervous tissue contained in the skull. It functions as the coordinating centre of sensation, integration, and response (explained in more detail on a later page).



THE SPINAL CORD

The spinal cord is a cylindrical bundle of nerve fibres that is enclosed in the spine. It connects nearly all parts of the brain, forming the central nervous system (CNS).



THE PERIPHERAL NERVOUS SYSTEM

The PNS consists of:

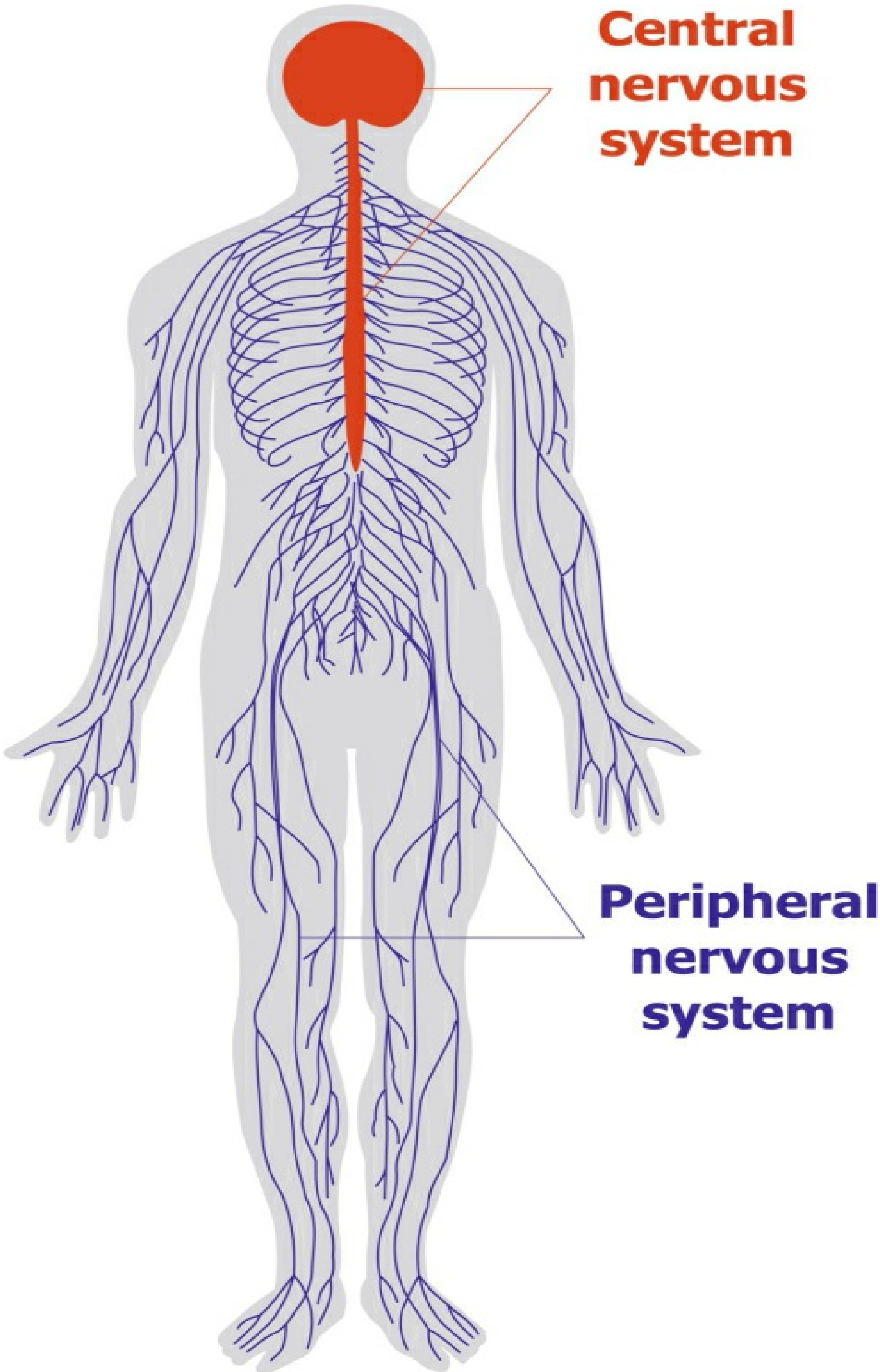
- Nerves, receptors and effector organs that lie outside the brain or spinal cord.

The neurons of the PNS are:

- Sensory neurons (affectors) carry messages to the CNS (afferent nerves).
- Motor neurons (effectors) carry messages from the CNS.

Sensory receptors provide feedback on internal and external environments (e.g., muscle spindles sense muscle length).

Effector organs carry out the actions as directed by the CNS via motor neurons (e.g., muscles).


Central nervous system
Peripheral nervous system

STRUCTURE

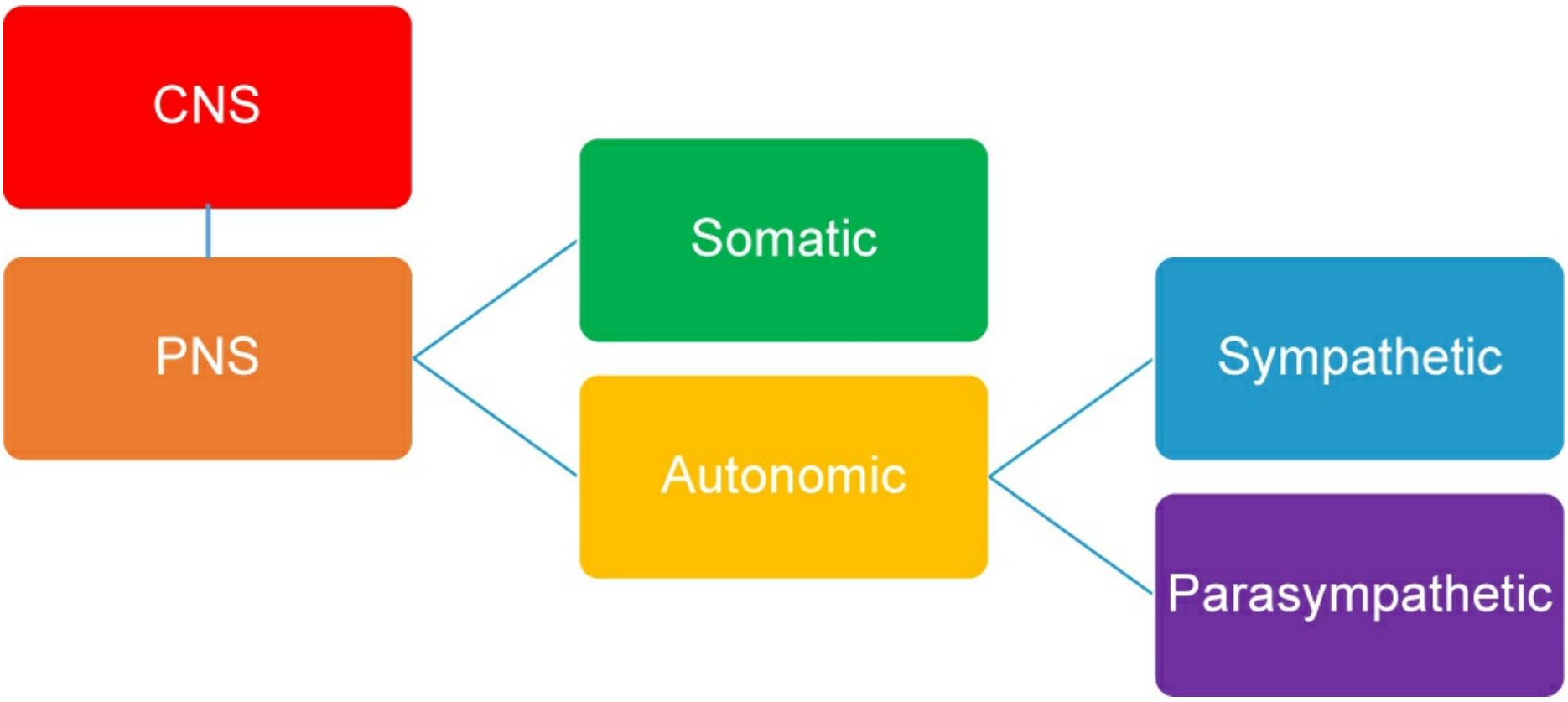
Here is a basic diagram of the structure of the central and peripheral nervous systems.

The PNS is split into two key components:

- **Somatic:** Controls voluntary, conscious movement, i.e., Skeletal muscles.
- **Autonomic:** Controls involuntary systems of the body, i.e., The digestive system.

The autonomic system is further split down into two components:

- **Sympathetic:** Gets things fired up – war/fight or flight system.
- **Parasympathetic:** Calms things down – peace/rest and digest system.

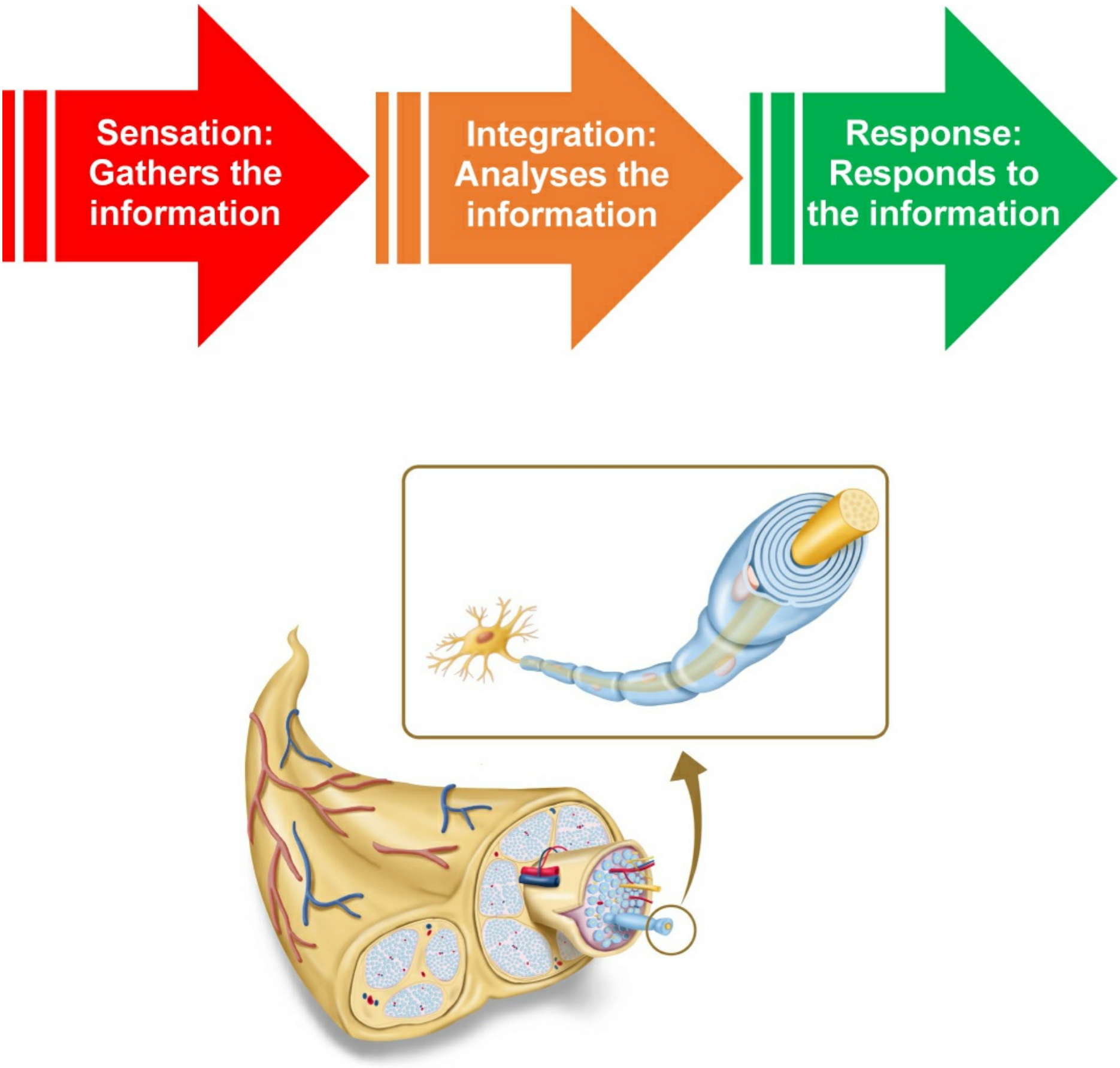


SENSATION, INTEGRATION AND RESPONSE

The nervous system is involved in Sensation, Integration and Response.

Example:

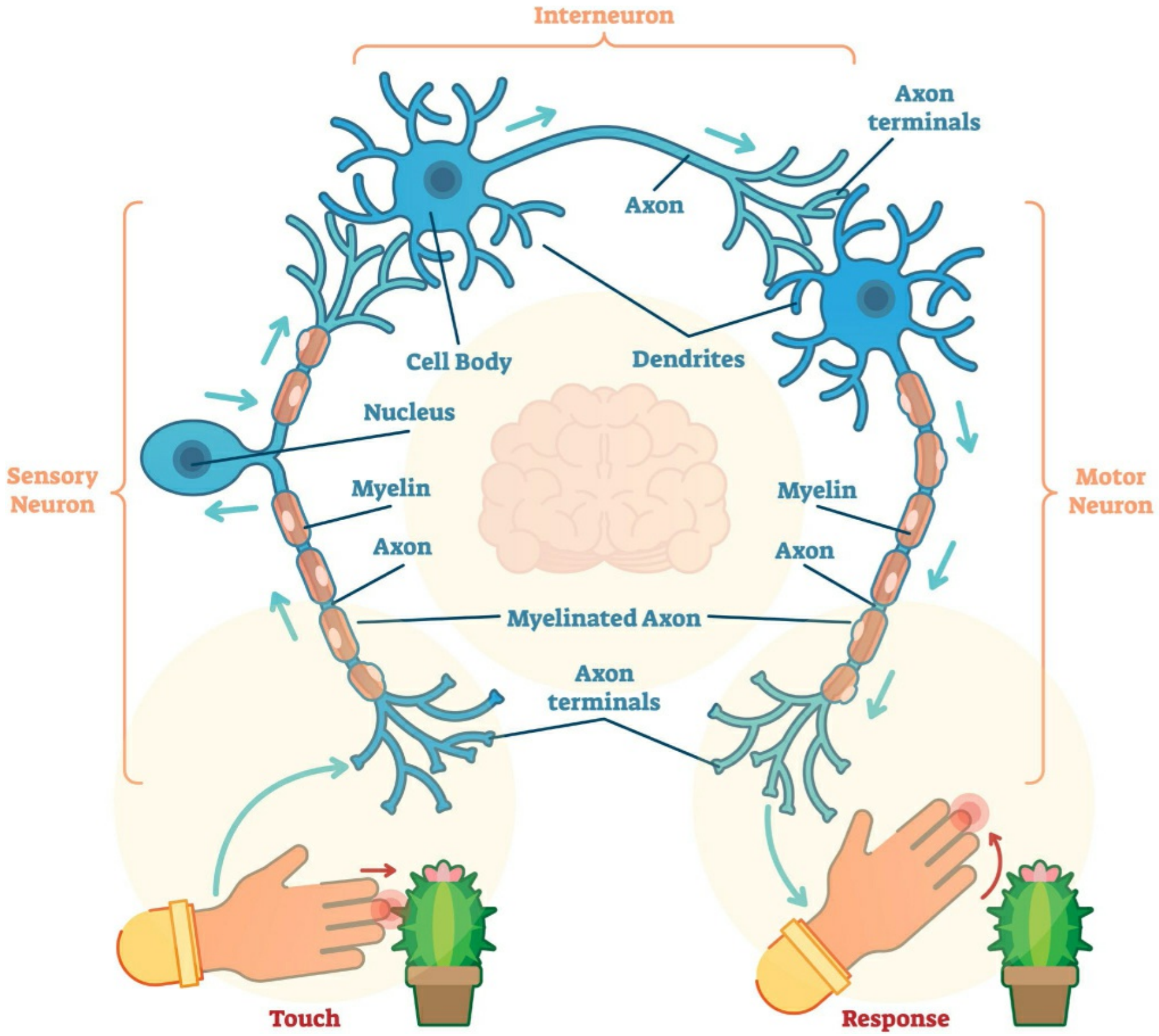
Sensory nerves in the PNS, such as proprioceptors which detect changes in muscle tension and length, send signals to the CNS for integration (analysis). From there, a signal is sent to innovate the appropriate action.



TYPES OF NEURONS

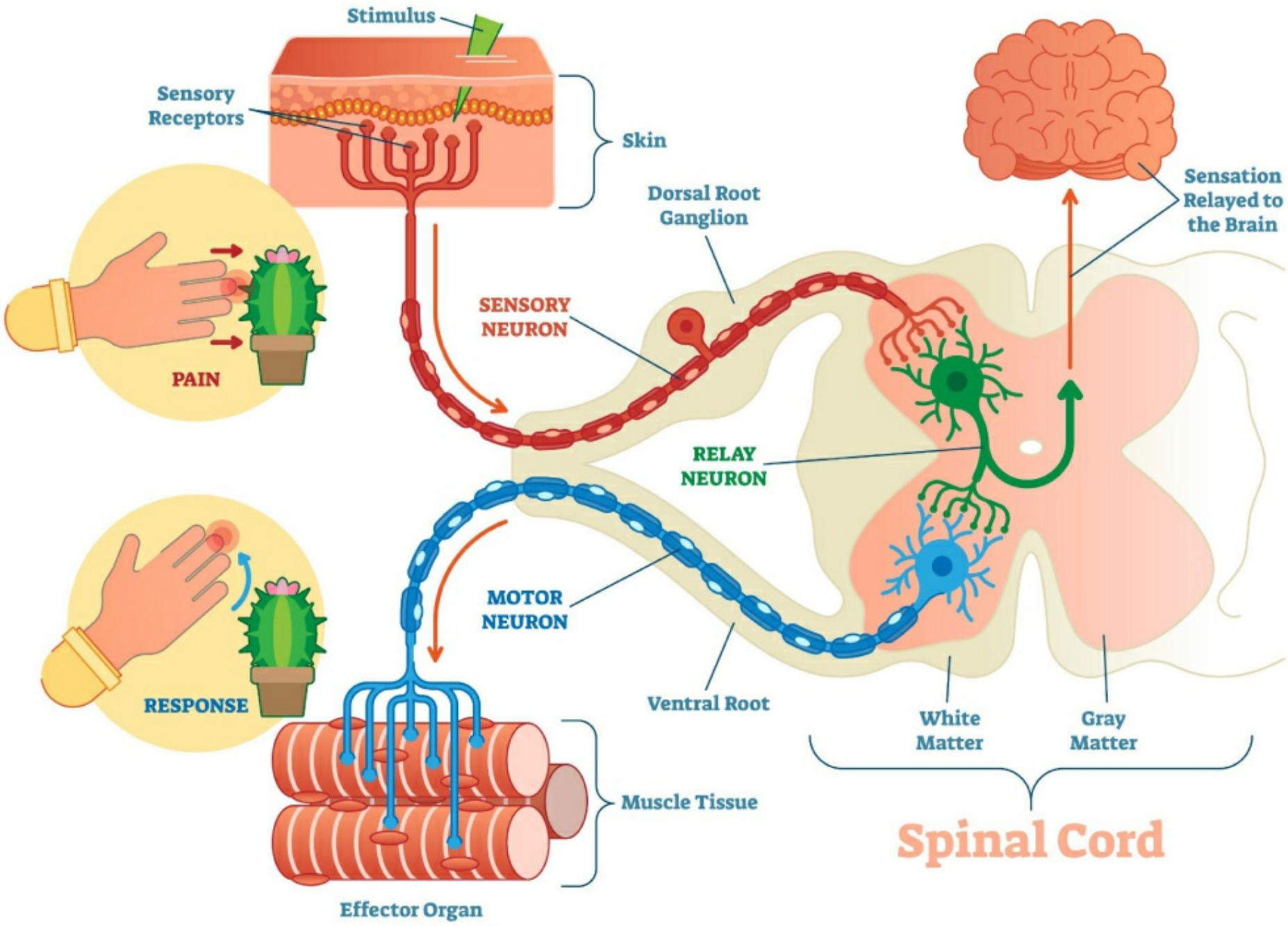
Neurons are categorized into three types:

- **Sensory Neurons:** These are triggered by physical and chemical inputs from your environment temperature, sounds and light are physical inputs, and taste and smell are chemical inputs.
- **Motor Neurons:** These play a role in both voluntary and involuntary movement.
- **Interneurons:** These are intermediary neurons found in tour brain and spinal cord.



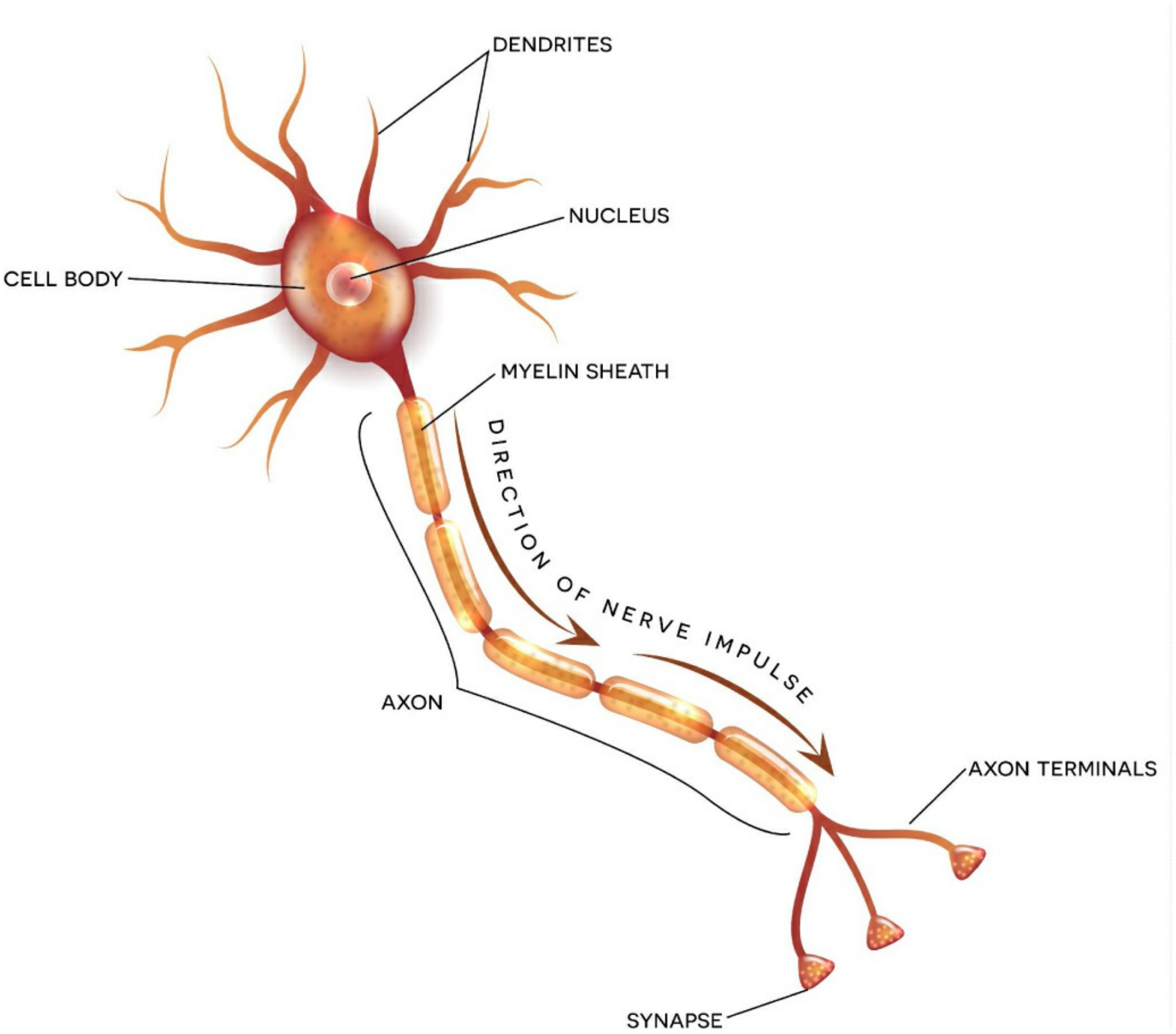
SENSORY NERVES

- **Baroreceptors:** Detect changes in blood pressure.
- **Proprioceptors**: Detect changes in muscle length and tension.
- **Chemoreceptors:** Detect changes in chemicals, for example, taste, smell.
- **Thermoreceptors:** Detect changes in temperature.



PROPRIOCEPTORS

- Sensory receptors which receive stimuli from within the body, especially ones that respond to po movement.
- Muscle spindles – monitor the length of skeletal muscles and the rate of change in muscle length.
- Golgi tendon organs (GTOs) – monitor the tension within skeletal muscles and the rate of tension change.



THE STRETCH SHORTENING CYCLE

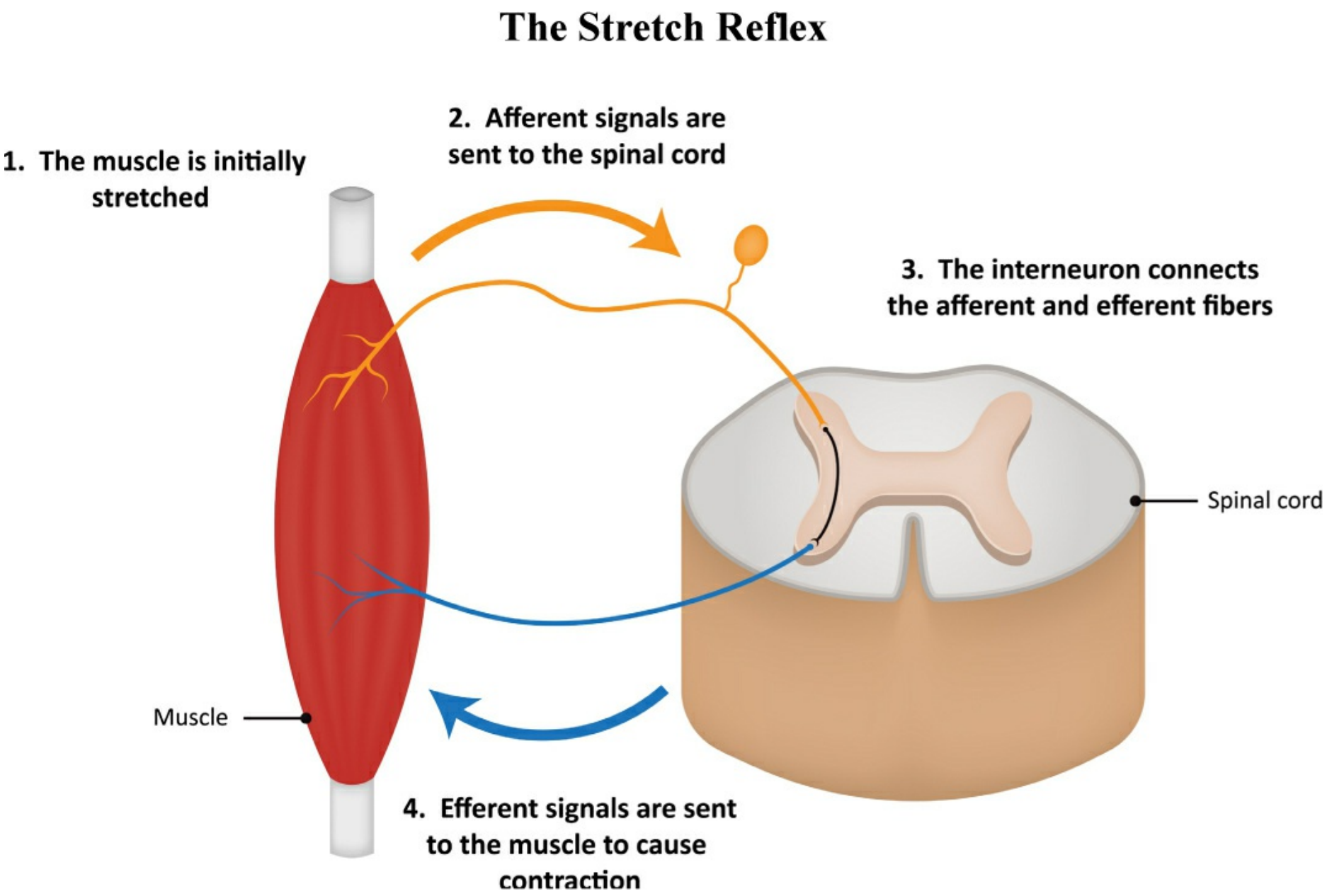
When we perform a countermovement (an initial movement in the opposite direction), our muscles undergo an eccentric contraction (muscles lengthening). This produces various mechanisms that can be capitalized on to produce more force, speed and power – the ability to effectively transition from the eccentric to the concentric phase is referred to as Reactive or elastic Strength.

Stored Elastic Energy: Just like a rubber band, a stretched muscle wants to return to its original length due to the tough elastic properties of tendons (attach muscle to bone).

Imagine the recoil of a thick tendon such as the Achilles tendon – if genetics gift an athlete with a long Achilles tendon and subsequent training toughens the tendon, this will greatly benefit their ability to jump.

The Stretch Reflex: There are receptors in the muscles and tendons (proprioceptors) that detect changes in muscle length (muscle spindles) and muscle tension (Golgi tendon organ).

When there is a sudden change in muscle length, the muscle spindles send a signal to the spinal cord and a signal is sent back to contract the muscle. On the other hand, the Golgi tendon organ can inhibit muscle contraction as a result of excessive tension that could result in injury. With progressive plyometric (jump) training, we can learn to capitalize on the stretch reflex (muscle spindles) and reduce the sensitivity of the Golgi tendon organ to maximize our ability to contract forcefully.

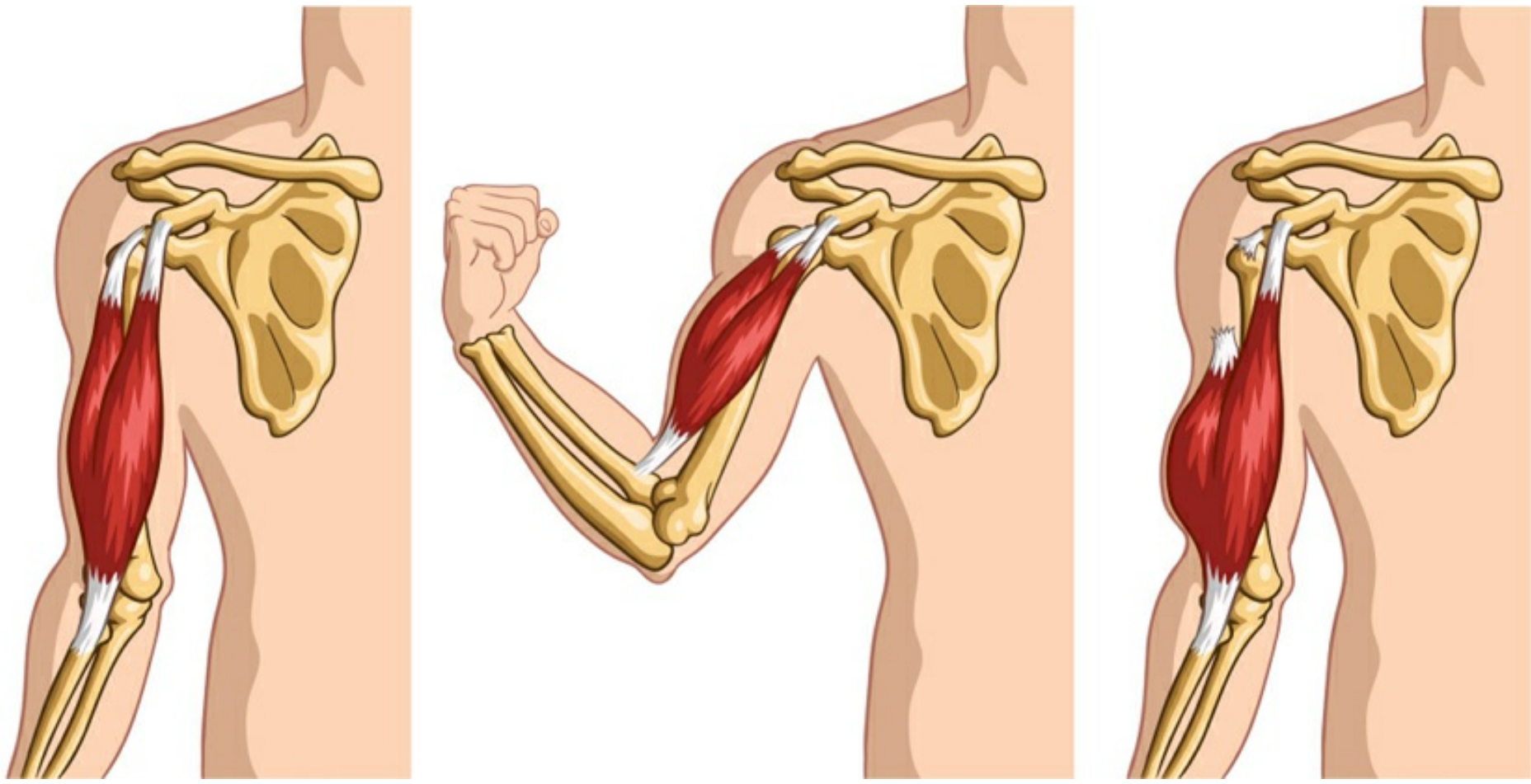


AUTOGENIC INHIBITION

Autogenic inhibition aka the inverse stretch reflex.

Autogenic inhibition means “self-generated inhibition”. The name given to the spinal reflex response occurs when the Golgi tendon organ receptor is activated, which produces an inhibitory response in the motor neurons that return to the same muscle and its synergists.

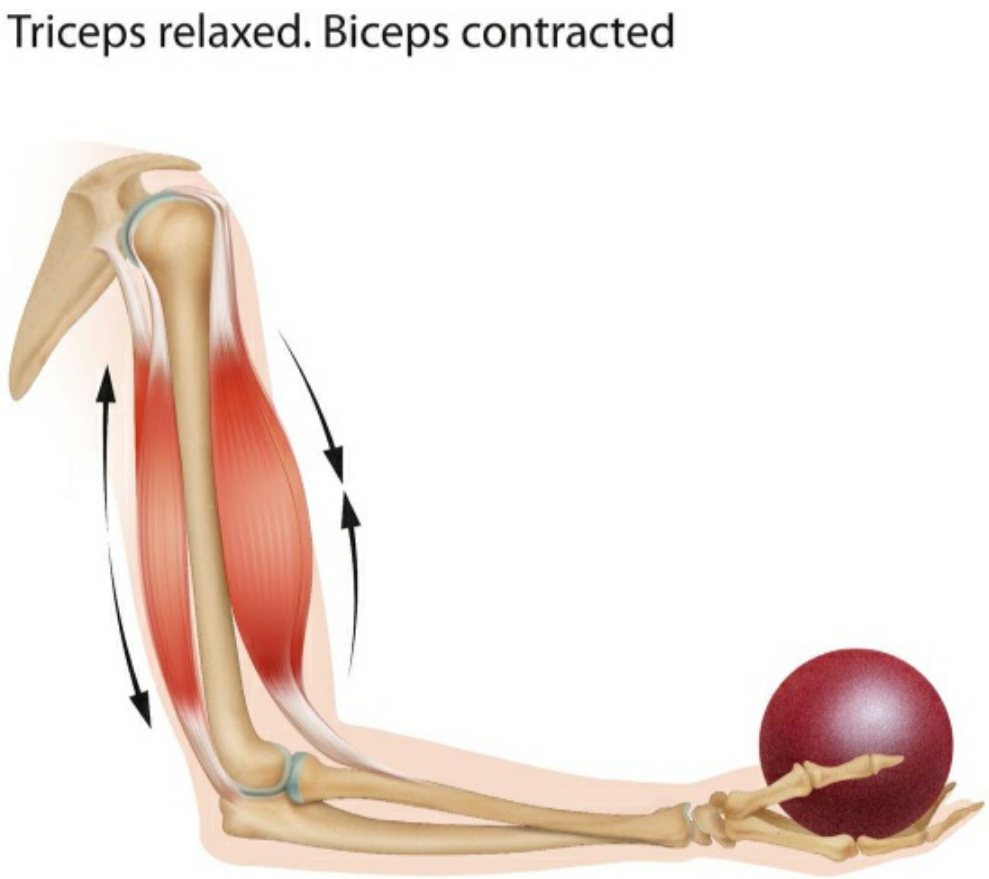
This is a protective mechanism that prevents muscles from exerting more force than the bones and tendons can tolerate – we don’t want tendons to snap!

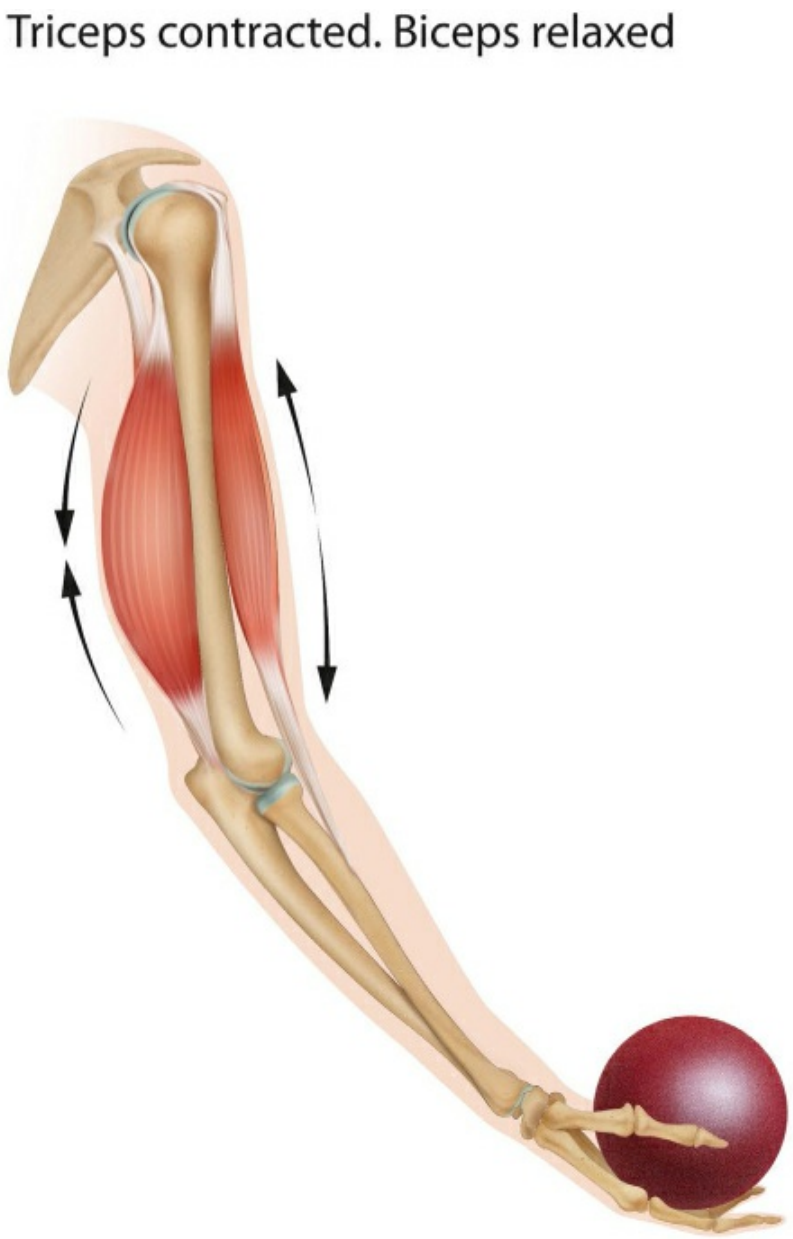


RECIPROCAL INHIBITION

To allow optimal movement of the agonist (prime mover), the antagonist needs to relax.

When a muscle spindle is stretched, the stretch reflex is activated, and the opposing muscle group must be inhibited to prevent it from working against the contraction of the agonist muscle. This inhibition is accomplished by the actions of an inhibitor interneuron in the spinal cord.





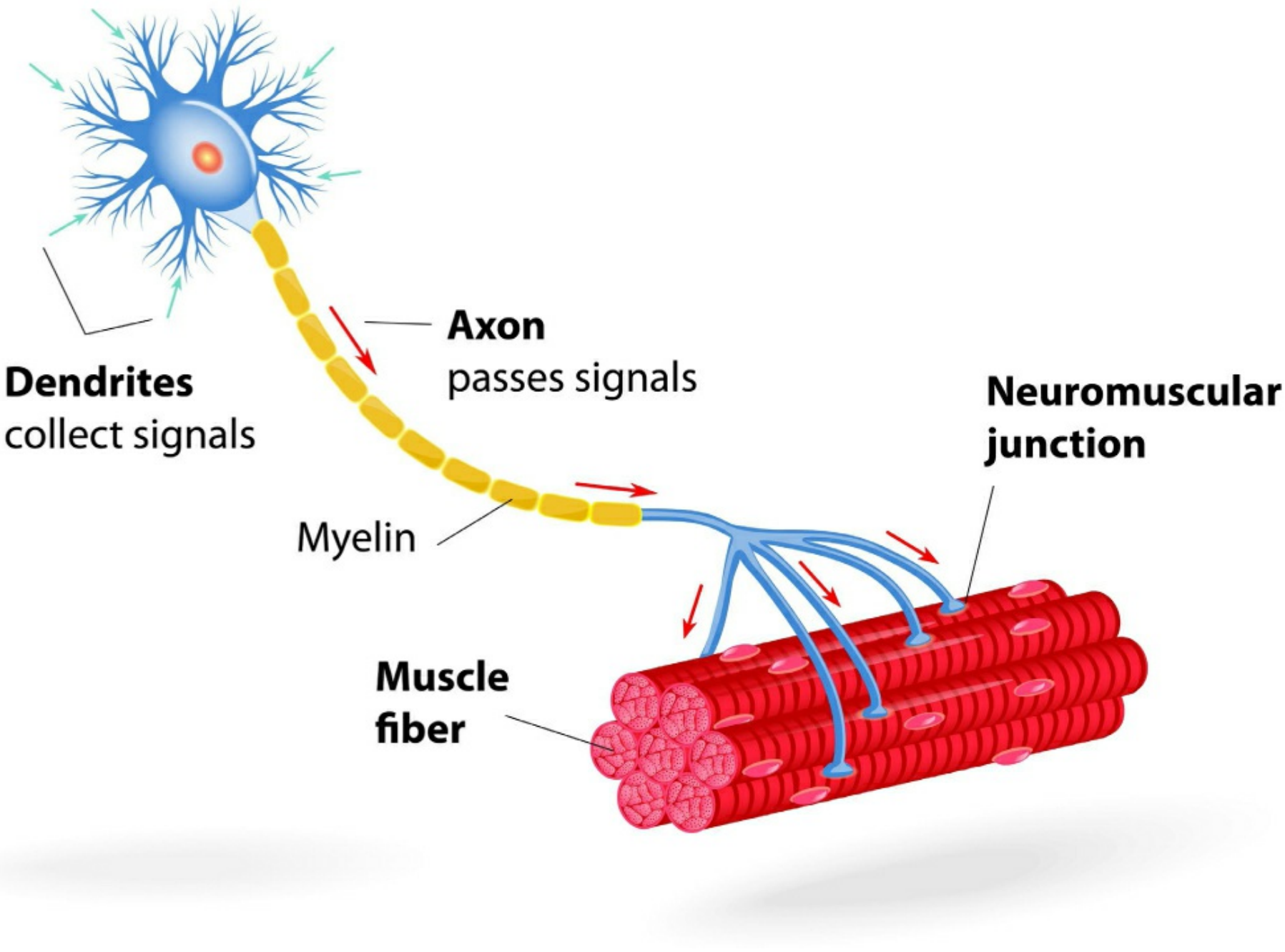
MOTOR UNIT

When a signal is sent to contract a muscle, a motor unit is used.

A motor unit is a motor neuron and the group of muscle fibres it innovates.

The “all or none law” states that motor units are either “on” or “off”, or in other words, when they contract, they contract maximally (they don’t contact at a required percentage). Therefore, if more force is required, more motor units are innovated.

This leads us onto the “size principle”. Due to the fact that motor units are either on or off, then to get more motor units engaged, we need to perform activities that require high force output. For example, lifting maximal loads (above 85% of 1RM).



THE SIZE PRINCIPLE

The size principle states that as more force is needed, motor units (motor neuron and the muscle fibres it innervates) are recruited in a precise order according to the magnitude (size) of their force output, with small units being recruited first and therefore, exhibiting task-appropriate recruitment.

This minimizes the fatigue a muscle experiences by using slow (fatigue-resistant) muscle fibres first and only using fast-twitch fibres when high forces are needed. It also permits fine control of force at all levels of output.

We know that fast-twitch muscle fibres have a much greater capacity for force and are also more anabolic in nature (growth potential). Therefore, if we consider the size principle when programming strength training, we must exert enough force to elicit the fast-twitch muscle fibres' recruitment, specifically the type 2b fibres.

When it comes to hypertrophy, there needs to be enough intensity (load) to maximize the fast-twitch fibres' recruitment and enough volume and metabolic stress to invoke more significant hypertrophy in the muscle.

For endurance, a high rep range will create more significant metabolic stress and encourage adaptations such as capillarization (increase in small blood vessels).

EFFECTS OF EXERCISE ON THE NEUROMUSCULAR SYSTEM

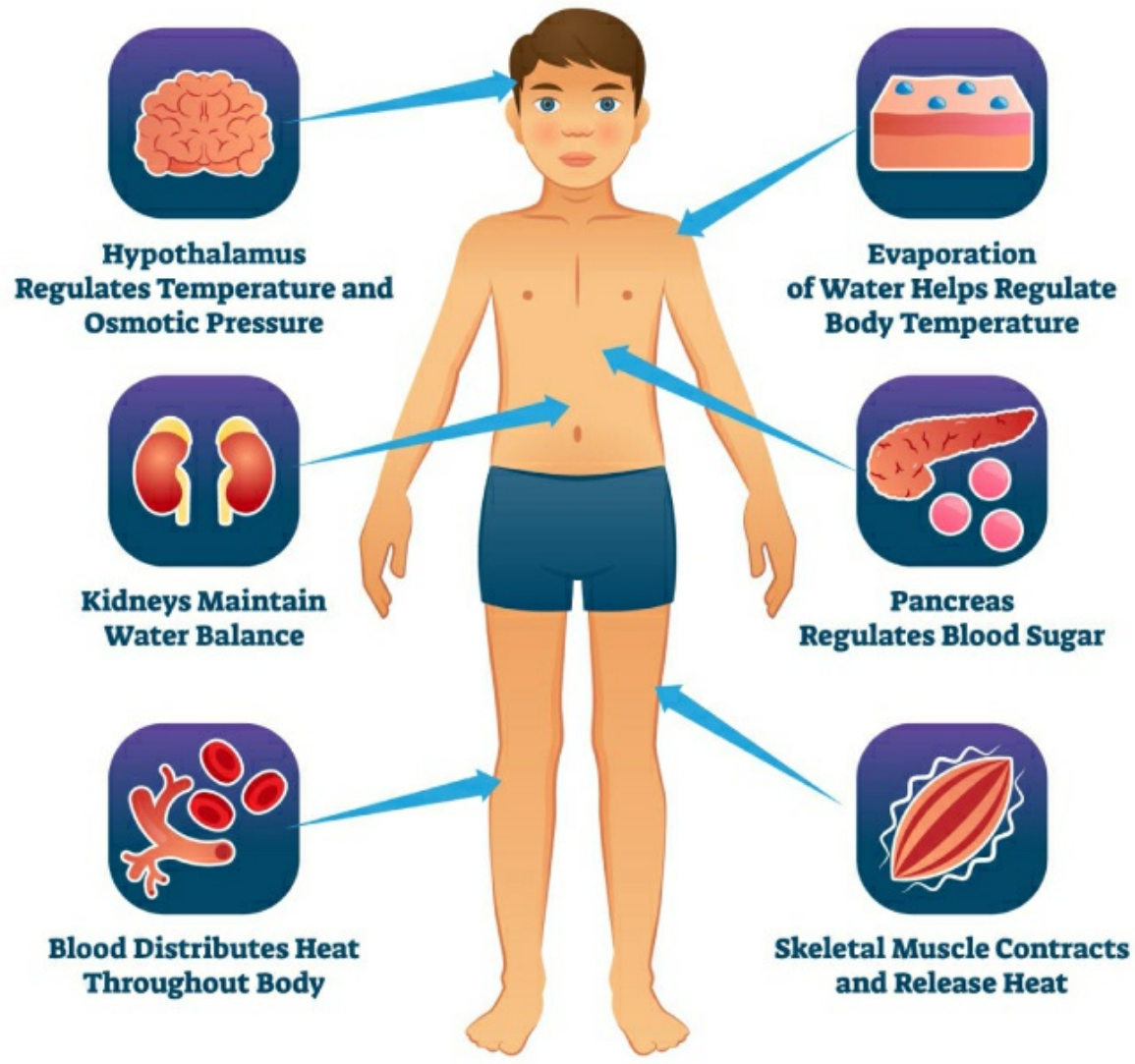
Immediate Effects	Long-Term Effects
Increased muscle temperature.	Increased muscular strength and endurance.
Increased muscle pliability (ability to stretch further).	Increased glycogen and CP stores in muscle.
Increased power output from muscles.	Increase in actin and myosin.
Increased nerve-to-muscle link.	Improved posture.
Increased recruitment of muscle fibres.	Increased neuromuscular connections.
	Increased recruitment of motor units.
	Increased basal metabolic rate (more muscle mass, etc.)

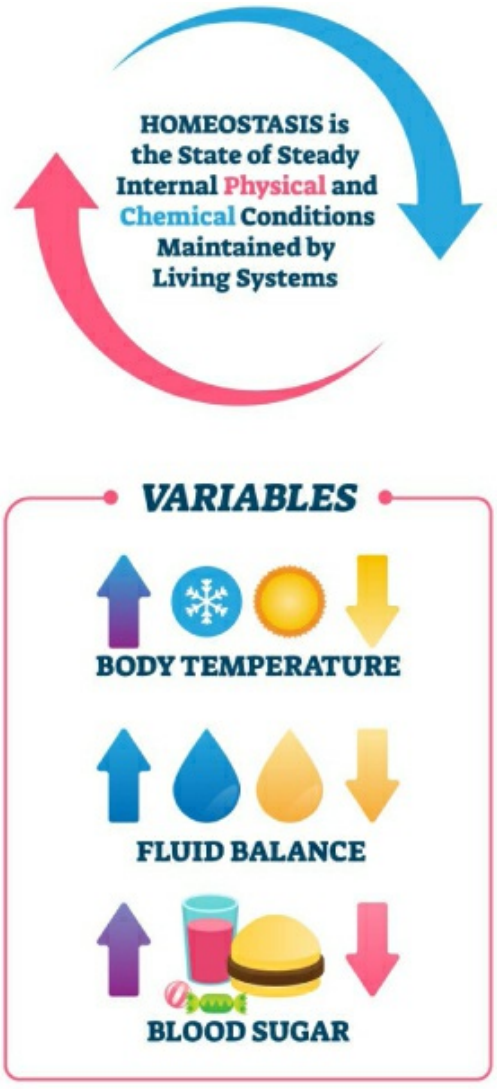
THE ENDOCRINE SYSTEM

Homeostasis is the process used by the body to maintain a stable internal environment, such as regulating body temperature, blood sugar, hormones and water balance.

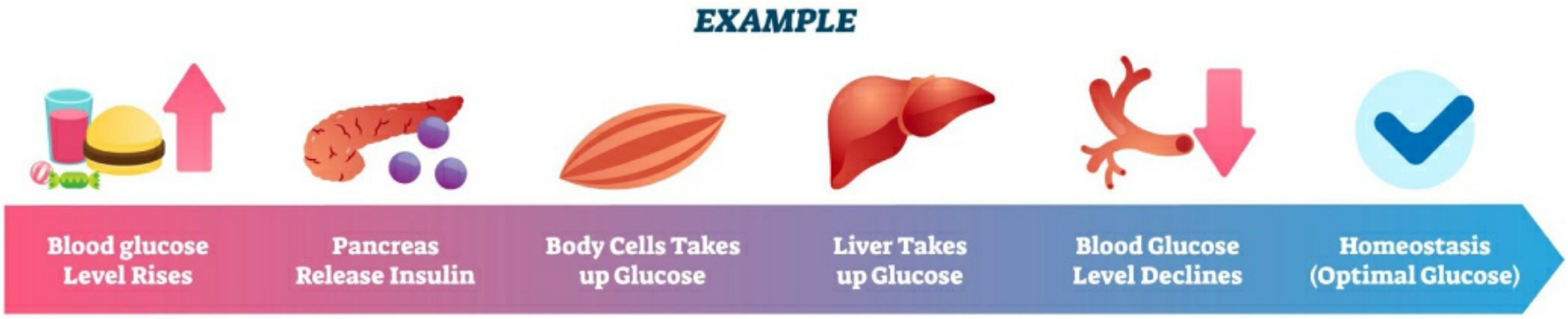
The endocrine system uses hormones (chemical messengers) released from glands to exert influence on effector organs.

The endocrine system uses negative feedback loops to maintain homeostasis (discussed in a later slide).





EXAMPLE



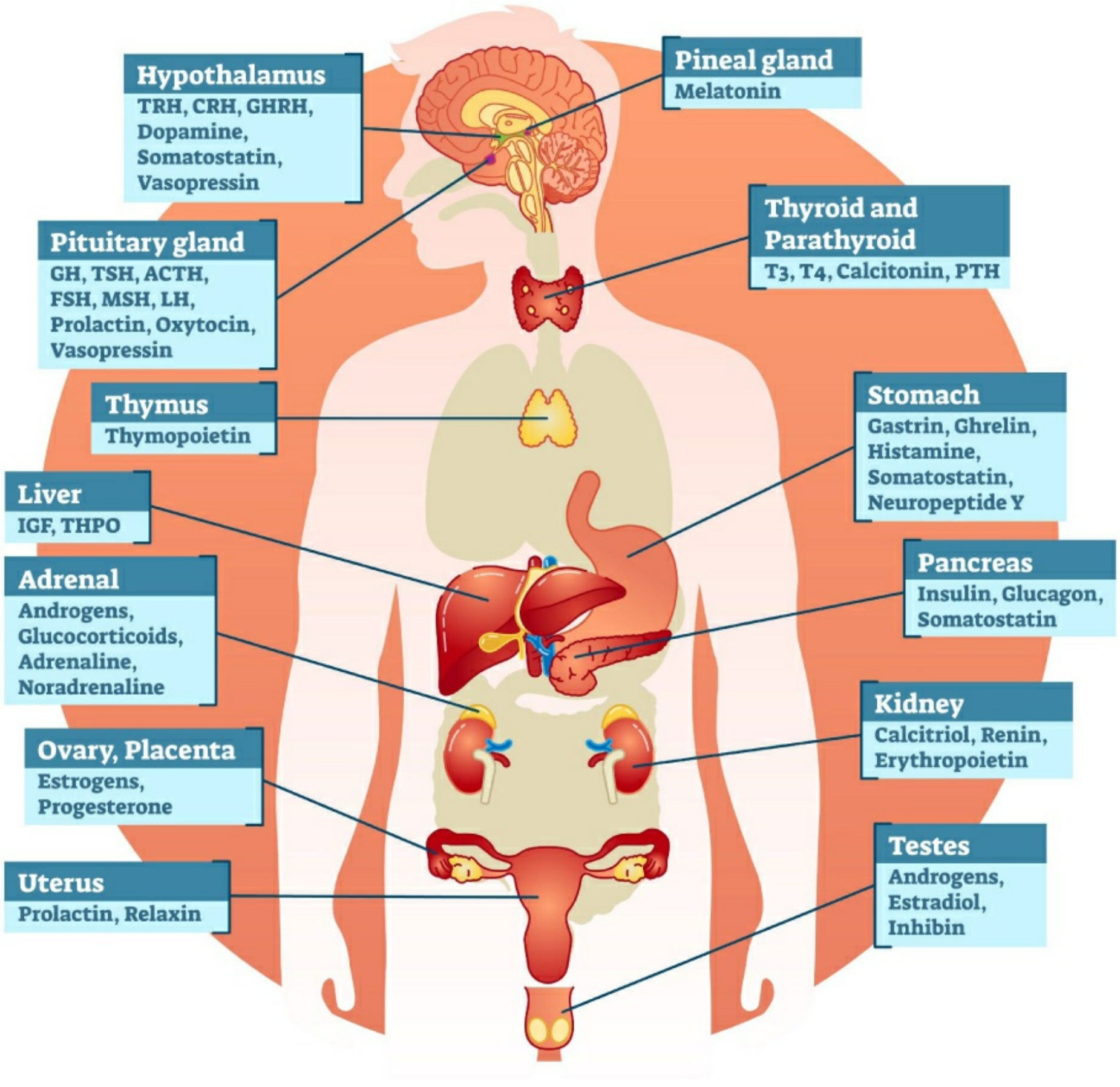
HORMONES

The endocrine system is a slow-speed regulator of the body that uses chemical messengers – hormones – to communicate instructions to the cells.

They are produced in specialized organs (endocrine glands), including:

Hypothalamus / Pituitary / Pineal / Pancreas / Thyroid / Parathyroid / Adrenal / Testes / Ovaries.

Other organs also produce hormones as shown in the diagram.



Hormones are grouped into three classes based on their structure:

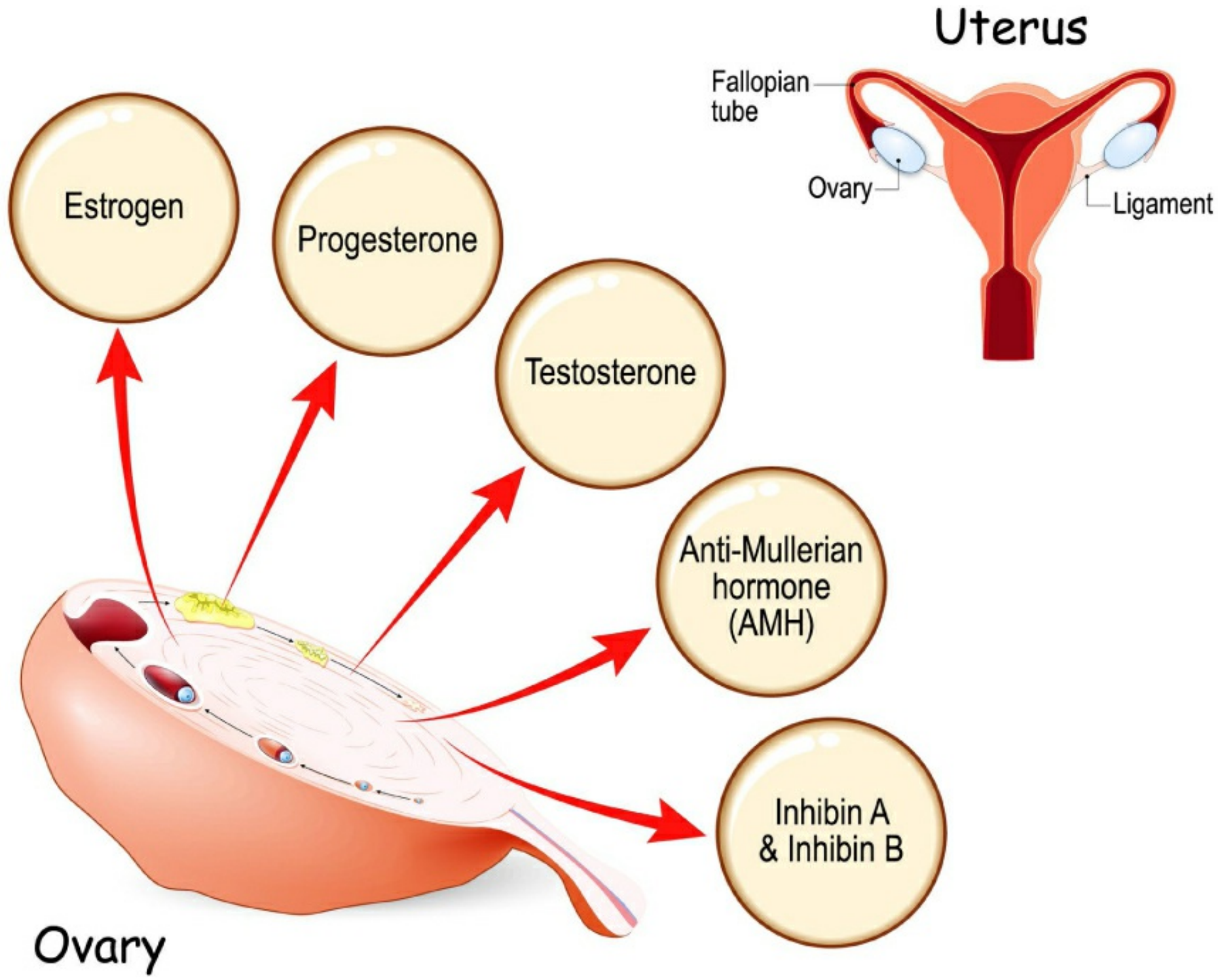
- **Steroids.**

- **Peptides.**
- **Amines.**

Steroids are lipids derived from cholesterol. Testosterone is the male sex hormone. Estradiol (an estrogen hormone), similar in structure to testosterone, is responsible for many female sex characteristics. Steroid hormones are secreted by the testes, ovaries and adrenal cortex.

Peptides are short chains of amino acids; most hormones are peptides. They are secreted by the pituitary, parathyroid, heart, stomach, liver, and kidneys.

Amines are derived from the amino acid tyrosine and are secreted from the thyroid and the adrenal medulla.

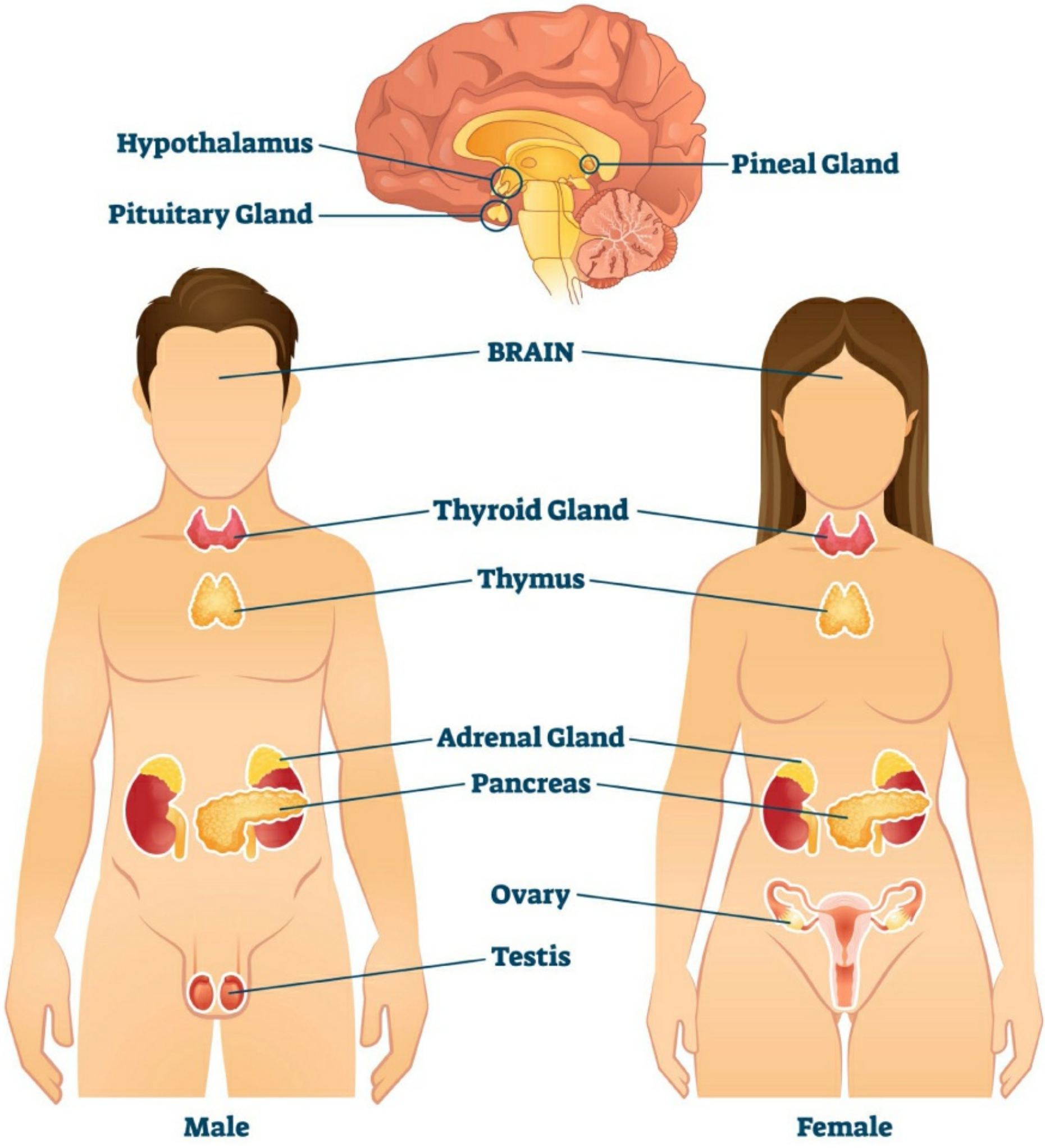


STIMULUS FOR HORMONE SECRETION

Most hormones are released from the glands through a mechanism referred to as ‘positive and negative feedback’:

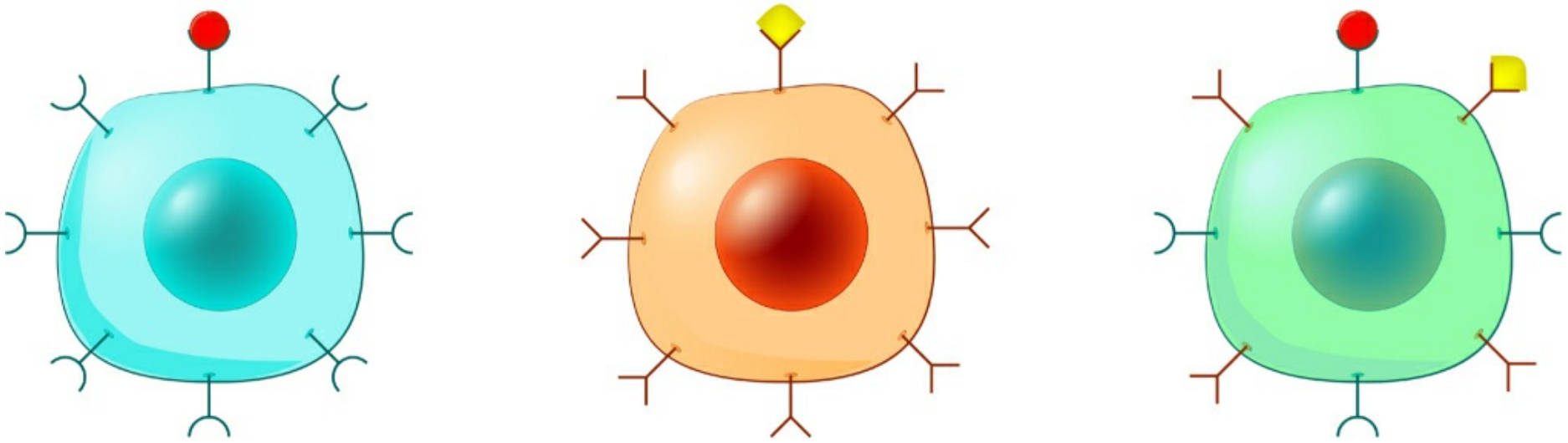
Positive feedback is an increase in output from tissues that causes an increase in hormone production to meet the tissues’ needs.

Negative feedback is a decrease in output from the tissues that decreases hormone production because the tissues’ needs have been met.



TARGET CELLS AND RECEPTORS

In order to ensure that a hormone affects the right cells (target cells), there are specific receptors on cell membranes that work like a lock and key.



TARGET CELL FOR
hormone A

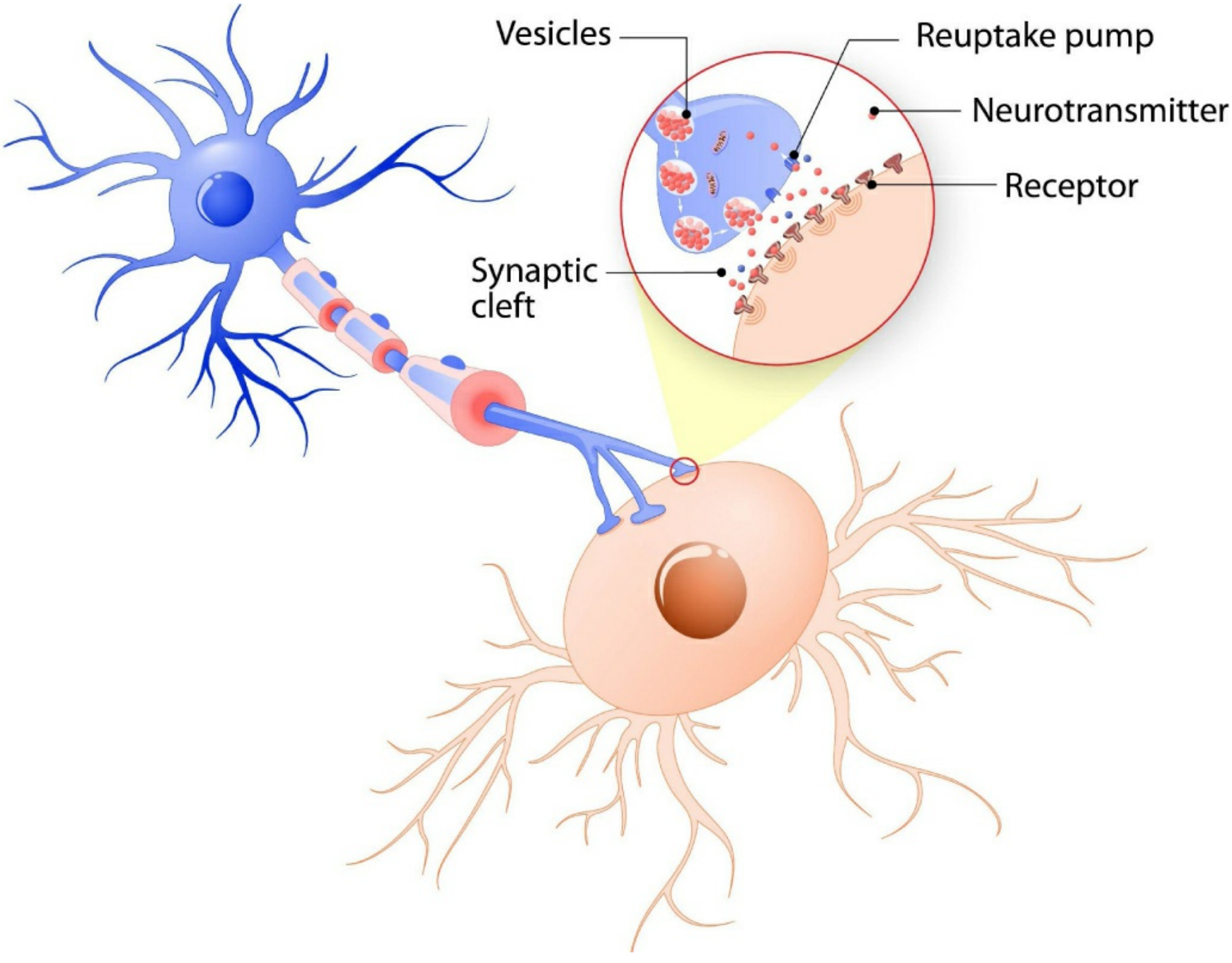
TARGET CELL FOR
hormone B

TARGET CELL FOR
hormone A and B

CHEMICAL SYNAPSE

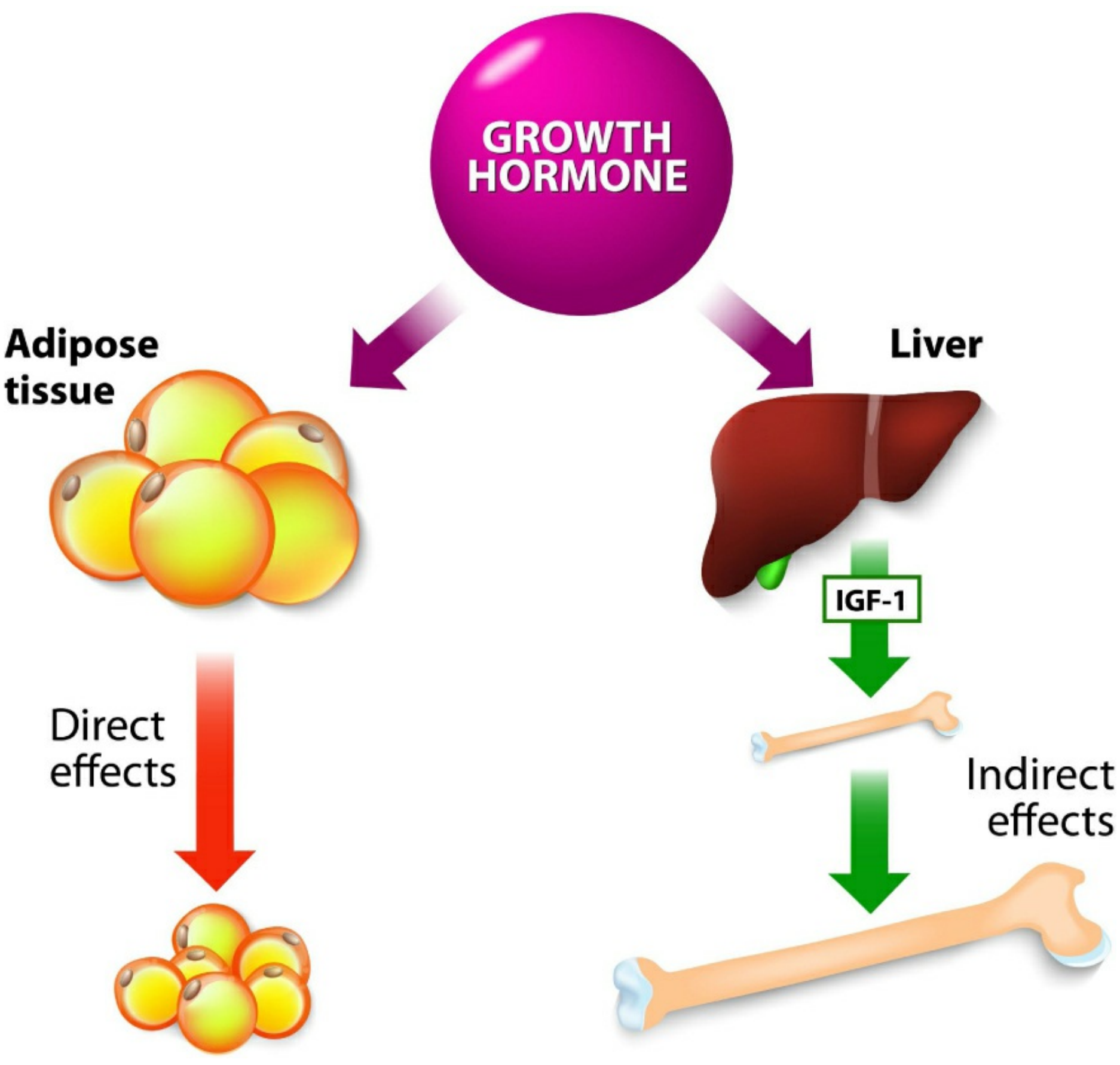
Chemical synapses are connections between two neurons or between a neuron and a non-neuronal cell (muscle cell, glandular cell, sensory cell).

The neurotransmitter binds to chemical receptor molecules located in the membrane of another neuron, the postsynaptic neuron, on the opposite side of the synaptic cleft.



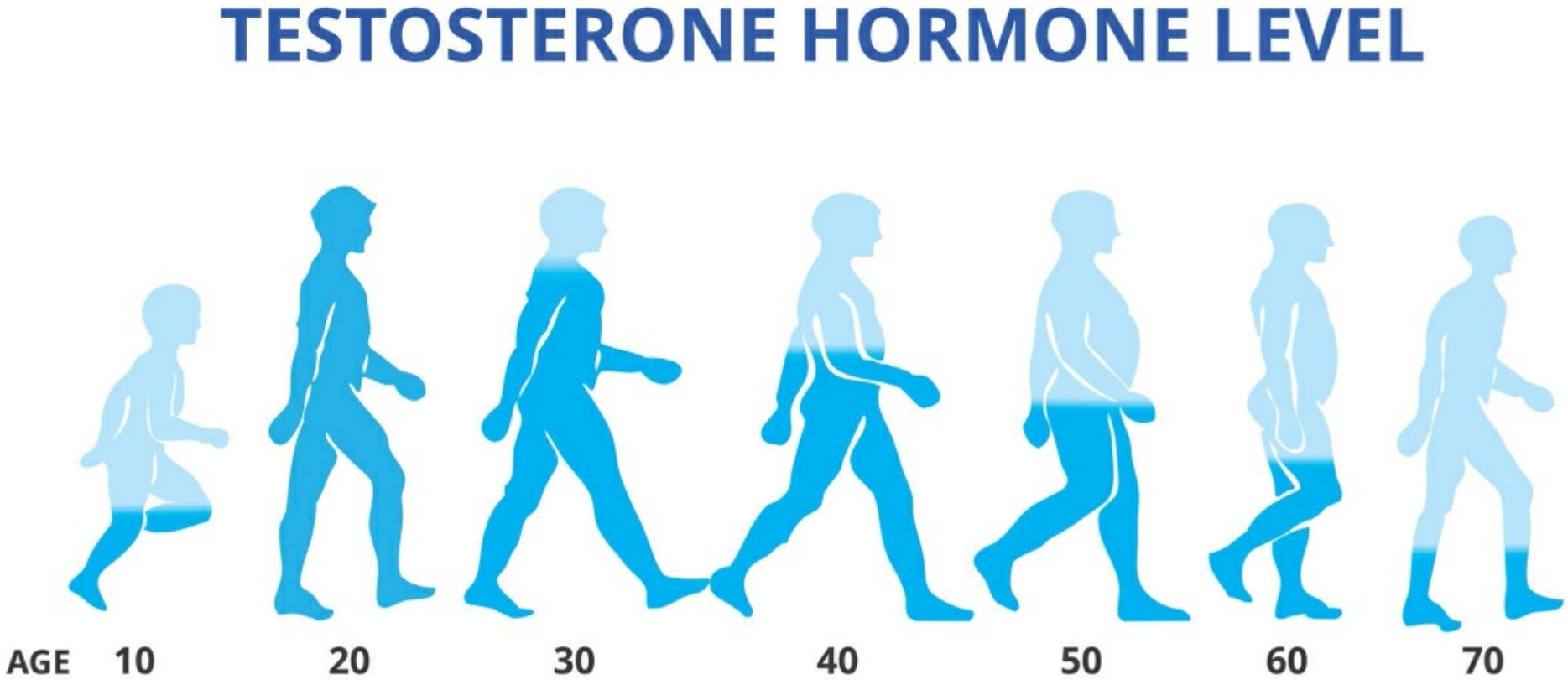
GROWTH HORMONE

- Growth hormone-releasing hormone (GHRH), released by the hypothalamus, stimulates growth horm release.
- It is released into the bloodstream from the anterior pituitary gland.
- It is a peptide hormone that stimulates growth, cell reproduction and cell regeneration.
- Its primary function is to stimulate growth in children and adolescents.
- In adults, it helps to maintain the skeleton and metabolism – it plays a role in keeping blood glucose le control.
- Its release is triggered by sleep, exercise, and stress – most of its production takes place at night
- It plays an important role in post-exercise recovery.



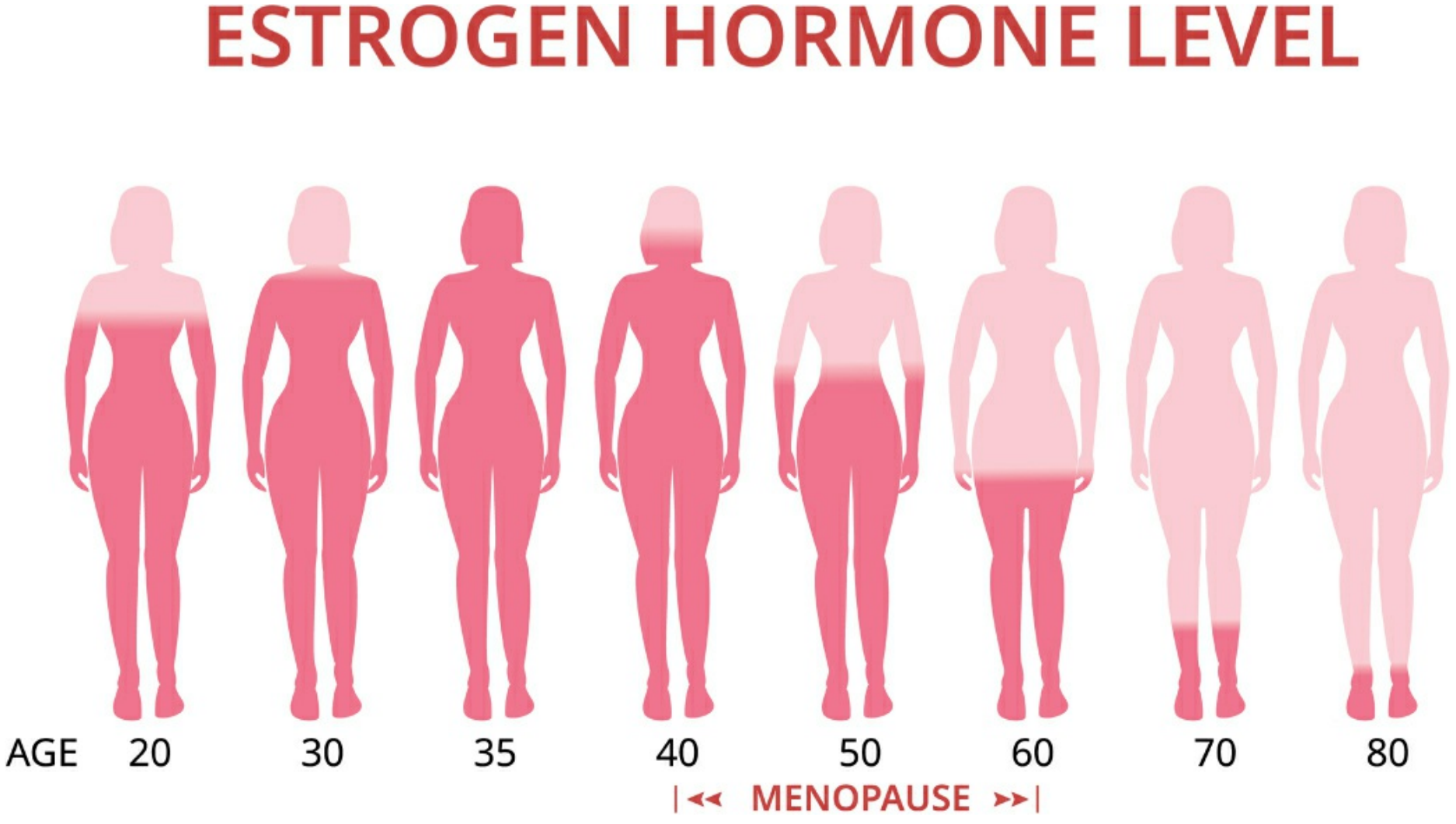
TESTOSTERONE

- A small amount is produced in the adrenal glands of both sexes and the ovaries in women.
- 95% of a man’s testosterone is produced in their testes.
- It is a steroid hormone.
- It drives the development of secondary sexual characteristics in men.
- It drives the development of the musculoskeletal system in both men and women.
- It signals the body to make new blood cells.
- It enhances libido in both men and women.
- Low levels are associated with depression in both sexes.



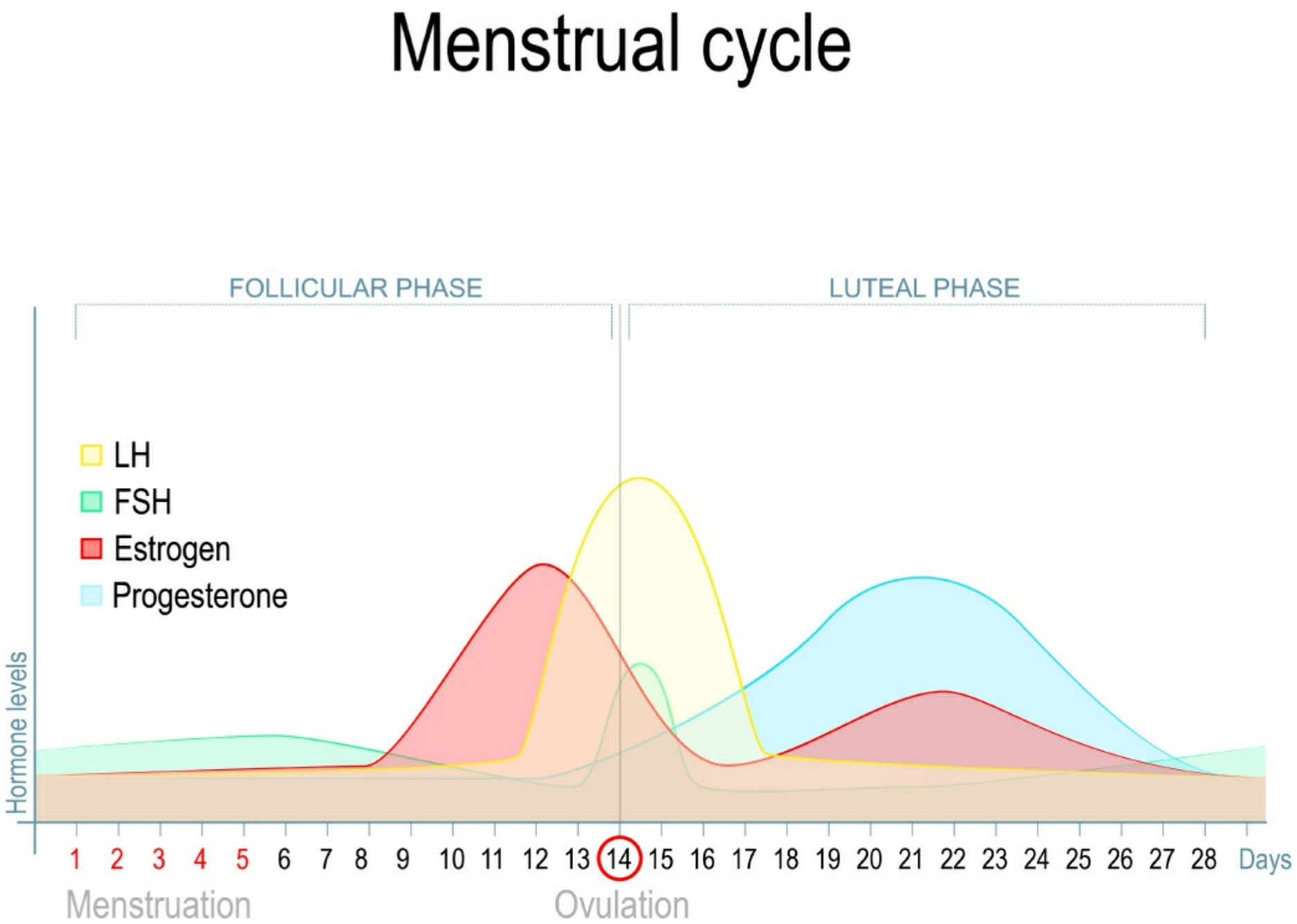
ESTROGEN

- It is produced by the ovaries, in fatty tissue and the adrenal glands.
- The ovaries produce three different types of estrogen – estradiol (most powerful), estrone and estriol.
- It is a steroid hormone.
- It drives the development of secondary sexual characteristics in women.
- It plays key roles in both men and women – regulates body temperature, promotes deep sleep and main density (menopause can affect bone density greatly).



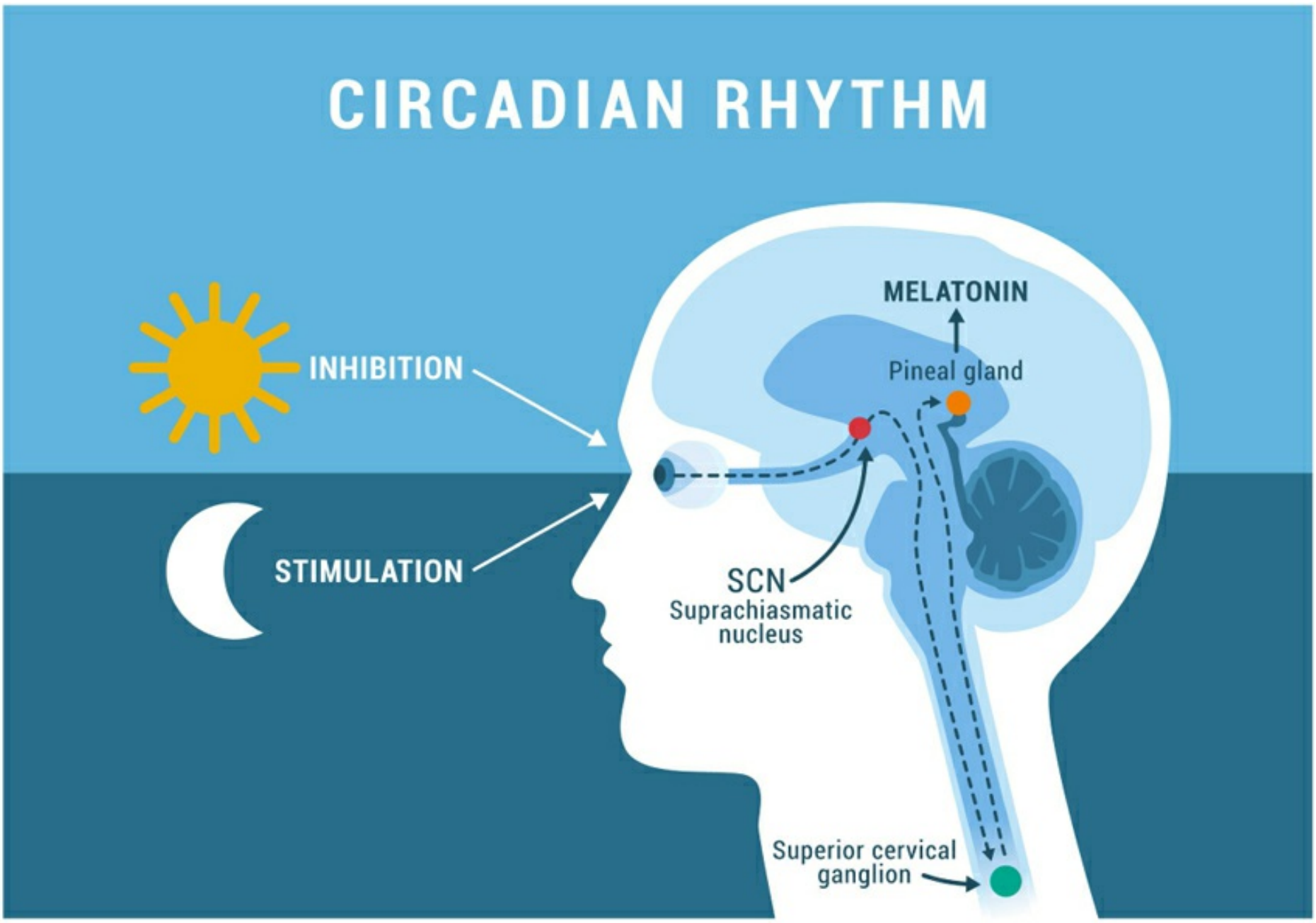
PROGESTERONE

- It is mainly secreted by the corpus luteum in the ovary during the second half of the menstrual cycle.
- It is also produced in small amounts by the ovaries themselves, the adrenal glands and the placer pregnancy.
- It is a steroid hormone.
- It plays an important role in the menstrual cycle and pregnancy.
- Luteinizing hormone (LH) is a hormone produced by gonadotropic cells in the anterior pituitary gland. the formation of the corpus luteum at around day 14 of the menstrual cycle.
- Follicle-stimulating hormone (FSH) is produced by the pituitary gland in the brain. It is important for t functioning of the reproductive system in men and women. In women, FSH helps control the menstrual the production of eggs by the ovaries.



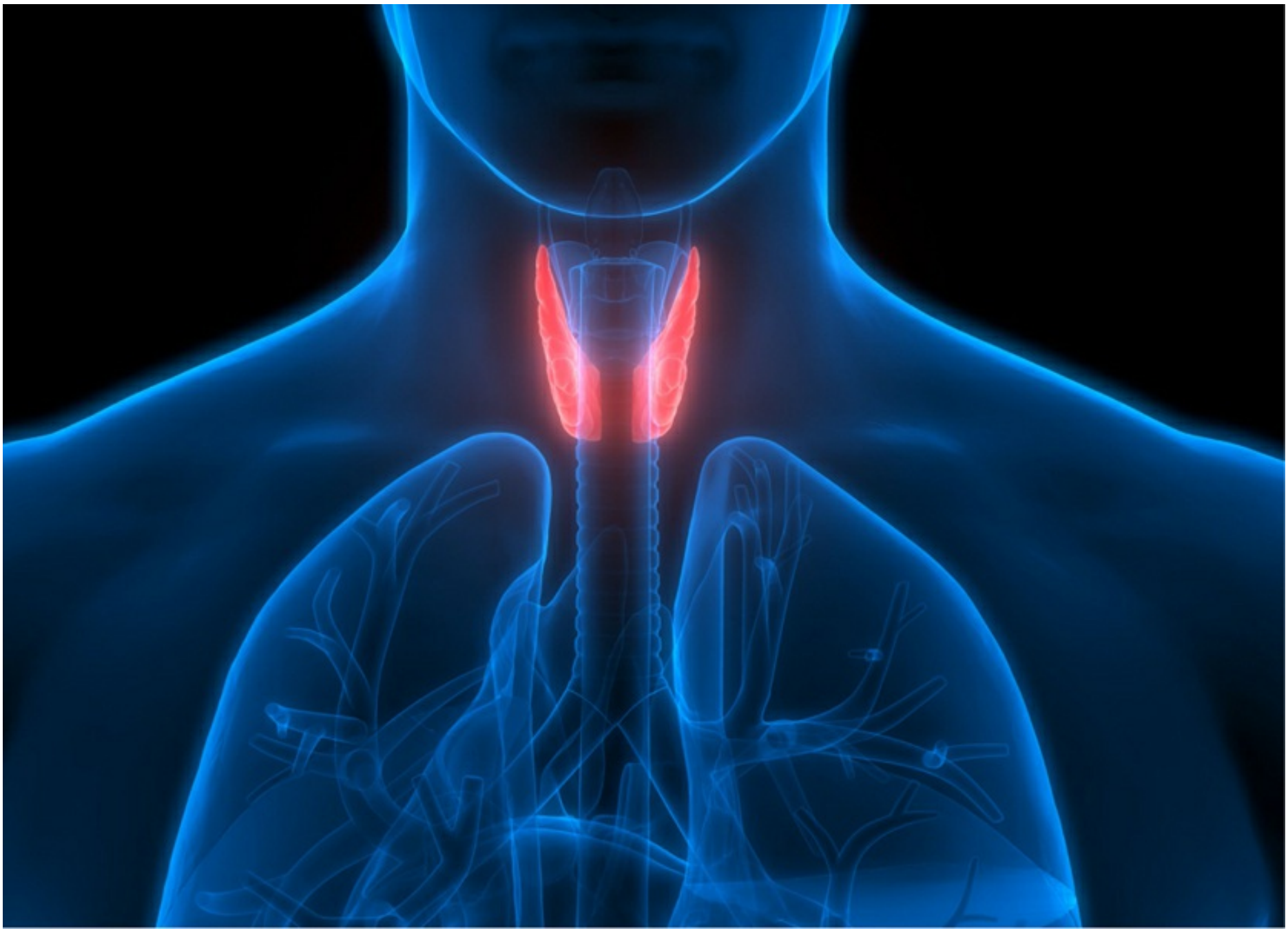
MELATONIN

- Melatonin is made in the pineal gland.
- It is an amine hormone.
- Natural light stimulates nerves at the back of the eye, which signal the pineal gland to inhibit the pro melatonin.
- At night, the lack of natural light stimulates melatonin production.
- It regulates sleep and helps to control circadian rhythm (the physical, mental, and behavioral changes tha 24-hour cycle).



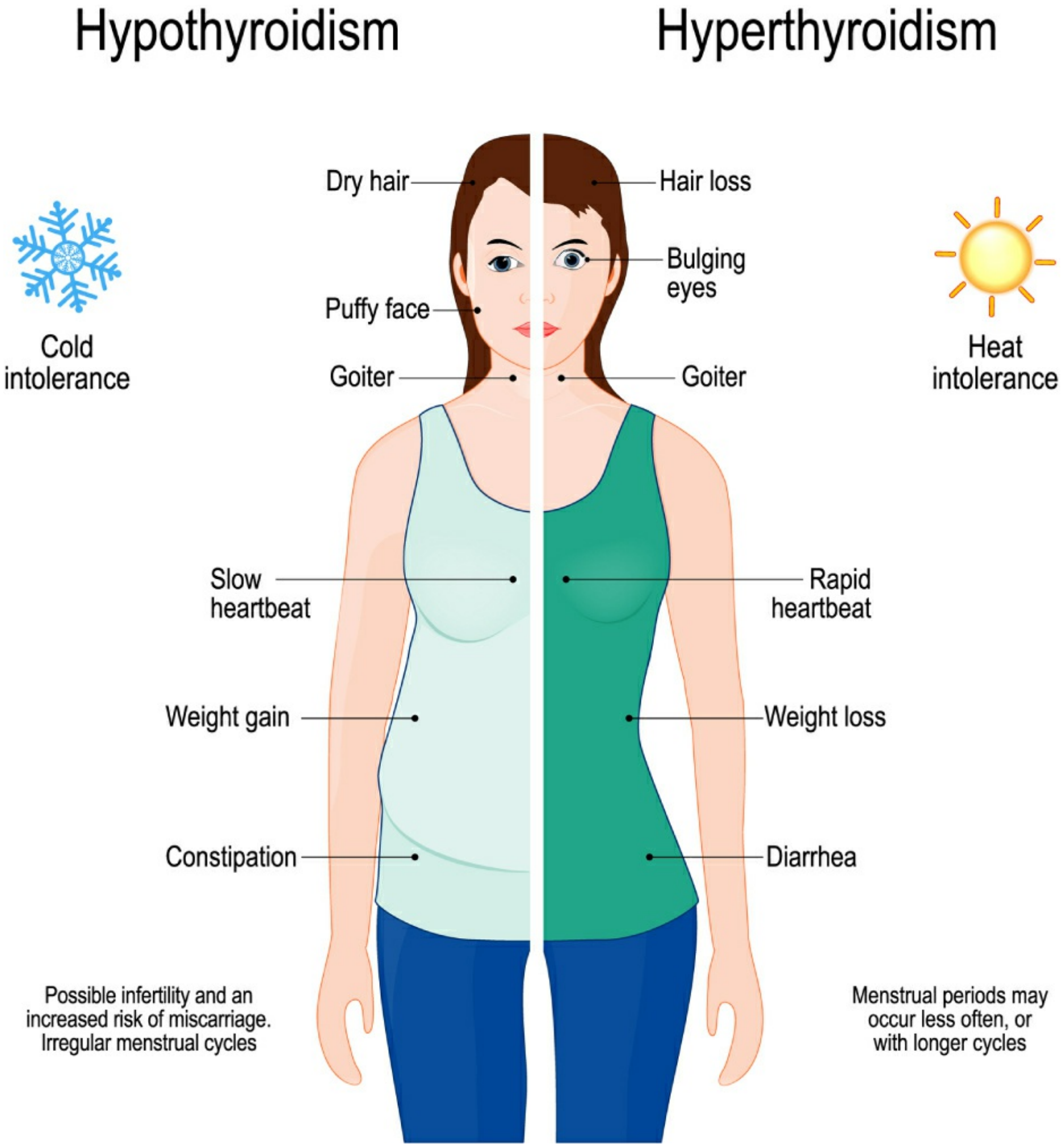
THYROID HORMONES

- The hypothalamus produces Thyrotropin-releasing hormone (TRH) and thyroid-stimulating hormone produced by the anterior pituitary gland.
- Thyroid hormones are two hormones produced and released by the thyroid gland – triiodothyronine and th
- The primary role of thyroid hormones is the regulation of metabolism.
- Other functions include roles in brain development, muscle control, digestion, and bone maintenance.
- A diet that supplies enough iodine (fruit and vegetables) is needed for adequate thyroid hormone productio



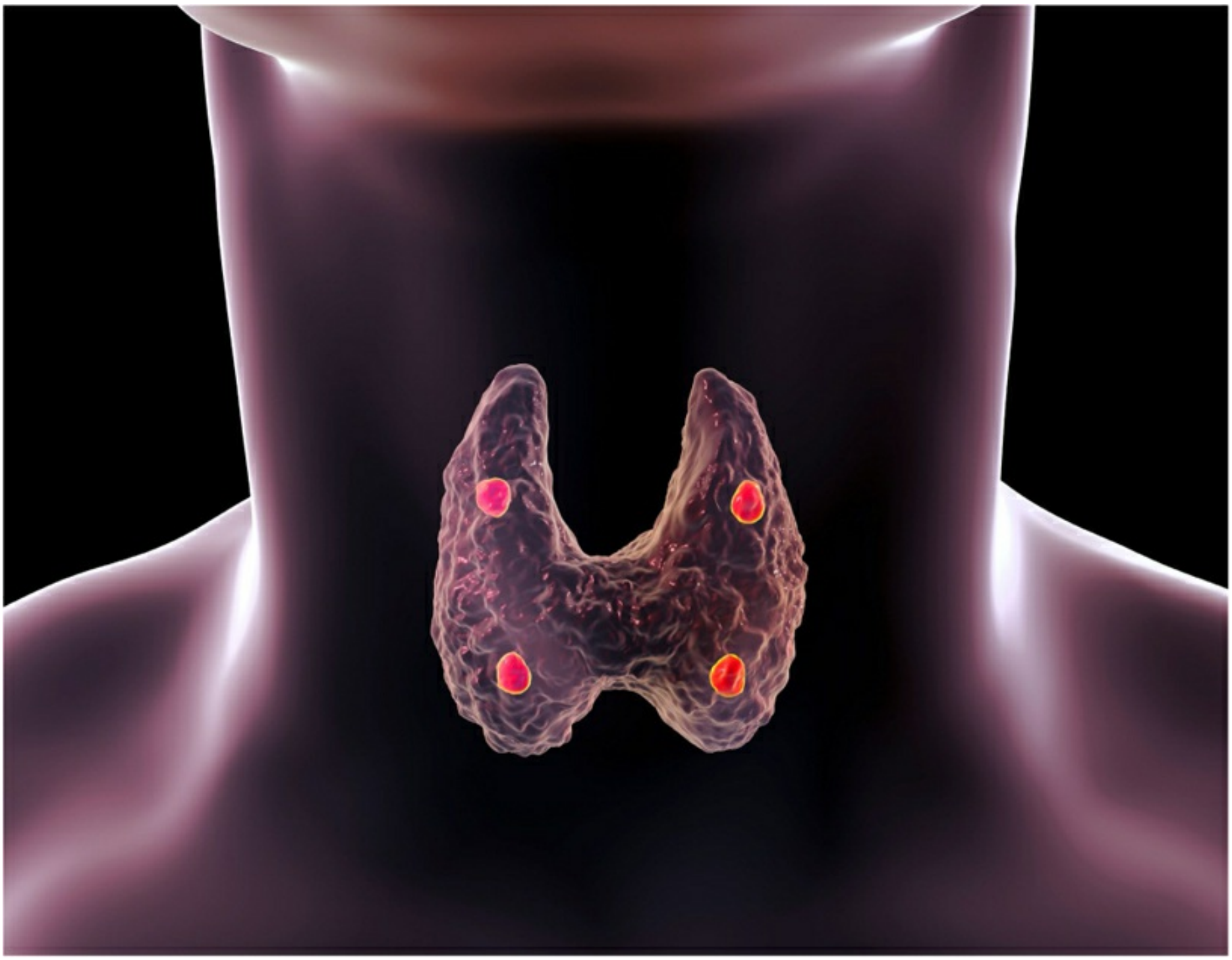
HYPER AND HYPOTHYROIDISM

- Hyperthyroidism (Graves' disease) can lead to thyrotoxicosis. Symptoms include weight loss, heat in palpitations and arrhythmias, tiredness and tremors.
- Hypothyroidism can result from an autoimmune attack or other causes. Symptoms include fatigue, cold in bradycardia (abnormally slow heart rate), weight gain, depression and muscle stiffness.



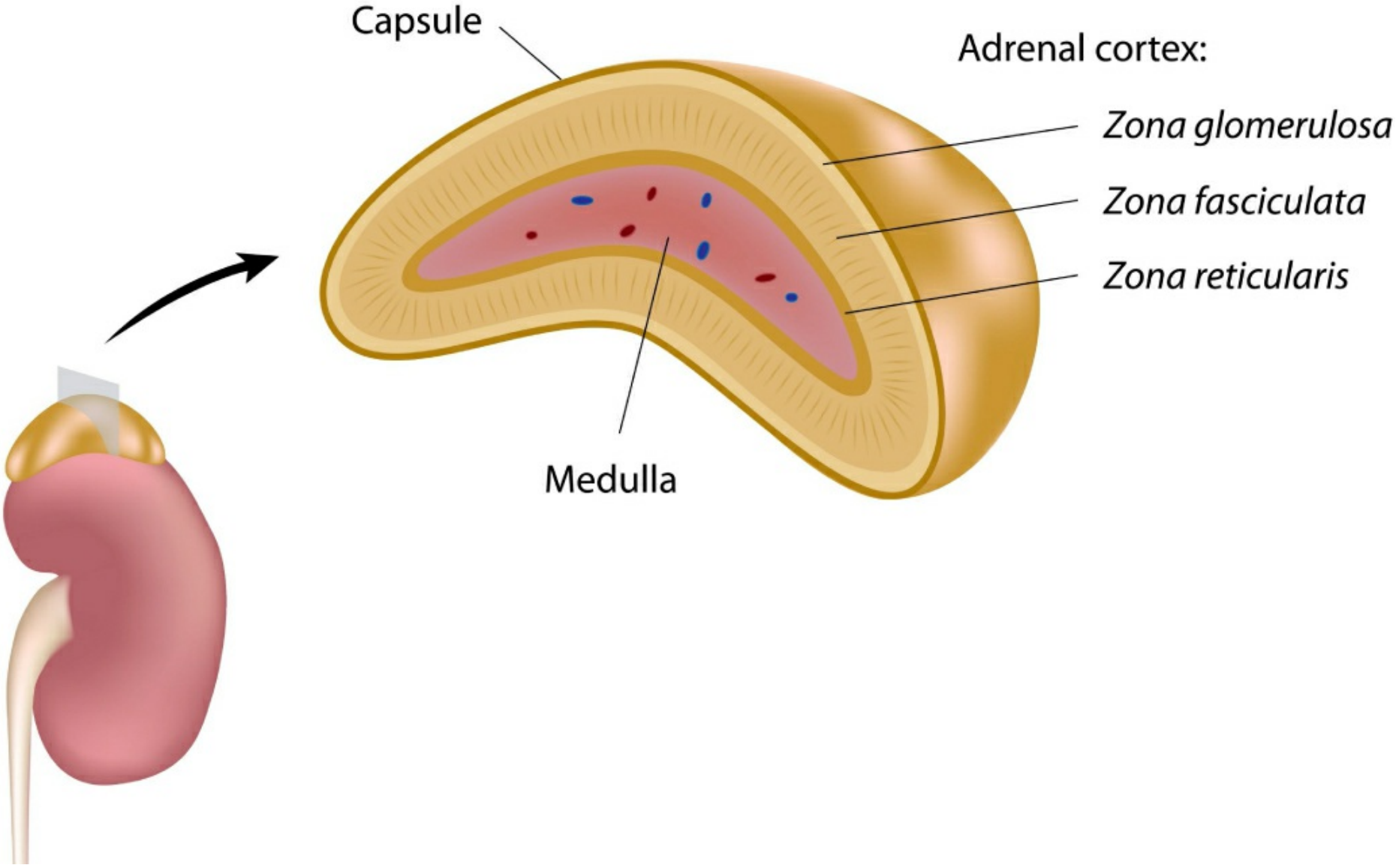
PARATHYROID HORMONE

- It is secreted from the parathyroid glands at the back of the thyroid gland.
- Its primary role is to regulate calcium levels in the blood.
- It typically increases calcium levels by acting on the bones, kidneys, and intestines.
- It is released with changes in blood calcium and magnesium levels.
- Diets that are chronically low in calcium can increase the risk of osteoporosis.



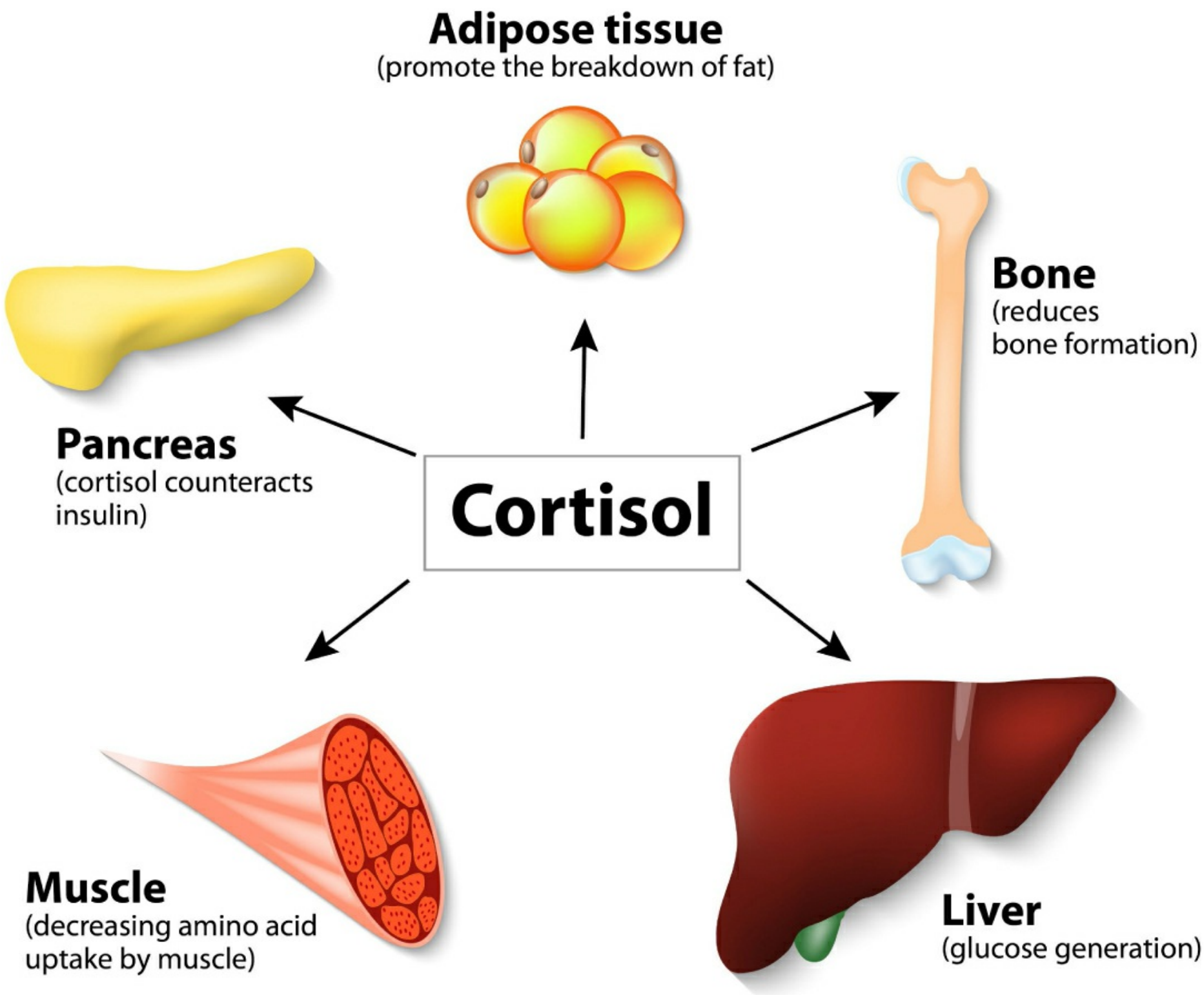
CORTICOSTEROIDS

- The steroid hormones produced in the outer layer (cortex) of the adrenal gland are collectively corticosteroids.
- There are two main classes of corticosteroids, glucocorticoids and mineralocorticoids.
- Cortisol is the main corticosteroid.
- Almost every cell in the body has cortisol receptors and is affected by this hormone.
- Cortisol plays roles in metabolism, immune response, regulation of inflammation, carbohydrate metabolis catabolism and blood electrolyte levels.



CORTISOL

- Cortisol is a steroid hormone in the glucocorticoid class of the hormones.
- The level of cortisol tends to rise and fall in a predictable daily rhythm every 24 hours.
- Cortisol release is controlled by the hypothalamic-pituitary-adrenal (HPA) axis.
- Almost every cell in the body contains receptors for cortisol.
- Cortisol is released in response to physical stressors, such as activity, exercise, illness, or injury.
- Psychological stress also increases cortisol secretion.

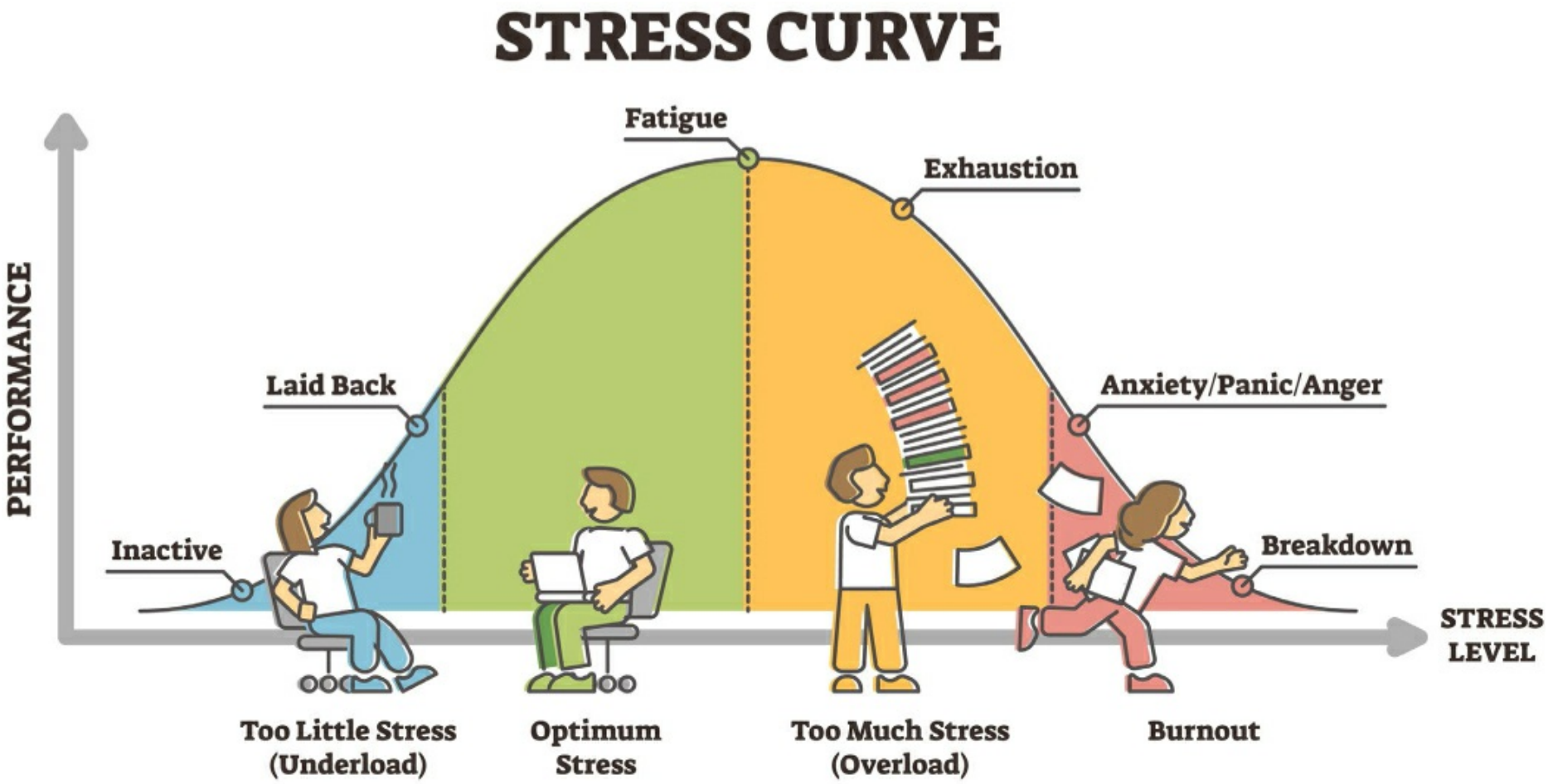


CORTISOL AND STRESS

In the short term, cortisol increases the body's resilience and prepares it for action as part of the fight-or-flight response to a stressful stimulus.

If the stressor persists, high levels of cortisol production are sustained due to an imbalance in the HPA axis (hypothalamic-pituitary-adrenal axis).

This can suppress the immune system and increase the risk of chronic medical conditions.



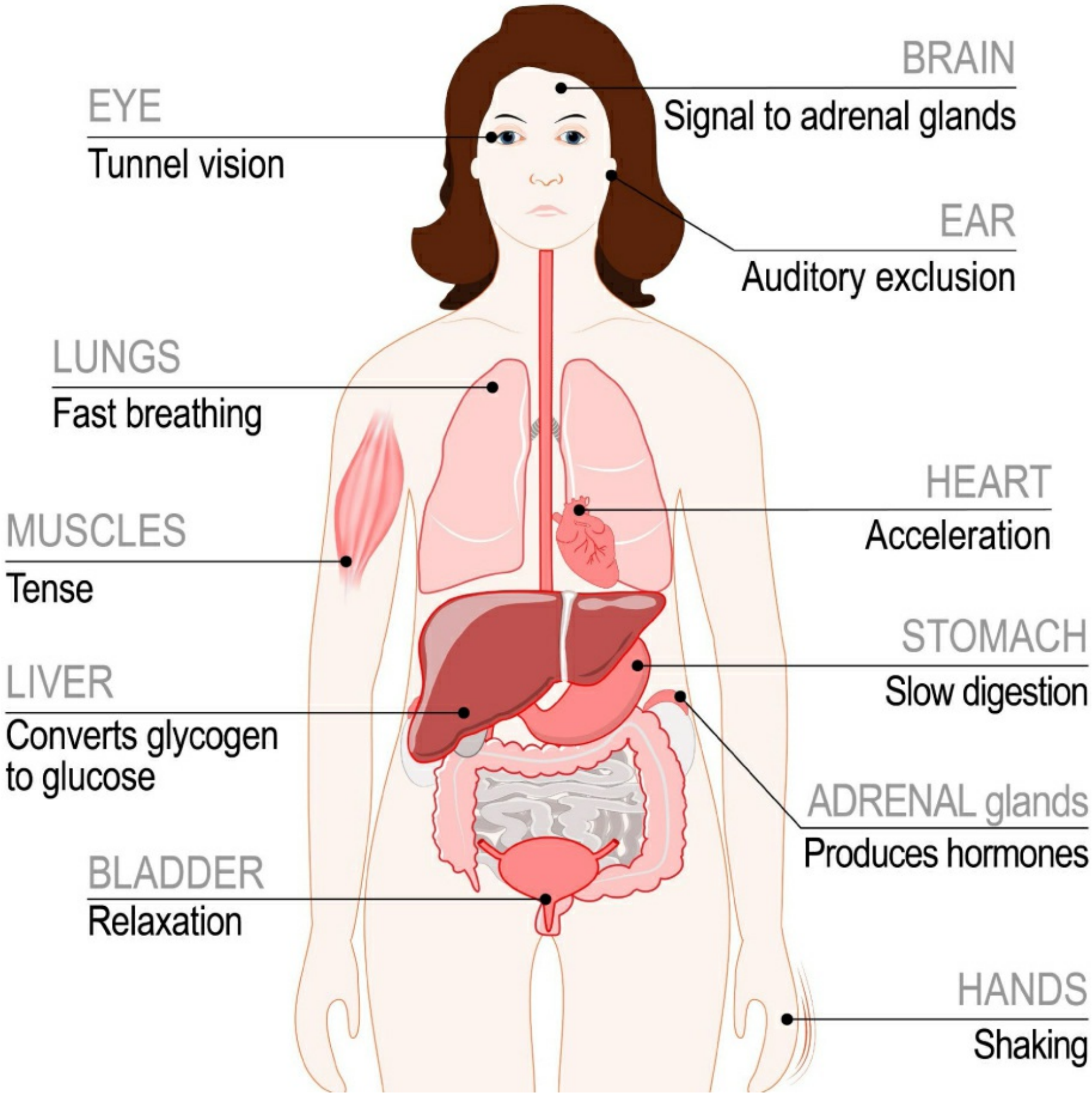
FIGHT OR FLIGHT RESPONSE

Fight or flight is a response to an acute threat to survival marked by physical changes, including nervous and endocrine changes, that prepare the human body to fight or flight (retreat – run away).

An example would be being approached by a dangerous animal. In this scenario, the somatic section of the autonomic nervous system is going to fire up and many of the effects shown in the diagram will occur.

Some individuals may find their fight or flight response is more sensitive, which is one of the reasons why individuals may experience a feeling of anxiety in what may be considered a "normal" activity. For example, being invited to a social event.

Of course, what is considered stressful or a risk to survival is subjective and can differ greatly from person to person.

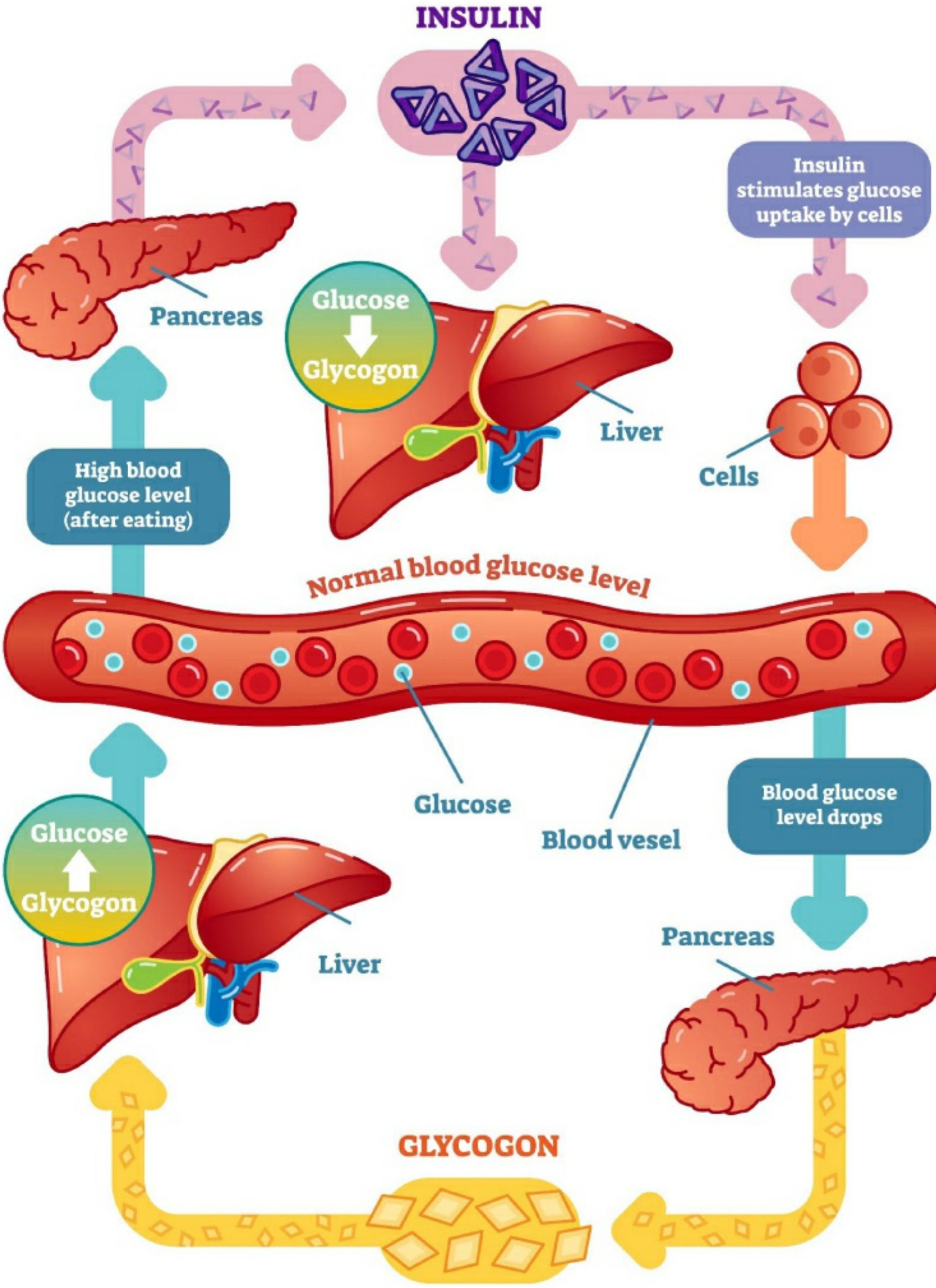


ADRENALIN AND NORADRENALIN

- Also known as epinephrine and norepinephrine.
- These hormones are known collectively as catecholamines due to their chemical structures.
- Catecholamines work in tandem with cortisol as part of the fight-or-flight response.
- Adrenaline is the main hormone produced by the adrenal medulla.
- Noradrenaline is the main neurotransmitter of the sympathetic nerves in the cardiovascular system.
- Adrenaline and noradrenaline increase heart rate, blood pressure and respiratory rate, diverting blood awa skin and gut towards the muscles, stimulating alertness by increasing blood flow to the brain.

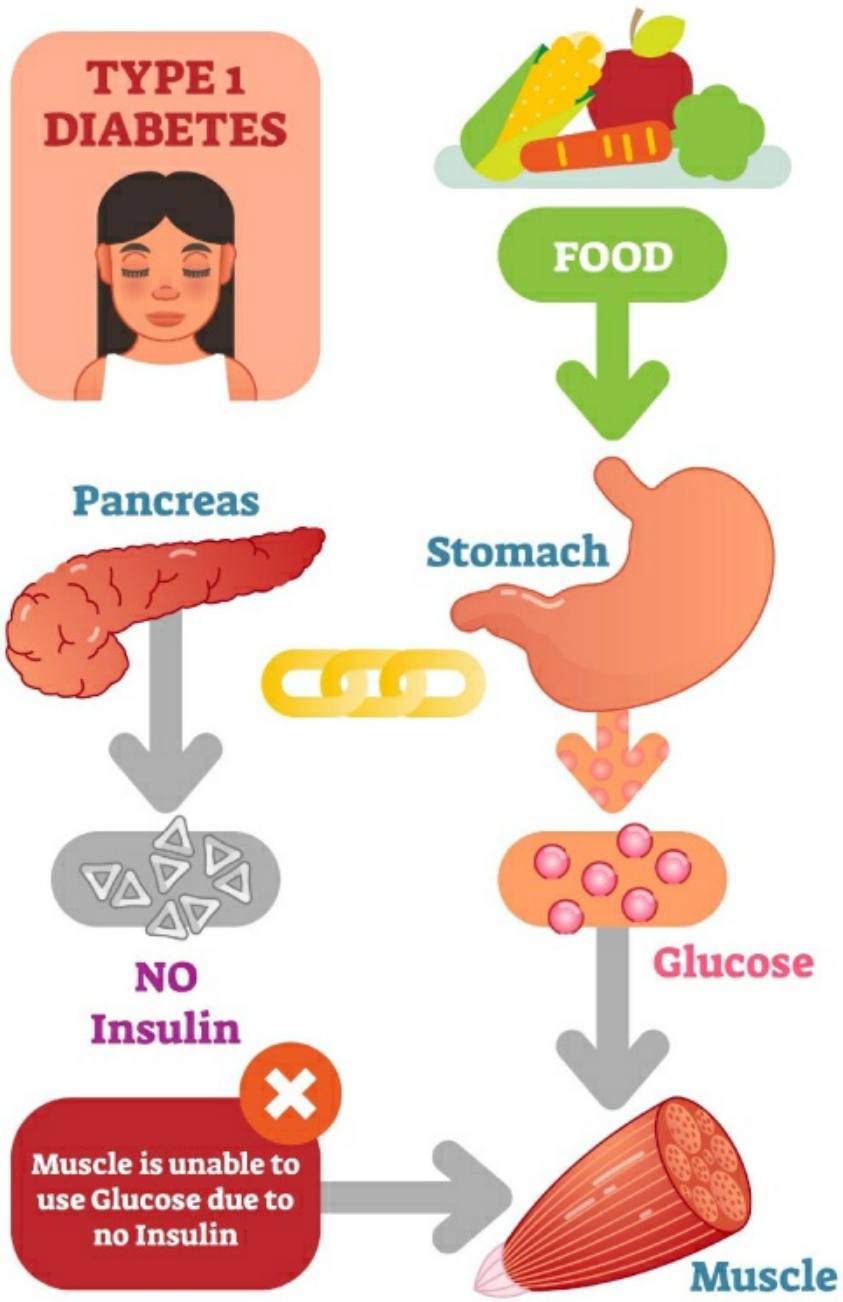
PANCREATIC HORMONES

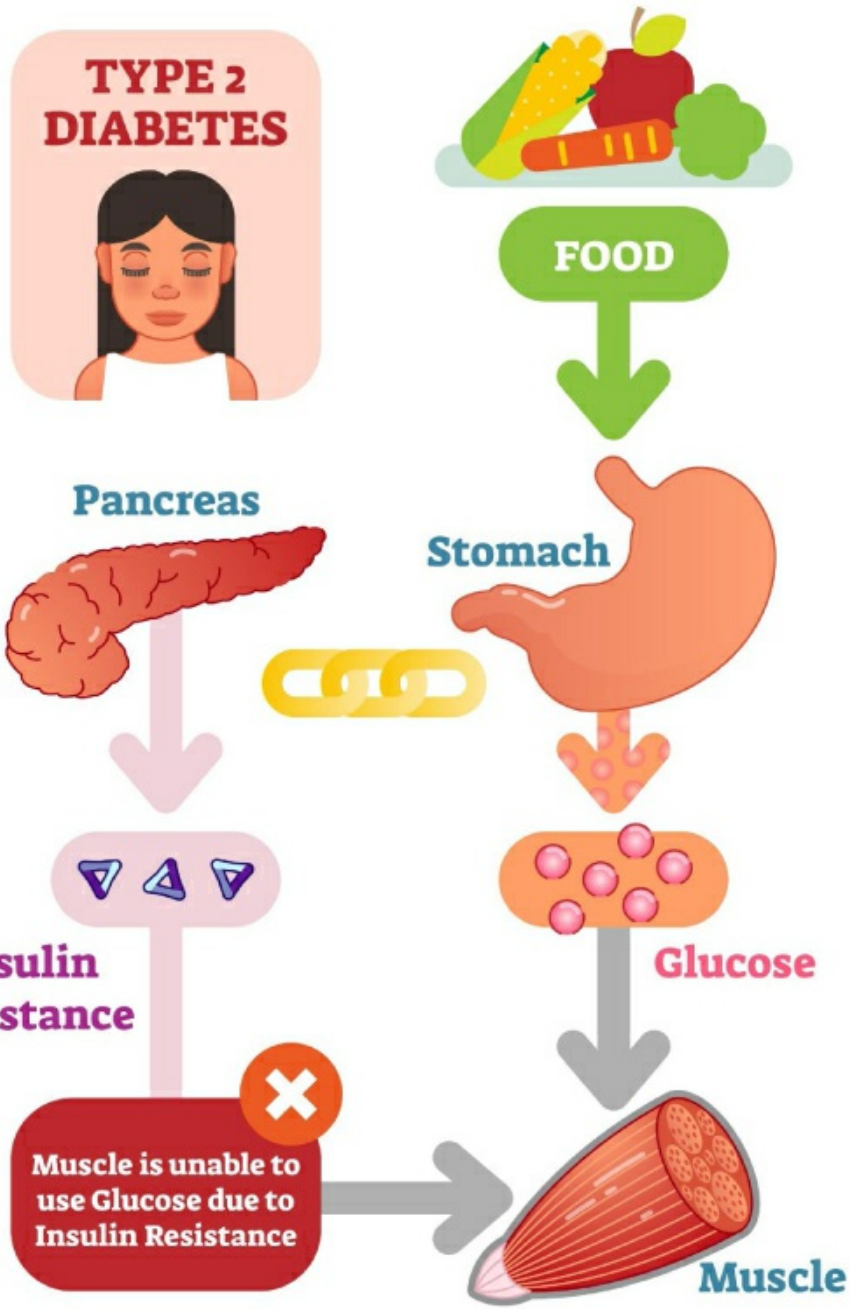
- Insulin and glucagon are secreted from the pancreas.
- These hormones share the role of maintaining a stable blood glucose level through opposing actions.
- Insulin lowers blood glucose levels by stimulating uptake in cells of the liver, muscles, and adipose tissue.
- Glucagon raises blood glucose levels by stimulating the liver to break down stored glycogen and relea into the blood.


INSULIN
Insulin stimulates glucose uptake by cells
Pancreas
Glucose
Glycogon
Liver
Cells
High blood glucose level (after eating)
Normal blood glucose level
Glucose
Blood vesel
Blood glucose level drops
Glucose
Glycogon
Liver
Pancreas
GLYCOGON

DIABETES

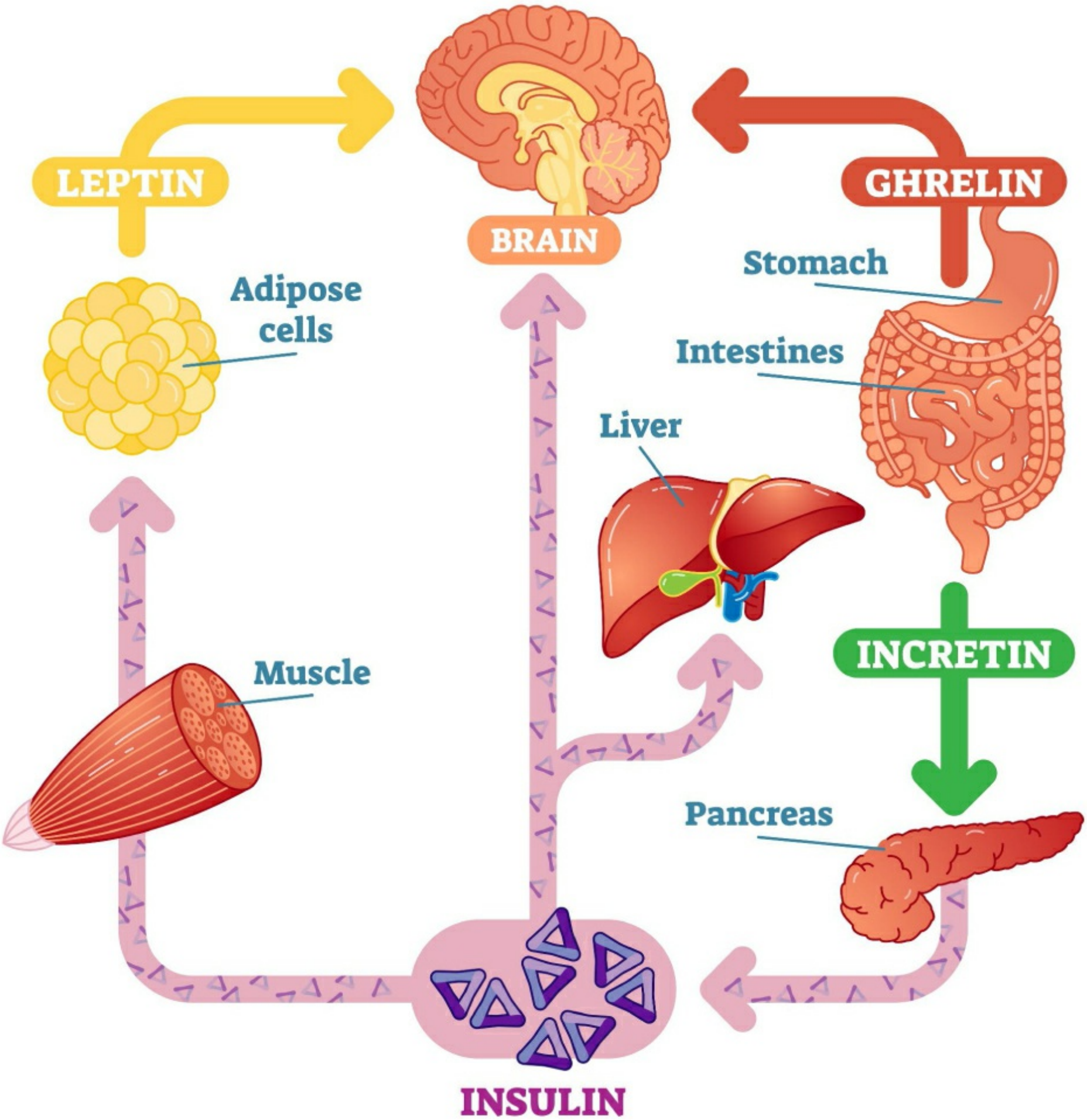
Diabetes is a disease where the body's ability to produce or respond to the hormone insulin is impaired. This has an impact on blood sugar levels and can result in a wide variety of health complications.





HUNGER HORMONES

- Leptin is a protein hormone made by fat cells that decreases your appetite.
- Ghrelin is a peptide hormone primarily made in the stomach that increases your appetite (the hunger horm
- Levels of leptin are lower when you're thin and higher when you're overweight. However, studies have s many obese people have built up a resistance to the appetite-suppressing effects of leptin.
- Incretin stimulates insulin secretion.



REWARD HORMONES

- Reward hormones are hormones that make us feel good. However, they are much more complex than just hormones and can impact a variety of areas, such as emotions, motor skills and learning.

Oxytocin

The Love Hormone

Released During Sex, Childbirth and Lactation

Serototin

Mood Stabilizer

Turns On When You Gain an Advantage

#1

Dopamine

The Reward Chemical

Released During Pleasurable Situations

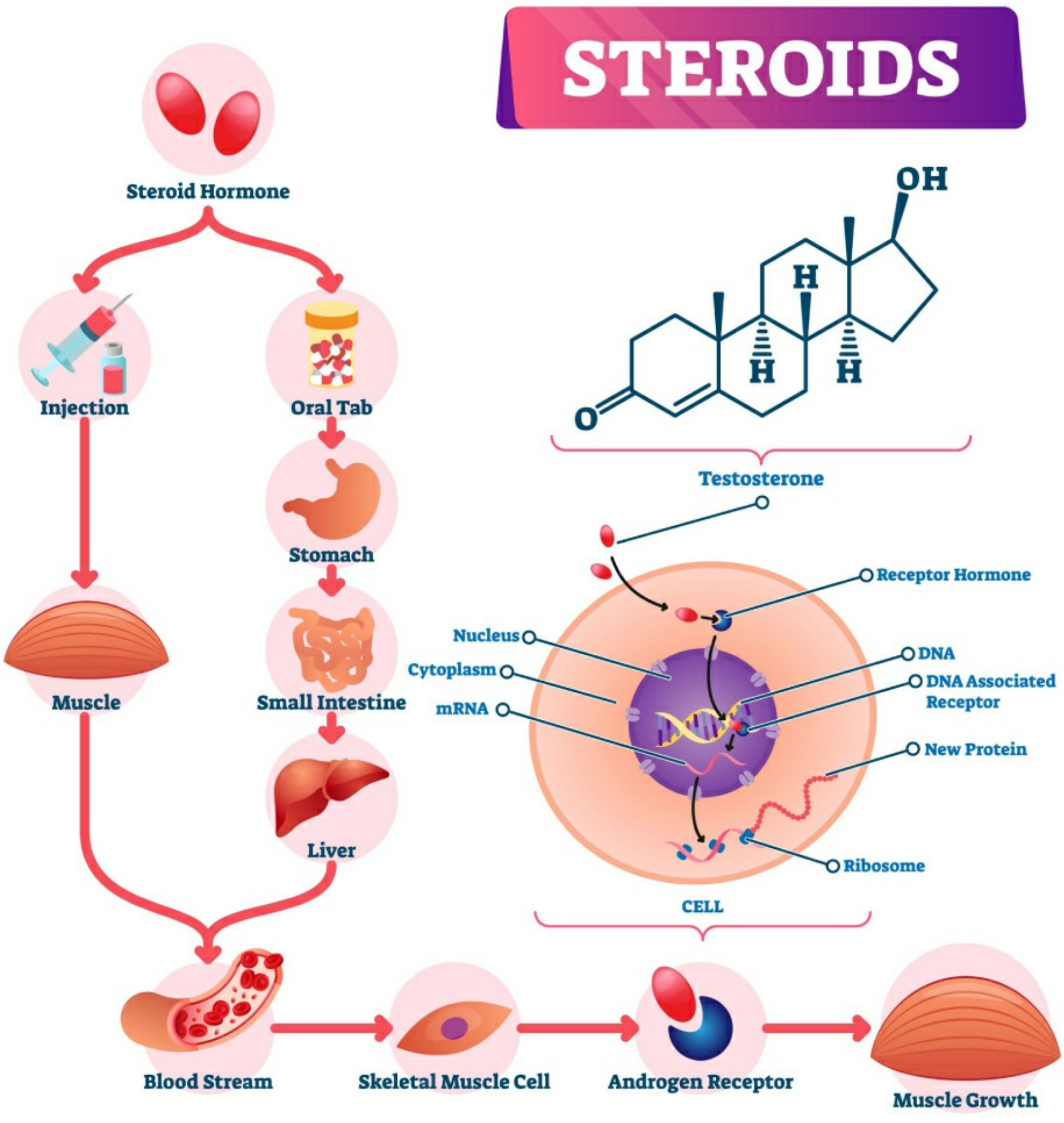
Endorphin

Works as a Pain Killer

Released After Exercise

ANABOLIC STEROIDS

- Some athletes and fitness enthusiasts take a form of steroids known as anabolic-androgenic steroids (AA anabolic steroids.
- AAS are synthetic (made in a lab) derivatives of the naturally produced hormone testosterone. There promote muscle growth and other typical traits of male puberty (androgenic effects).
- Once injected or ingested, an AAS travels through the bloodstream to the muscle tissue. From there, it is the muscle cell's receiving dock called an androgen receptor.
- Once in the muscle cell, the AAS can interact with the cell's DNA and stimulate the protein synthesis p promotes muscle growth.



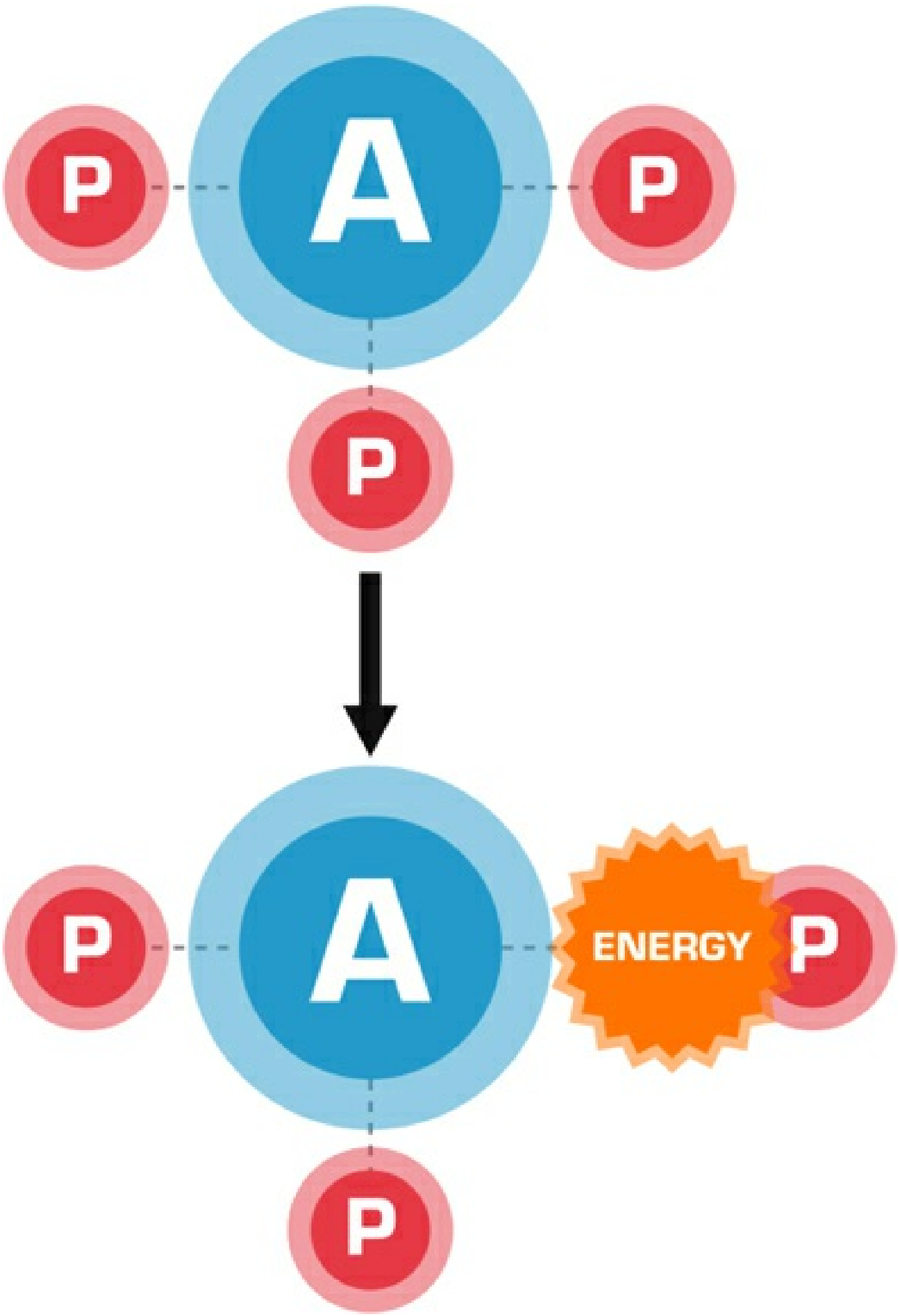
THE ENERGY SYSTEMS

The key to the energy systems is a molecule called Adenosine Triphosphate (ATP).

ATP is in all forms of life and is referred to as the Energy Currency Molecule or Molecular Currency. ATP is a complex organic chemical found in most cells (particularly muscle cells) that provides energy to drive many processes, such as moving muscles.

ATP is made up of 1 adenosine molecule attached to 3 phosphate groups. When one of the phosphate bonds is broken off (dephosphorylation), leaving adenosine diphosphate (1 adenosine + 2 phosphate groups), energy is produced. The breaking of the bond occurs when a molecule of water is added, a process called hydrolysis, which is catalyzed by the enzyme ATPase. ATP is able to power cellular processes by transferring a phosphate group to another molecule, a process called phosphorylation.

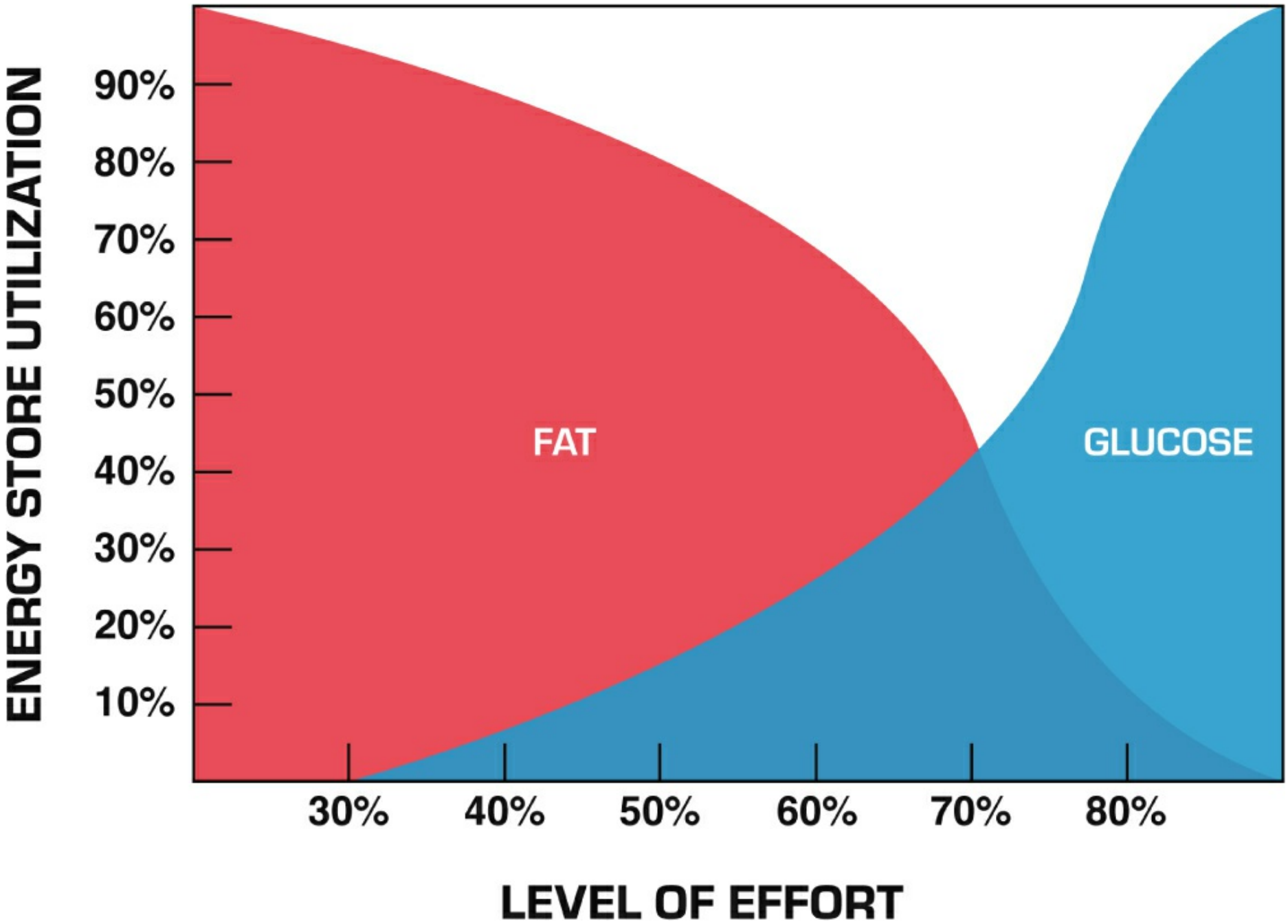
ATP is not stored in any great quantity. Therefore, synthesis has to follow consumption closely, and this is where the energy systems come in – our energy systems turn ADP back to ATP.


P
A
P
P
P
A
ENERGY
P
P

THE PRODUCTION OF ATP

To put it simply, creatine phosphate (CP) and the food we take in, specifically fat and carbohydrate, is used to convert ADP to ATP for energy – protein can be used for energy but is primarily used for growth and repair.

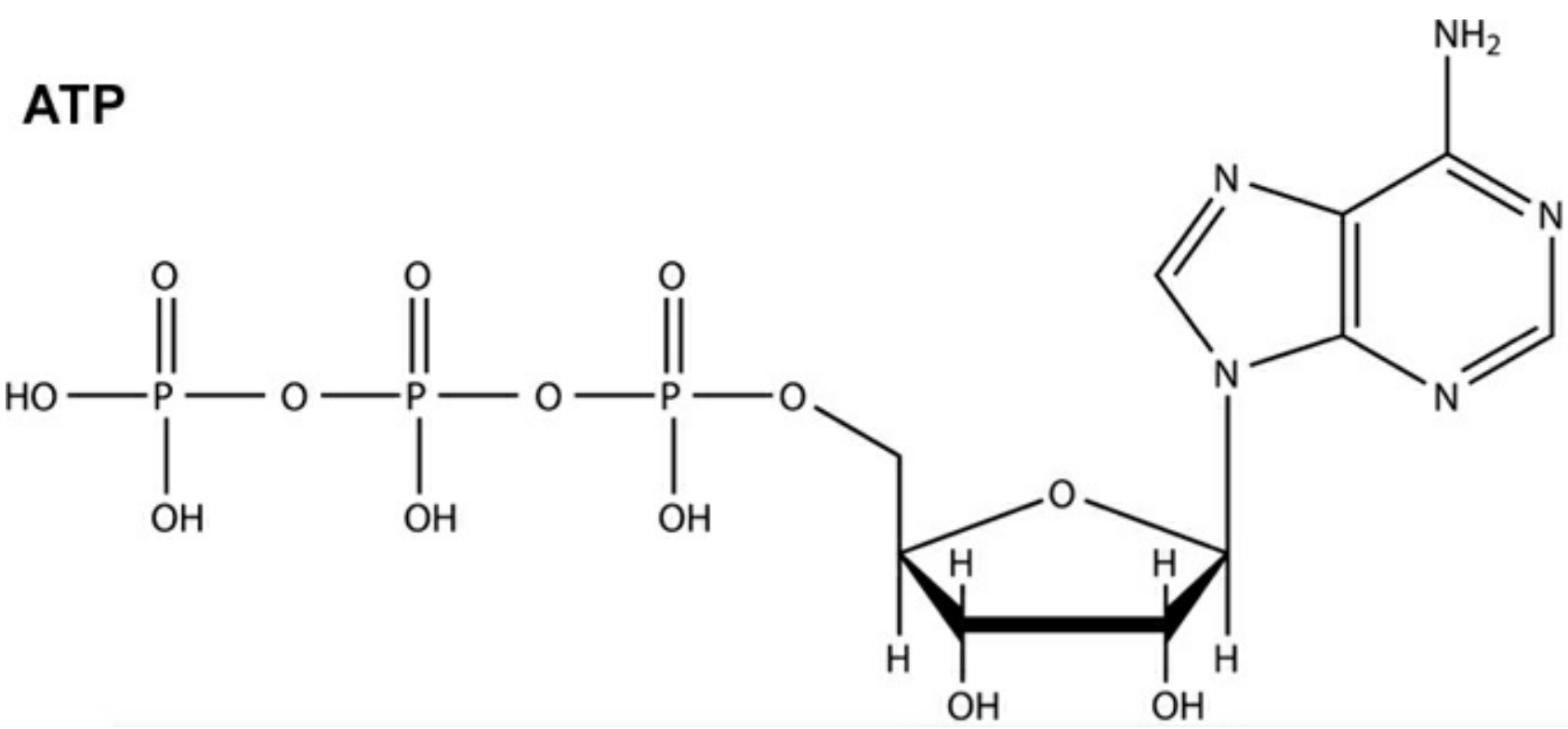
- **Fat:** Broken down into fatty acids.
- **Carbohydrate:** Broken down into glucose – stored in the muscles and liver as glycogen.
- **Protein:** Broken down into amino acids.



COMMON NAMES

The table below shows the many names which are used to refer to the energy systems.

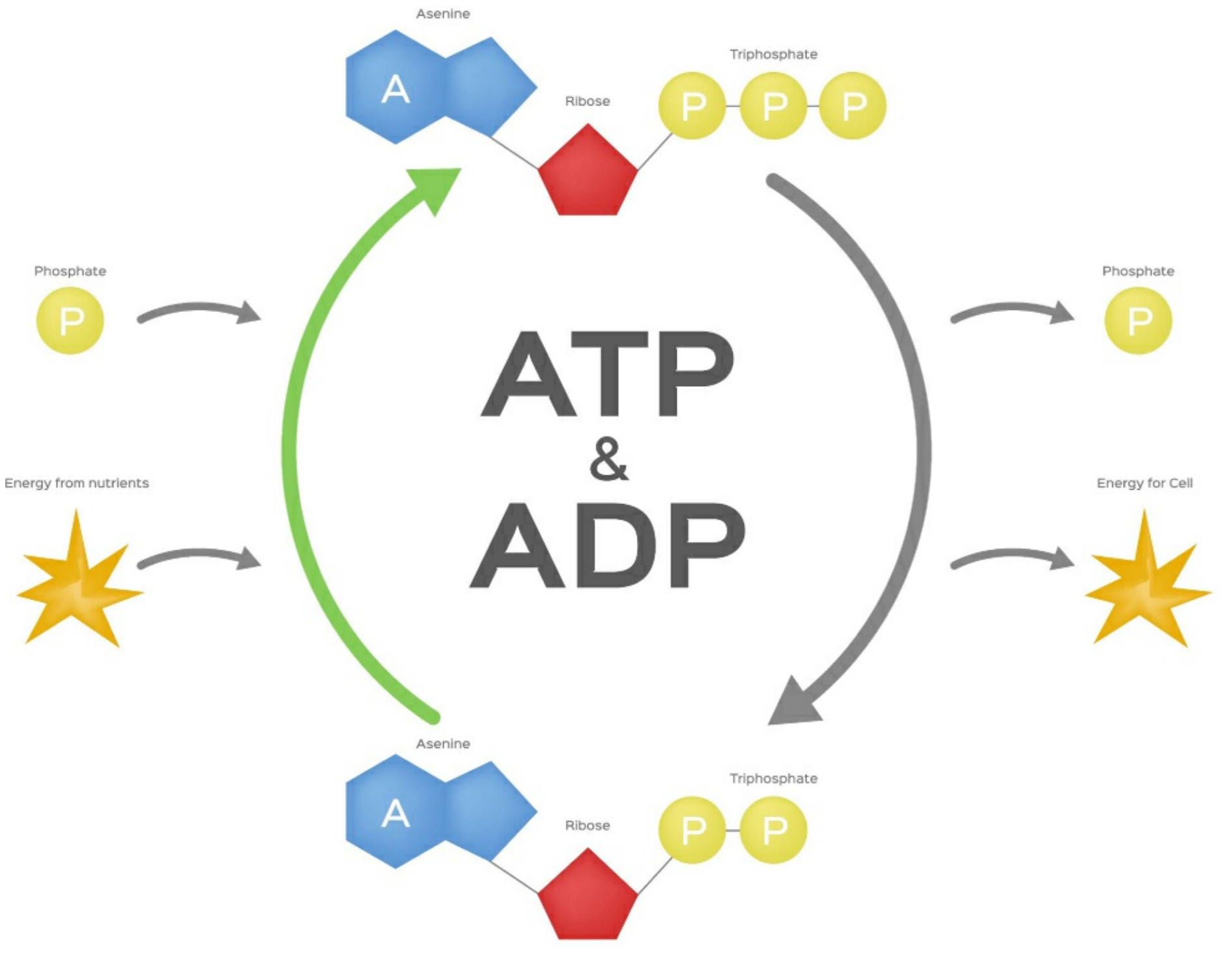
ATP-CP (Alactic) System	Lactate System	Aerobic System
Short-Term System	Mid-Term System	Long-Term System
Alactic System	Glycolytic System	Oxidative System
ATP-PCr System	Lactic Acid System	Oxidative Dependant System
PCr System	Lactic System	
Phosphagen System	Oxidative Independent Glycolytic System	
Phosphocreatine System	Non-Oxidative Glycolytic System	
Creatine Phosphate System		
Oxidative Independent System		



POWER, CAPACITY AND UTILIZATION

To effectively develop each system, it is important that we understand three key factors:

- **Rate of Energy Production (Power):** How quickly can the system produce energy.
- **Duration of Energy Production (Capacity):** How long can the system produce energy for.
- **Energy Utilization:** How efficiently the energy is used.

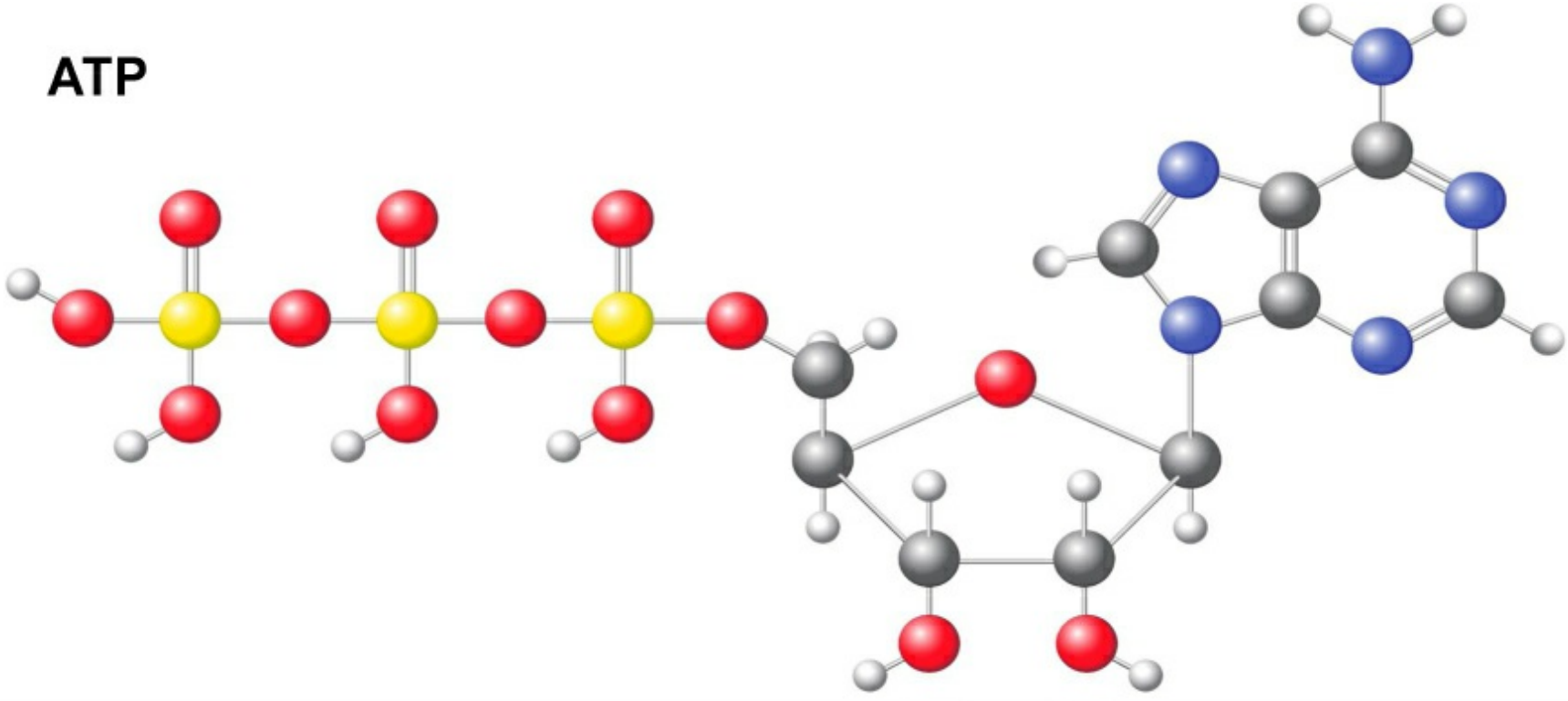


POWER AND CAPACITY

The table below shows the speed (power) and duration (capacity) of each energy system.

Classification	Power	Capacity	Energy Supplied by
ATP-CP	Very Fast	0-2 or 4 Seconds	ATP
		4-10 Seconds	ATP + CP
ATP-CP & Lactate	Fast	10-45 Seconds	ATP + CP + Glycogen
Lactate	Fast	45-120 Seconds	Glycogen – Fast Anaerobic Glycolysis
Lactate & Aerobic	Moderate	2-3 Minutes	Glycogen & Fatty Acids – Fast & Slow (Aerobic) Glycolysis + Beta Oxidation + Lipolysis.
Aerobic	Slow	3 Minutes +	Slow Glycolysis + Beta Oxidation + Lipolysis

ATP

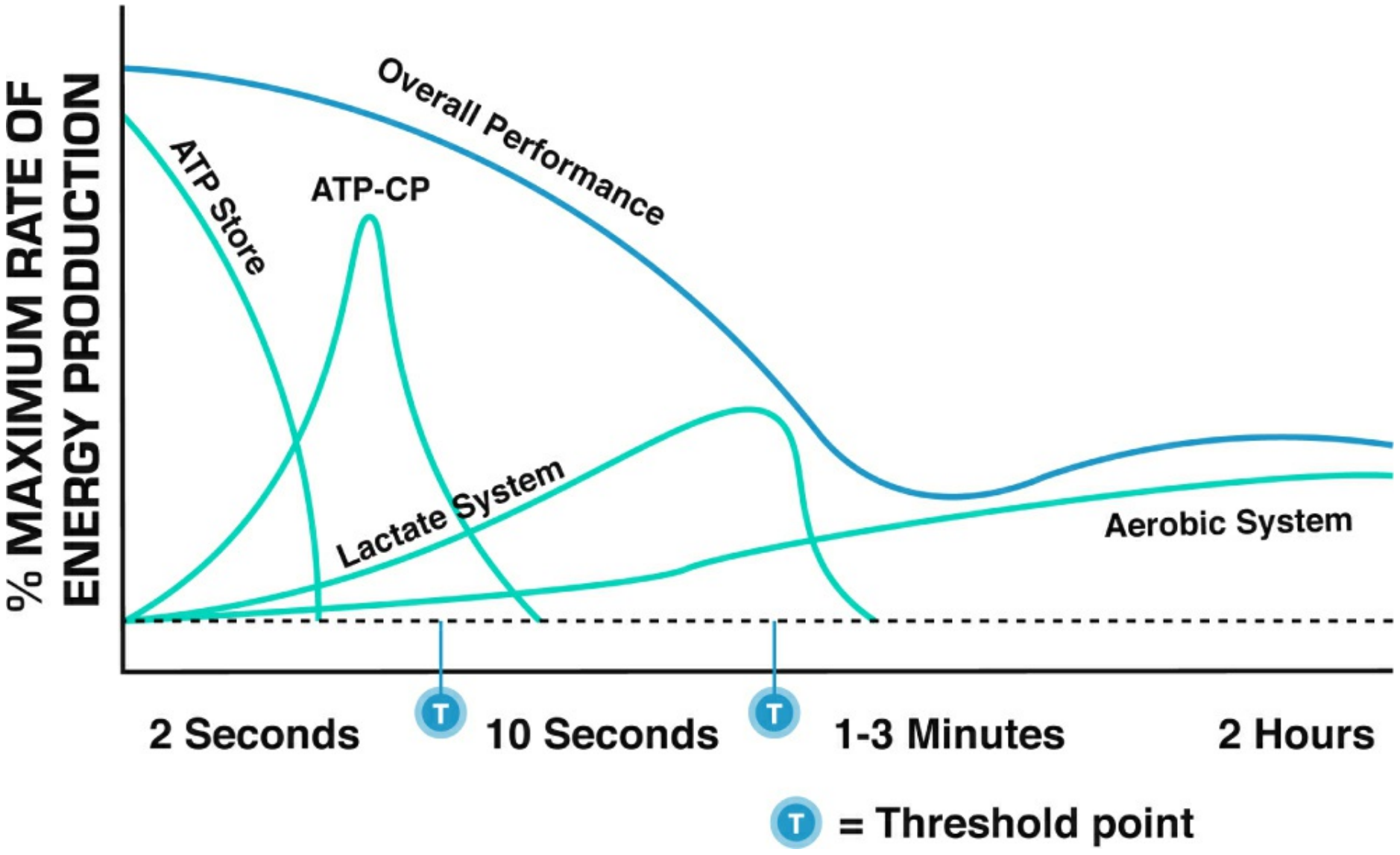


THRESHOLDS

As we can see from the table in the previous slide, the ATP-CP system has the greatest power but the most limited capacity, while the aerobic system has limited power but the greatest capacity. The lactate system is in the middle with great power and good capacity. However, for this it pays a price in the form of waste products. These waste products eventually build up faster than they can be cleared, performance diminishes, and we are forced into an aerobic level of power.

The anaerobic threshold (AT), commonly referred to as the lactate threshold (LT), due to blood lactate levels being used to measure it, is the intensity at which the body transitions from primarily using the aerobic system to using the anaerobic lactate system.

When the body is primarily anaerobic, fatuiging by-products build up and performance diminishes – depending on genetics and an individual's fitness levels, the LT is generally around 75-90% of max heart rate, but most commonly described as 85% of max heart rate.



ADAPTABILITY

Genetics play a large role in an individual's baseline fitness (untrained) and their peak fitness (fittest they can be). However, all three energy systems can be improved to varying degrees. With the aerobic system having the highest adaptability, then the lactate system and finally the ATP-CP system.

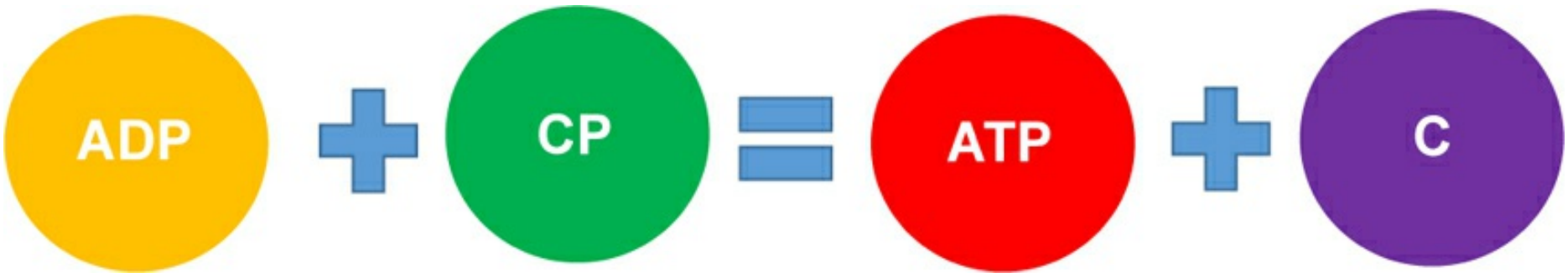
Although we often perceive the energy systems as working independently, it is key to understand that they work concurrently, with one predominating depending on the duration and intensity of the work being done.

Not only do energy systems work alongside each other, but they can help to refuel each other. Therefore, the specific training of 1 energy system will benefit the others, both in the metabolic processes and the utilization of the energy produced.

For the reasons explained above, it is vital that all athletes specifically target each energy system. However, it is also important for athletes to specialize and place emphasis on the energy system required most for their sport. This is well illustrated when we consider the three muscle fibre types and their adaptability to training.

ATP-CP (ALACTIC) SYSTEM

- Anaerobic.
- Utilizes creatine phosphate (chemical energy) to remake ATP almost instantly.
- CP supplies in muscle are limited (4–10 seconds).
- Rapid energy for short periods when exercise intensity is maximal.
- Does not require oxygen, fat or carbohydrate.
- No fatiguing by-products.

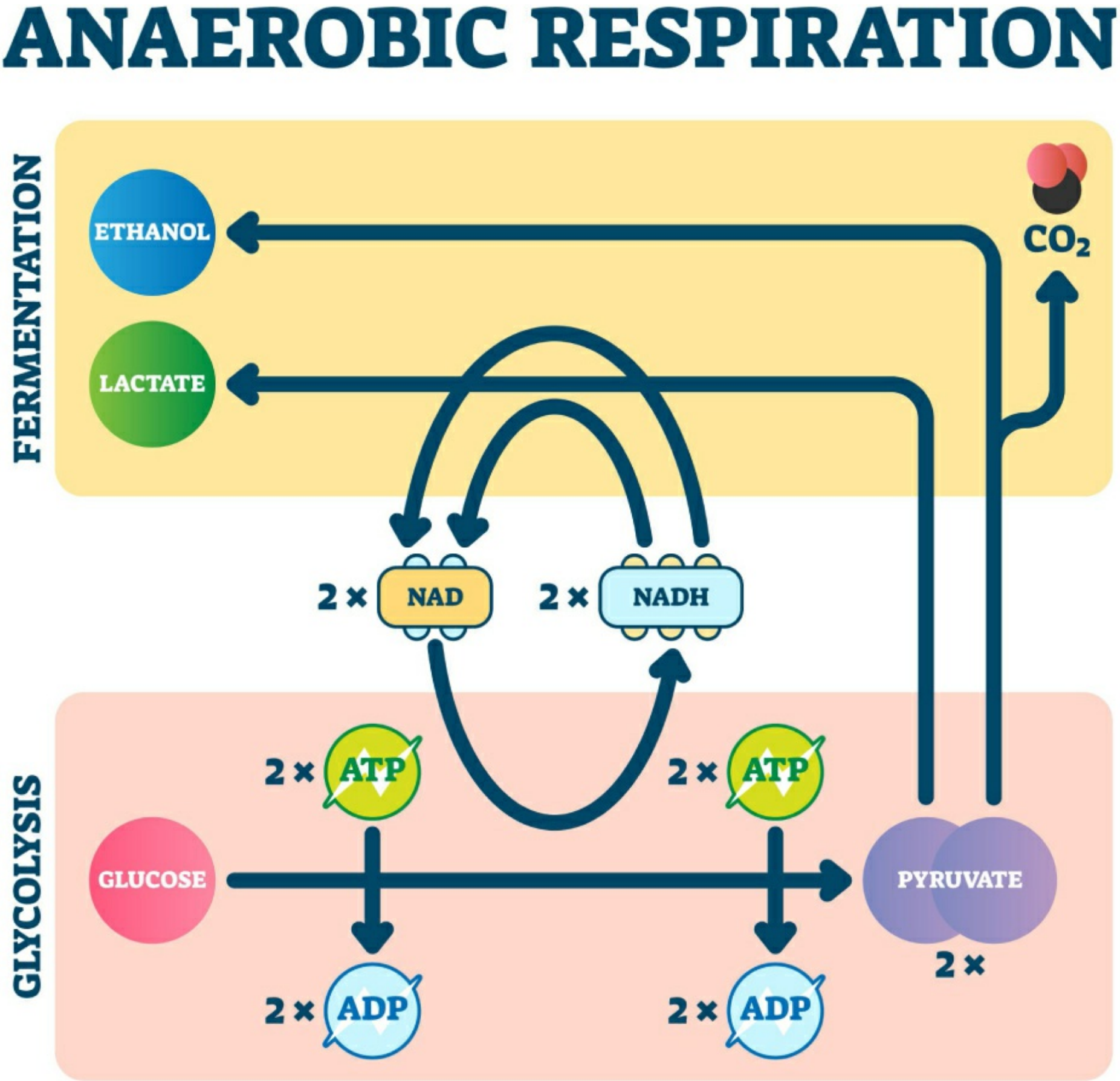


ATP-CP (ALATIC) SYSTEM ACTIVITIES

- <100-metre sprint.
- Javelin.
- Shot-put.
- Racket sports swings.
- Strikes (punches and kicks, etc).
- Weightlifting.
- High jump.

LACTATE SYSTEM

- Anaerobic.
- Uses stored glycogen to remake ATP.
- Provides ATP when oxygen is not freely available within the cell.
- Produces fatiguing by-products.
- Burning sensation in muscles.
- 1–3 minutes of intense activity.
- High intensity (60–95% max effort).

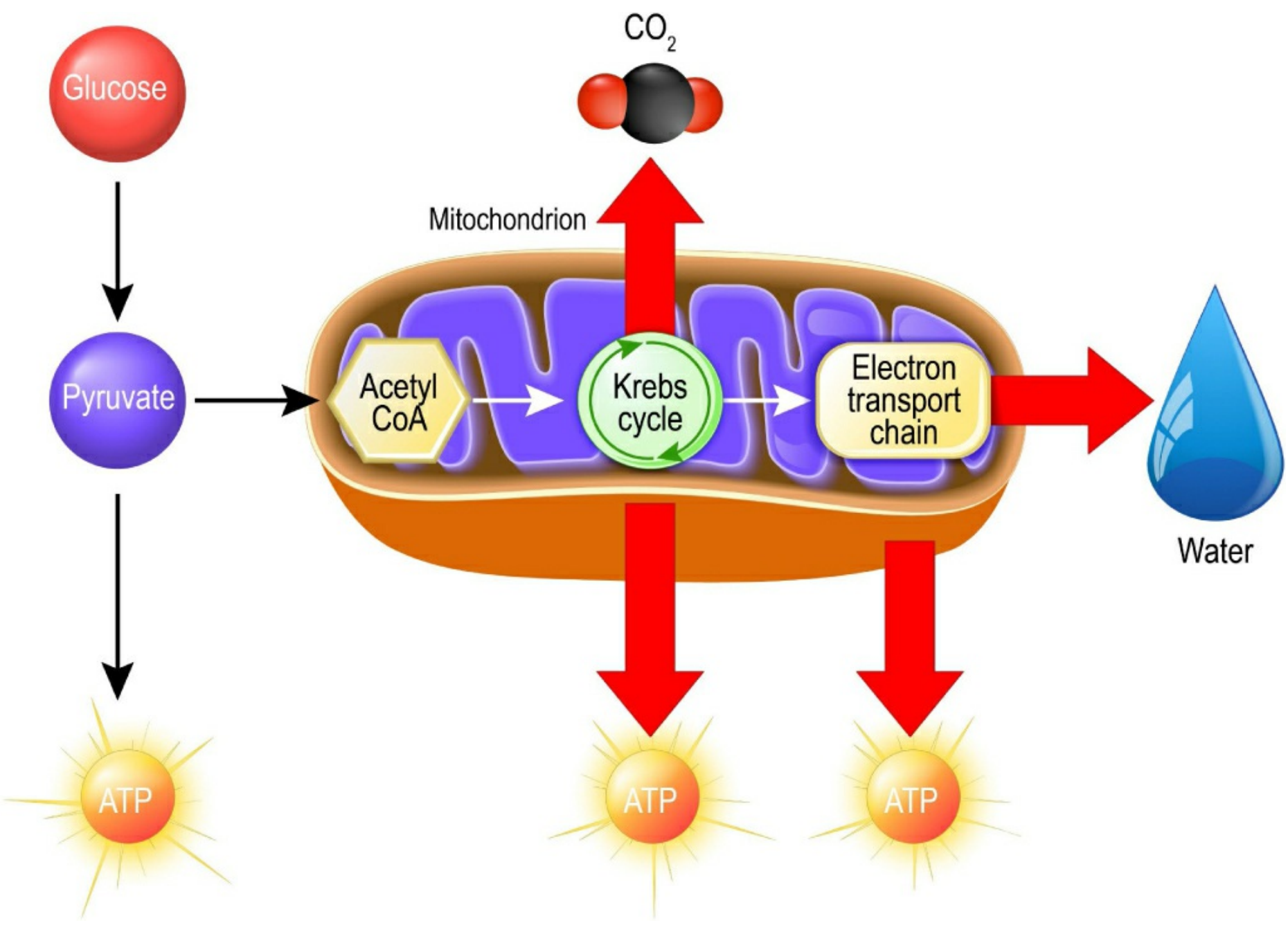


LACTATE SYSTEM ACTIVITIES

- 400-metre run.
- 100-metre swim.
- 200-metre swim.
- Hurdles.
- Field/pitch, court, and combat sports involve bursts of anaerobic work.

AEROBIC SYSTEM

- Aerobic.
- Breakdown of carbohydrate and fat in the presence of oxygen.
- ATP breakdown takes place in the mitochondria.
- By-products are carbon dioxide and water.
- Long duration.
- Low to moderate intensity (generally up to 60% max. effort).
- Increasing cardiorespiratory fitness will improve the delivery of O2 to the working muscles, allowing t system to produce ATP at higher intensities.

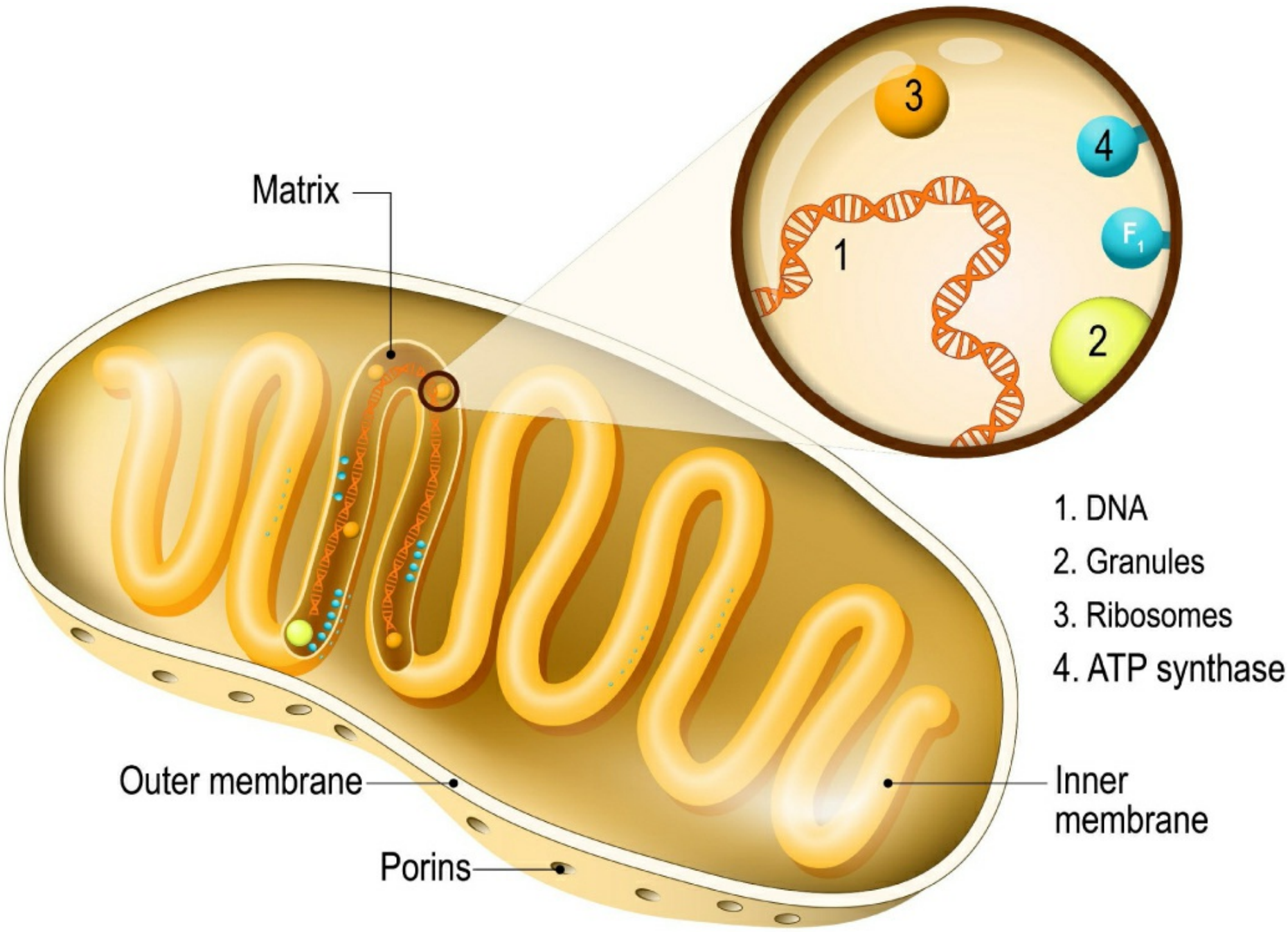


AEROBIC SYSTEM ACTIVIES

- Long-distance running (5km, 10km, marathon, etc).
- Long-distance swimming.
- Long-distance cycling.
- Triathlon.
- Cross-country skiing.

MITOCHONDRIA

- Known as the ‘powerhouse’ of the cell.
- Location of aerobic energy production (anaerobic energy production occurs outside the cell).
- The more mitochondria there are, and the larger they are, the more potential there is for energy production
- Training can enhance mitochondrial density and therefore improve exercise performance.



DIGESTIVE SYSTEM

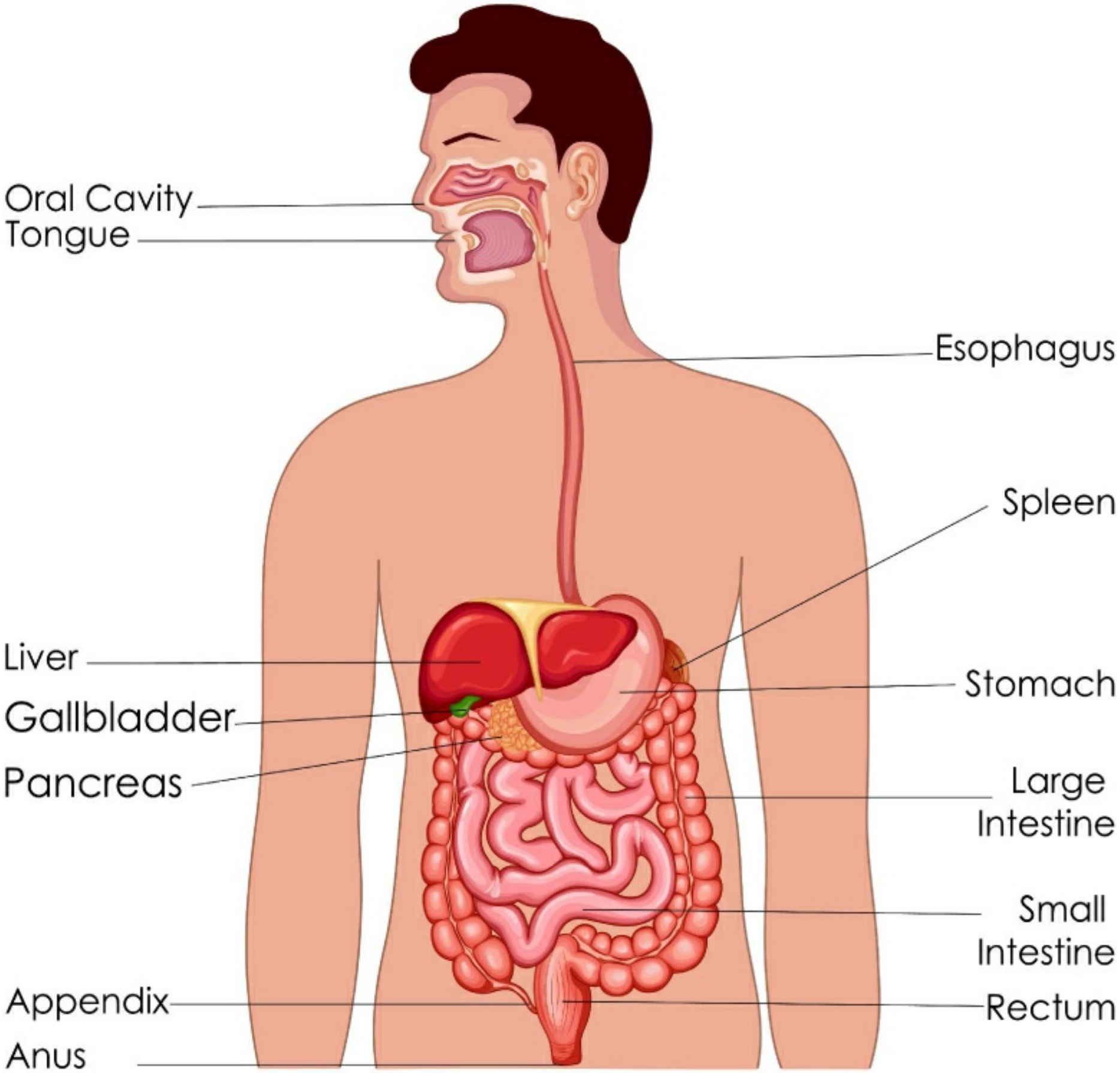
Gastrointestinal (GI) Tract (Alimentary canal) includes:

(The route taken by food from the mouth to the anus)

Mouth – Pharynx – Esophagus – Stomach – Small intestine – Large intestine – Rectum and anus.

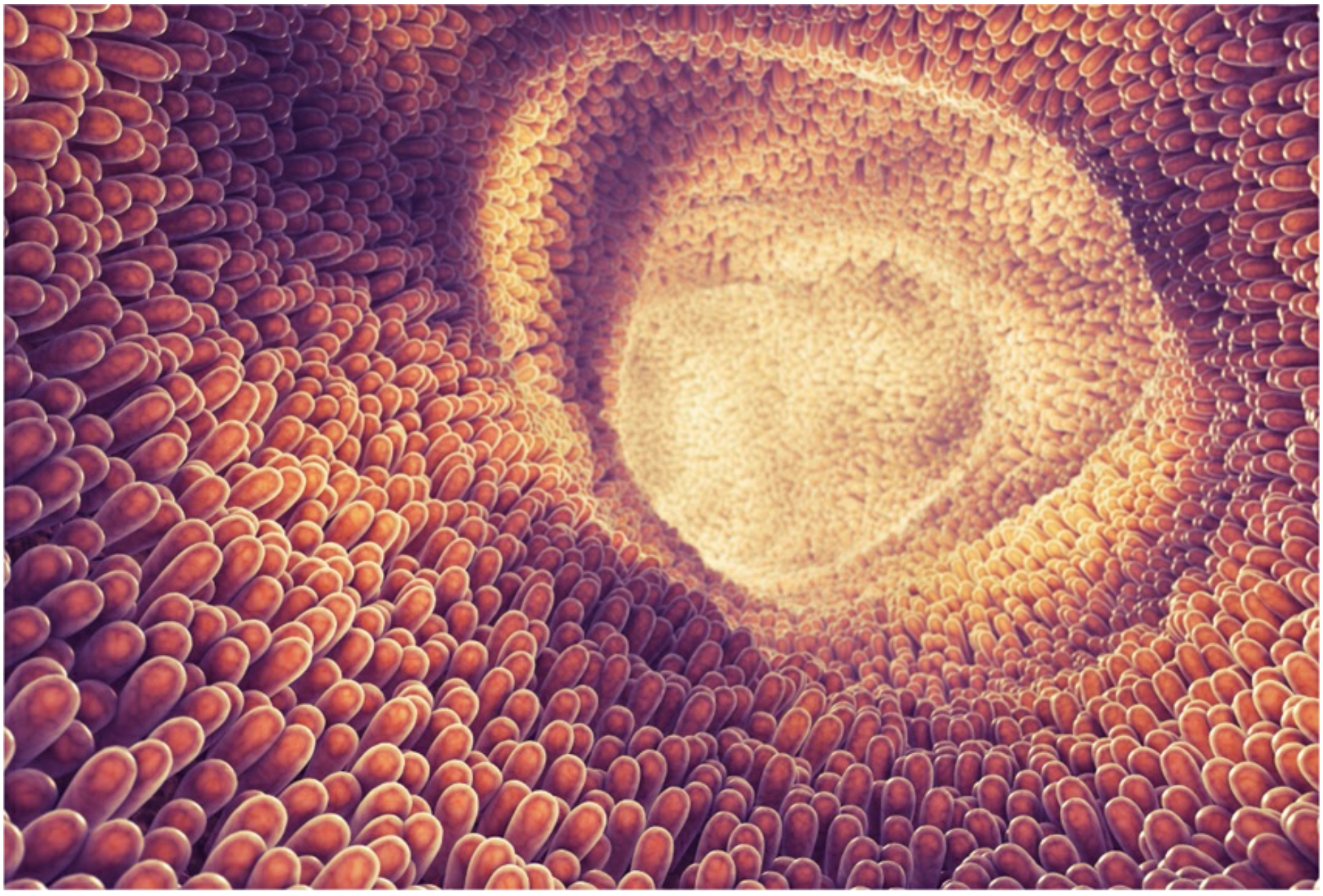
Organs that aid digestion:

Teeth / Tongue / Salivary glands / Liver / Pancreas / Gall bladder and bile ducts.



FUNCTIONS

Function	Explanation
Ingestion	Food enters the body through the mouth and is broken down through mastication (chewing).
Digestion	Food is broken down through the action of smooth muscle tissue and digestive enzymes.
Absorption	Food is passed into the blood stream on its way to the body's tissues that need it for energy.
Elimination	Any waste is removed.



FUNCTIONS OF EACH STRUCTURE

Mouth:

- The entry point of food and where it begins to be broken down through the process of mastication (chewi seconds) into a ball, or bolus. Salivary glands produce saliva which moistens the food and helps to protec against decay.
- Salivary amylase – a digestive enzyme in saliva that begins to breakdown carbohydrates.

Esophagus (Gullet):

- Carries broken down food from the mouth to the stomach.

Stomach:

- The stomach produces gastric juices containing hydrochloric acid and pepsin.
- Hydrochloric acid kills bacteria.
- Pepsin is an enzyme that breaks down protein.

Small Intestine:

- Receives food from the stomach and absorbs important nutrients into the bloodstream to be passed to t tissues and used for energy.
- Is approximately 7m long.
- Is made up of three parts:

➢ Duodenum.

➢ Jejunum.

➢ Ileum.

The small intestine is where most digestion and absorption occurs – contains villi and microvilli (tiny finger-like projections that increase surface area for absorption).

Large Intestine:

- Absorbs water and vitamins from food residue, and forms and stores feces ready for excretion.

Liver:

- Bile secretion, vital for the breakdown of fats in the small intestine – enable fats to mix with water (emuls
- Removal of nutrients from the blood and conversion for storage.
- Detoxifying harmful substances in the blood.
- Storage of vitamins and minerals.
- Removal of bacteria from the bloodstream.

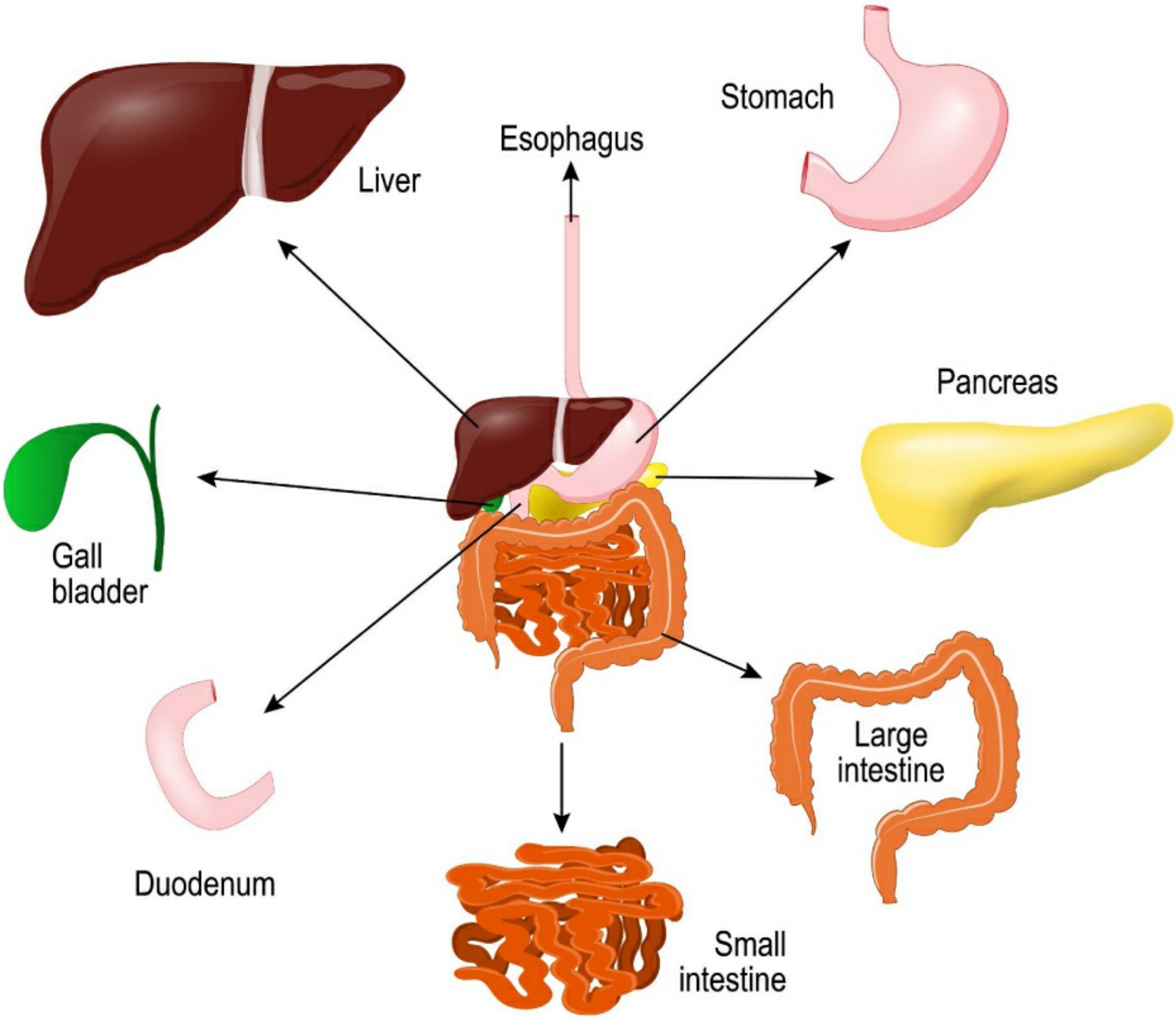
Gall Bladder:

- Store's bile to be released into the small intestine.

Pancreas:

- Secreting digestive juices into the small intestine, which contain enzymes, in order to break down nutrient

- Lipase breaks down fats.
- Amylase breaks down carbohydrates.
- Trypsin breaks down proteins.



EXERCISE AND THE DIGESTIVE SYSTEM

Physical activity has been shown to have benefits on the digestive system:

- Improves peristalsis and the motility of the GI tract – peristalsis the involuntary constriction and relaxat muscles of the intestine or another canal, creating wave-like movements that push the contents of the cana
- Increases insulin sensitivity and aids blood sugar management.
- Reduces the risk of gastrointestinal cancers.

THE COMPONENT OF FITNESS

Now we have gained a good understanding of human anatomy and physiology, it is time to look at how we develop many of the structures and systems that we have looked at.

To optimize our health and performance, we first need to understand:

- **The Components of Total Fitness.**
- **The Components of Physical Fitness.**
- **The Training Principles.**
- **The Training Variables.**

COMPONENTS OF TOTAL FITNESS

Component	Description
Physical Fitness	The well-being of the body's systems, including the heart, lungs, muscles, bones and joints. It covers health-related and skill-related components.
Mental and Emotional Fitness	The well-being of the mind; a positive mental state and harmony between the mind and emotions. It includes a person's ability to manage stress.
Medical Fitness	Being free from injury, chronic disease and illness.
Nutritional Fitness	Having access to healthy food; eating a healthy diet with a balanced nutritional intake for fuel, growth and repair.
Social Fitness	Having healthy interactions and relationships with others.

FACTORS THAT AFFECT HEALTH

Non-Controlled Factors	Controlled Factors (Lifestyle Behaviours)
Genetics	Activity Levels
Age	Diet
Gender	Alcohol
	Smoking
	Drug Use

COMPONENTS OF PHYSICAL FITNESS

Health-Related Components	Skill-Related Components
Muscular Strength The ability of a muscle or group of muscles to exert maximal force.	**Agility** The ability to move, change direction and body position quickly and efficiently while maintaining control.
Muscular Endurance The ability of a muscle or group of muscles to sustain repeated contractions.	**Balance (Static & Dynamic)** Static balance is the ability to maintain equilibrium when stationary. Dynamic balance is the ability to maintain equilibrium when moving. (Equilibrium – a state in which opposing forces are balanced).
Cardio-Respiratory Endurance The ability of the heart, lungs and blood vessels to deliver oxygen to the tissues.	**Coordination** The ability to move two or more body parts under control, smoothly and efficiently.
Mobility / Flexibility Flexibility is the passive length a muscle can achieve. Mobility is the range of motion a joint can achieve (includes flexibility).	**Speed** The ability to move quickly across the ground or move limbs rapidly.
Body Composition The percentage of muscle, fat, bone and water in the human body.	**Power** The ability to exert high force in minimal time.
	Reaction Time / Quickness The ability to respond quickly to a stimulus.

SOMATOTYPES

Body composition (the ratio of muscle, fat, water and bone in the body) is directly linked to both health and performance – athletes may benefit from a weight cut (boxer), or increased bodyweight (rugby forward).

For the most part, individuals will look to strip fat and build lean muscle, and we can change our body composition drastically with the right diet and appropriate daily activity and training regime. However, we should understand that humans are built differently, and we can identify 3 body types.

ECTOMORPH

MESOMORPH

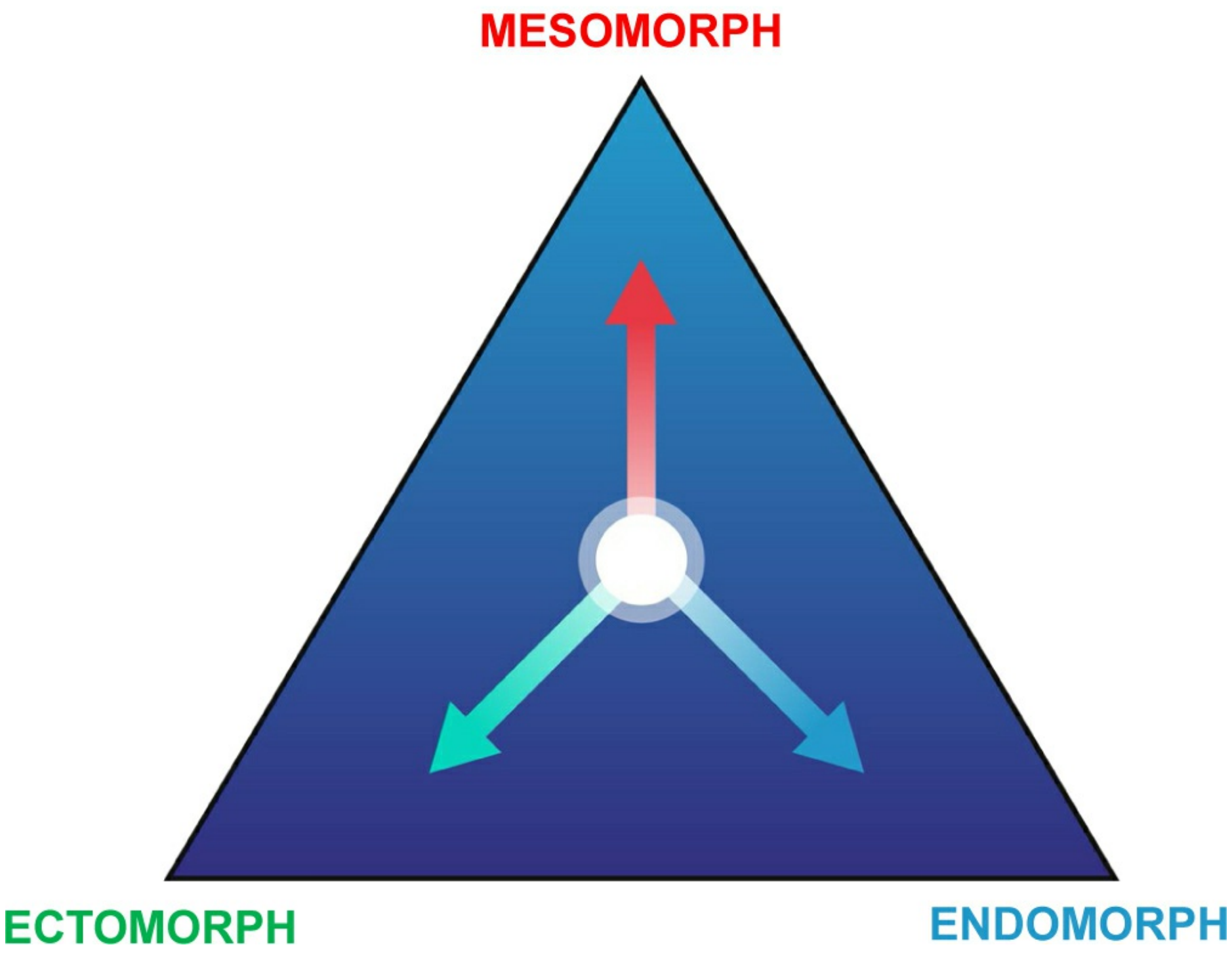
ENDOMORPH

Ectomorph	Mesomorph	Endomorph
• Tall and thin. • Low body fat. • Low muscle tissue. • Find it difficult to gain weight. • Typical distance-runner physique.	• Lean and muscular. • Low body fat. • Naturally athletic. • Typical sprinter physique.	• Apple or pear-shaped. • High body fat. • Low muscle tissue. • Typical shot-putter physique.

Rather than considering yourself as one of the three, it is better to imagine a triangle with each somatotype at one of the three points.

Rather than you being directly at the point, you are somewhere within the triangle.

Where do you sit within the triangle?



THE TRAINING PRINCIPLES

The table below shows the training principles that underpin all physical development.

Training Principle	Description
Individuality	Everyone responds to training differently. Some need more volume while others need more intensity.
Specificity	Any changes or adaptations the body makes will be specific to the stress or stimuli it is exposed to. This is often described as the SAID principle (Specific Adaptation to Imposed Demands).
Adaptability	Over time the body becomes accustomed to the stress or stimuli it is exposed to and therefore, improves in a number of ways (specific to the stress). This is a good thing. However, we must also consider the law of accommodation which states that our response to a constant stress will decrease overtime. Therefore, we need to ensure our training is progressive and doesn't plateau (cease improving).
Overload	In order to elicit adaptations, the body must be put under additional stress (overloaded).
Progression	The additional stress which we put on our bodies to elicit adaptations needs to be progressive and gradually increase over time.
Recovery	The body needs time to repair. We need to overreach where possible to elicit the most results, but if we overreach too far and too often, we will overtrain which can result in injuries and illness etc.
Reversibility	If stressors are taken away or if sufficient recovery isn't allowed, then performance levels can be lost.

PROGRESSIVE OVERLOAD

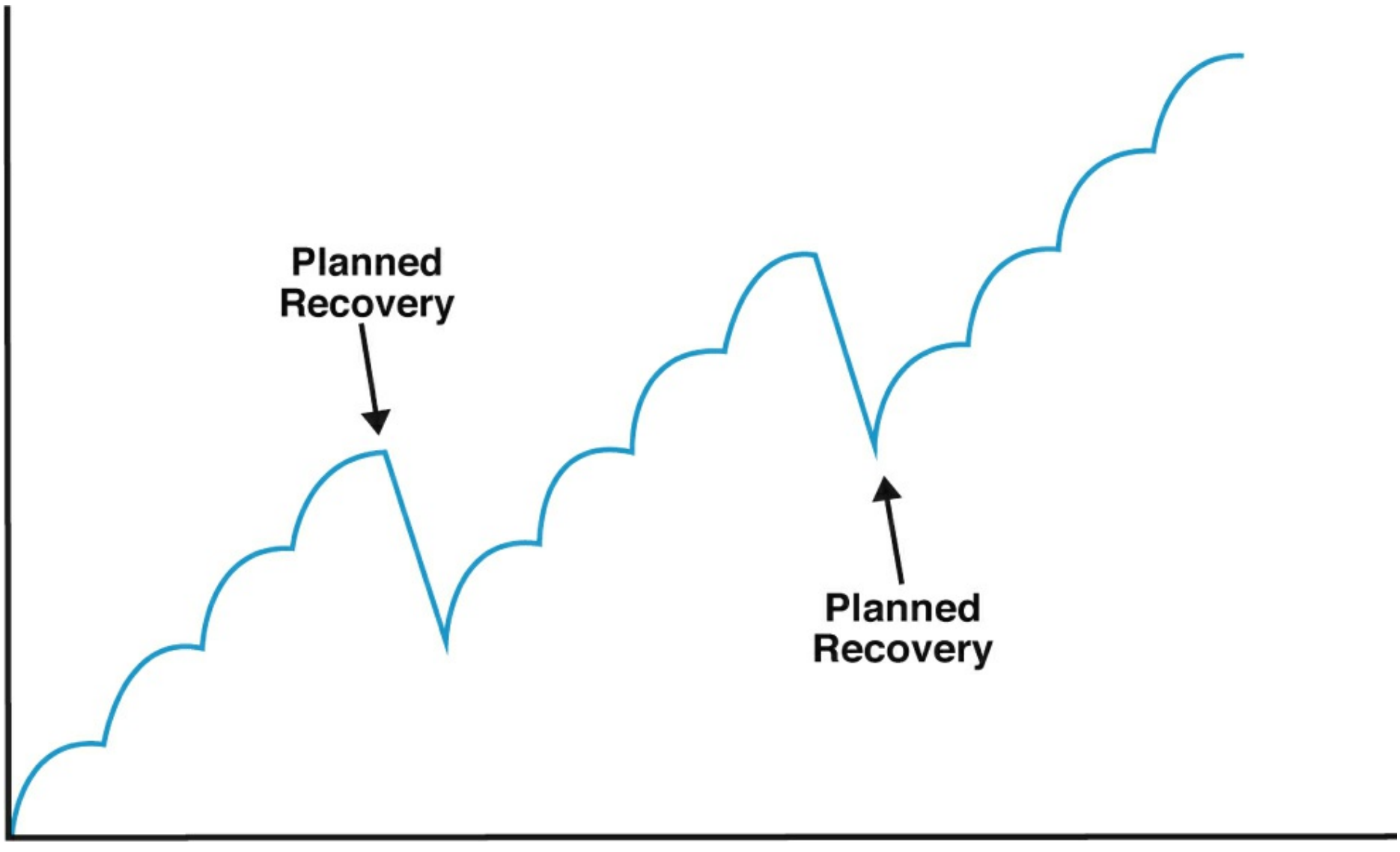
The training principles overload and progression are combined to create the principle of Progressive Overload.

Progressive overload simply means that training needs to get progressively harder.

We want to adapt and find things easier, but we also want to keep pushing forward without injury. Therefore, we overload the body with stress to invoke adaptations, but we do this progressively (little by little) to ensure we don't sustain injuries.

Programming 101: Ensure there is Progressive Overload.

When it comes to strength training, we aim to progressively overload fundamental movements such as squat, push and pull with various exercise variations.



TRAINING VARIABLES

The acronym FITT (Frequency, Intensity, Time, Type) is a useful acronym to describe the training variables. However, these can be broken down further and ordered in a way that will systematically build a program.

The primary variables that are adjusted during programming are Intensity (how hard) and Volume (how much).

Training Variable	Description
Frequency	How often? i.e. How many training sessions can be carried out each day, each week, each month etc.
Exercise Type	What mode of training are these sessions going to include? i.e., Strength Training, Metabolic Conditioning, Speed & Agility.
Exercise Selection	What specific exercises will be used? i.e. Back Squat, Rower, Track.
Complexity	What is the complexity of the exercise? i.e., Olympic Weightlifting
Exercise Order	What order will the exercises be performed in? (Consider fatigue sensitivity).
Intensity	To what intensity are the exercises performed at? i.e., 90% of 1RM / Heart Rate Zone 4 / RPE 8.
Volume	How many sets and reps / how long (duration)?
Density	How long are the rest periods? i.e., Volume + Rest Periods = Training Density: 5x5 at 80kg done in 20-Minutes, is less density than 5x5 at 80kg in 15-Minutes.

INJURIES

Injuries (physical trauma) are damage to your body.

Major trauma is described as injuries that are likely to cause prolongued disability or death.

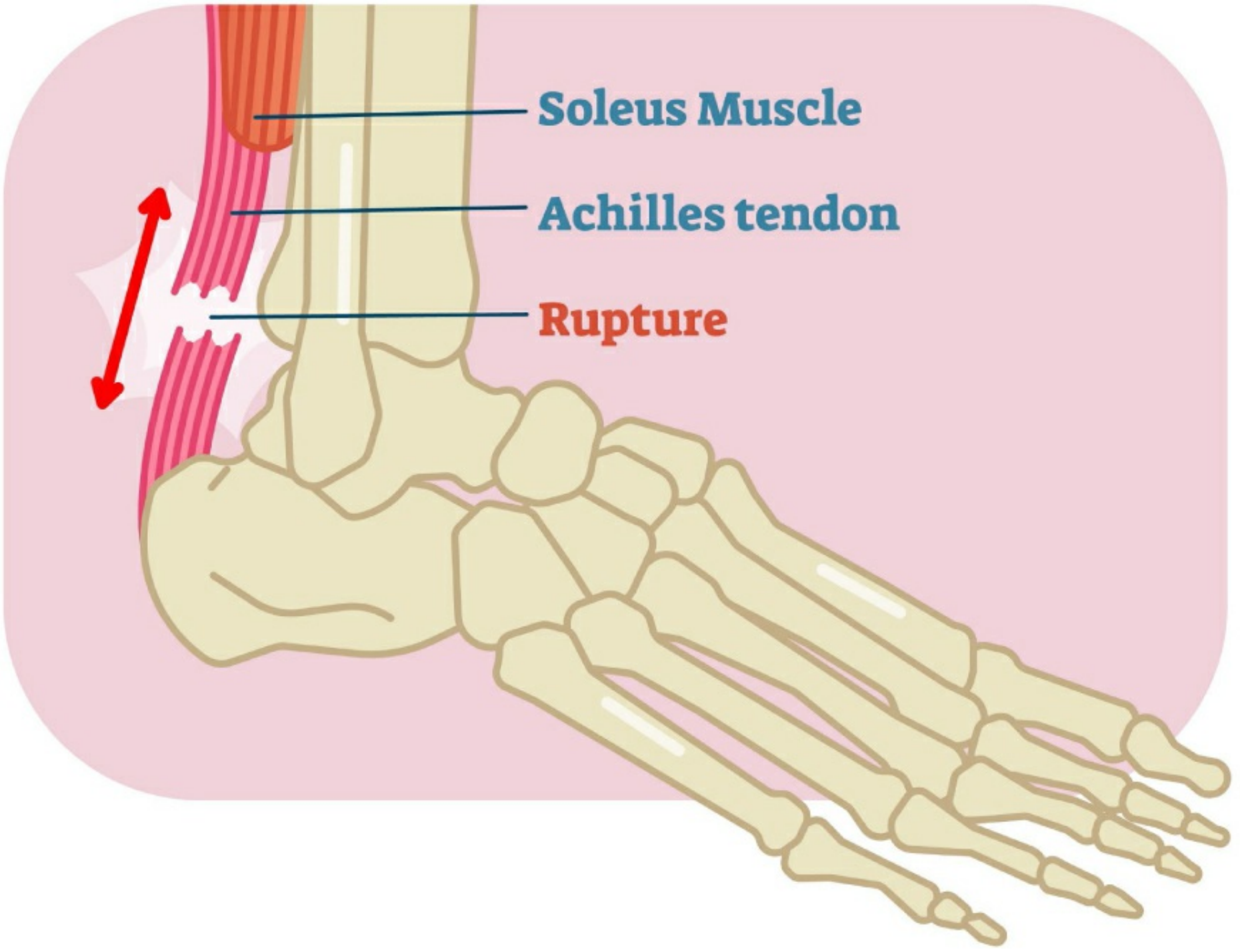
Areas that are often considered when it comes to injury are:

- Part of the body injured.
- Place of occurrence.
- Activity when injured.
- Mechanism of injury.

INTRINSIC INJURIES

Caused by forces within the body, for example:

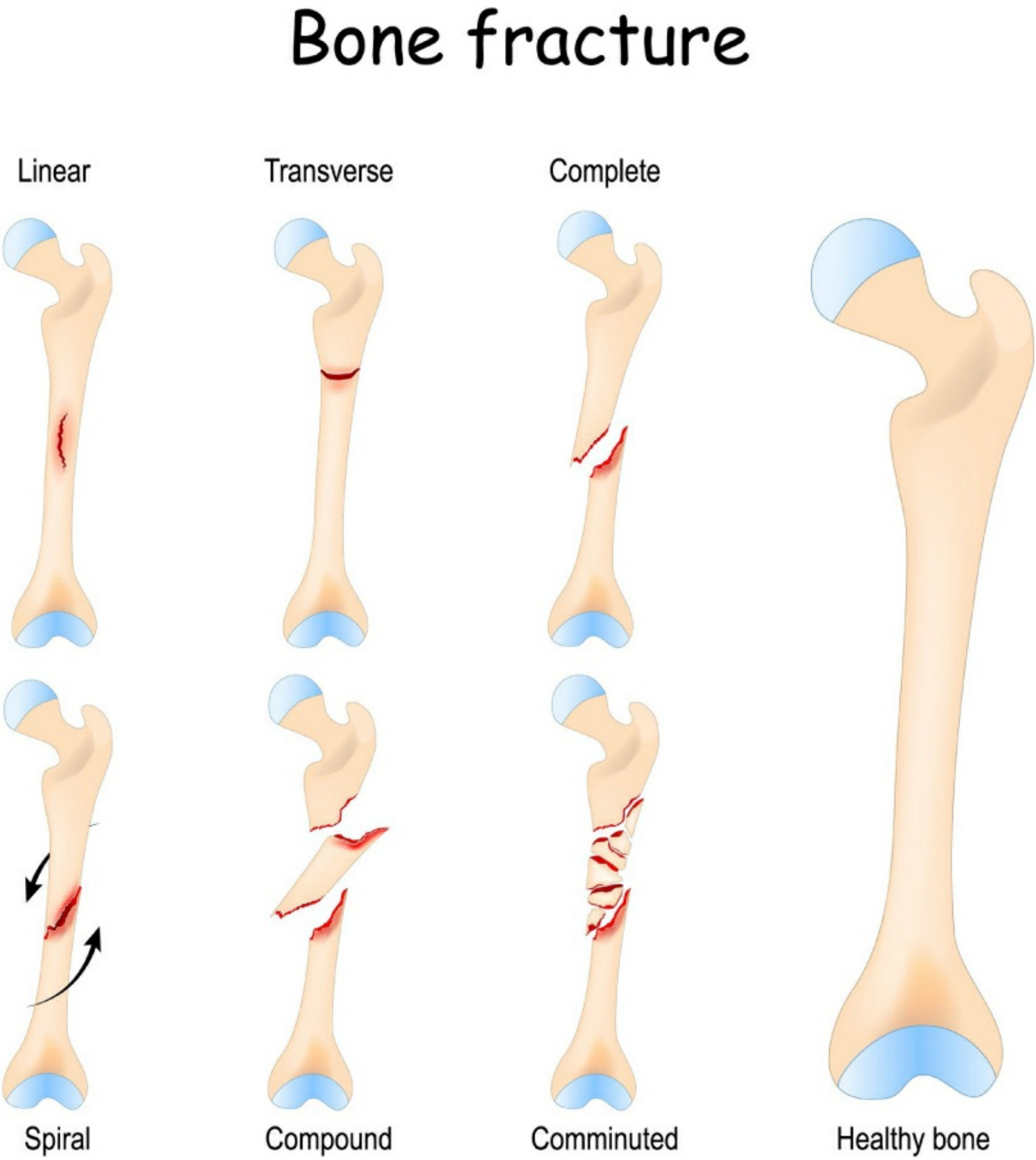
- Weak muscles.
- Tense muscles.
- Muscular imbalances.
- Dysfunctional movement patterns/poor form.
- Excessive internal force.
- General overuse.



EXTRINSIC INJURIES

Caused by forces/impacts outside the body, for example:

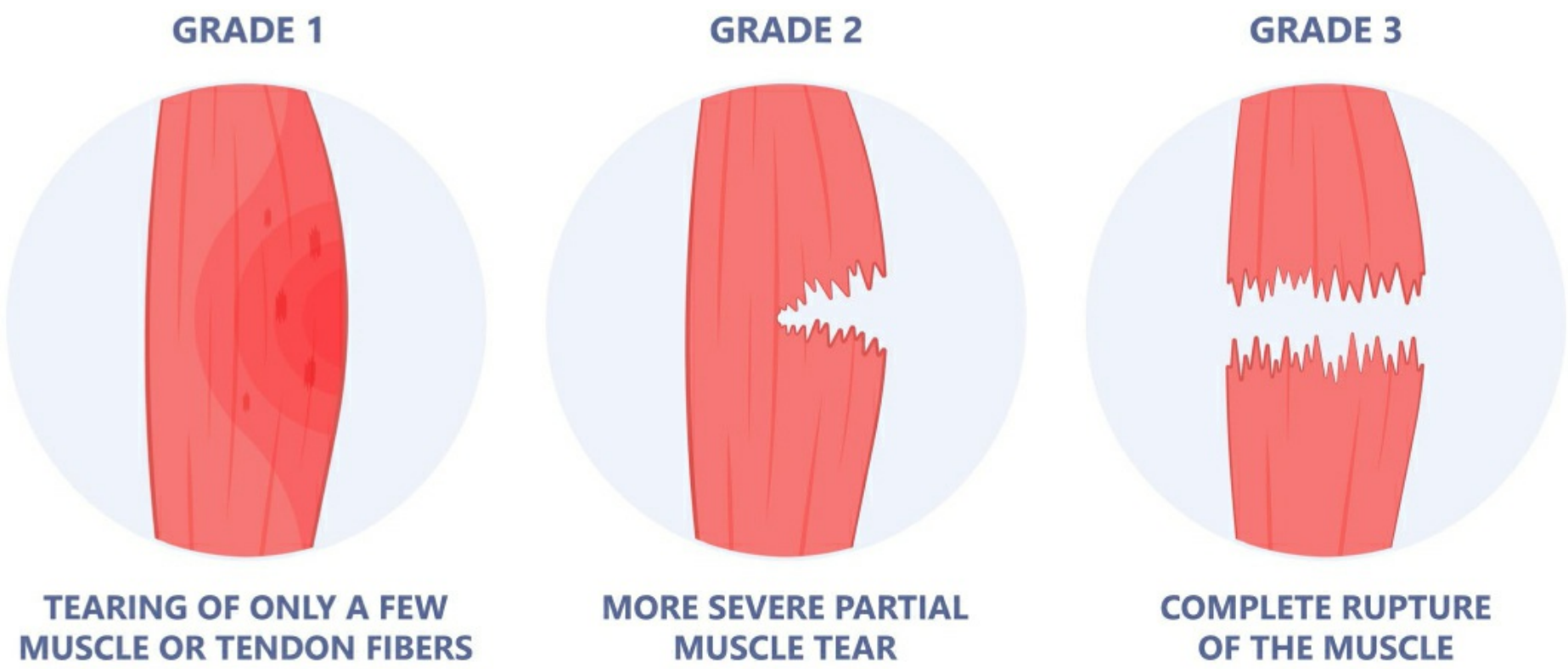
- Human: Clash of heads during a rugby match, a blow in boxing.
- Implemental: Dropping equipment on the foot.
- Vehicular: Being involved in a car accident.
- Environmental: Slipping on an icy road surface when running.



SOFT TISSUE INJURIES

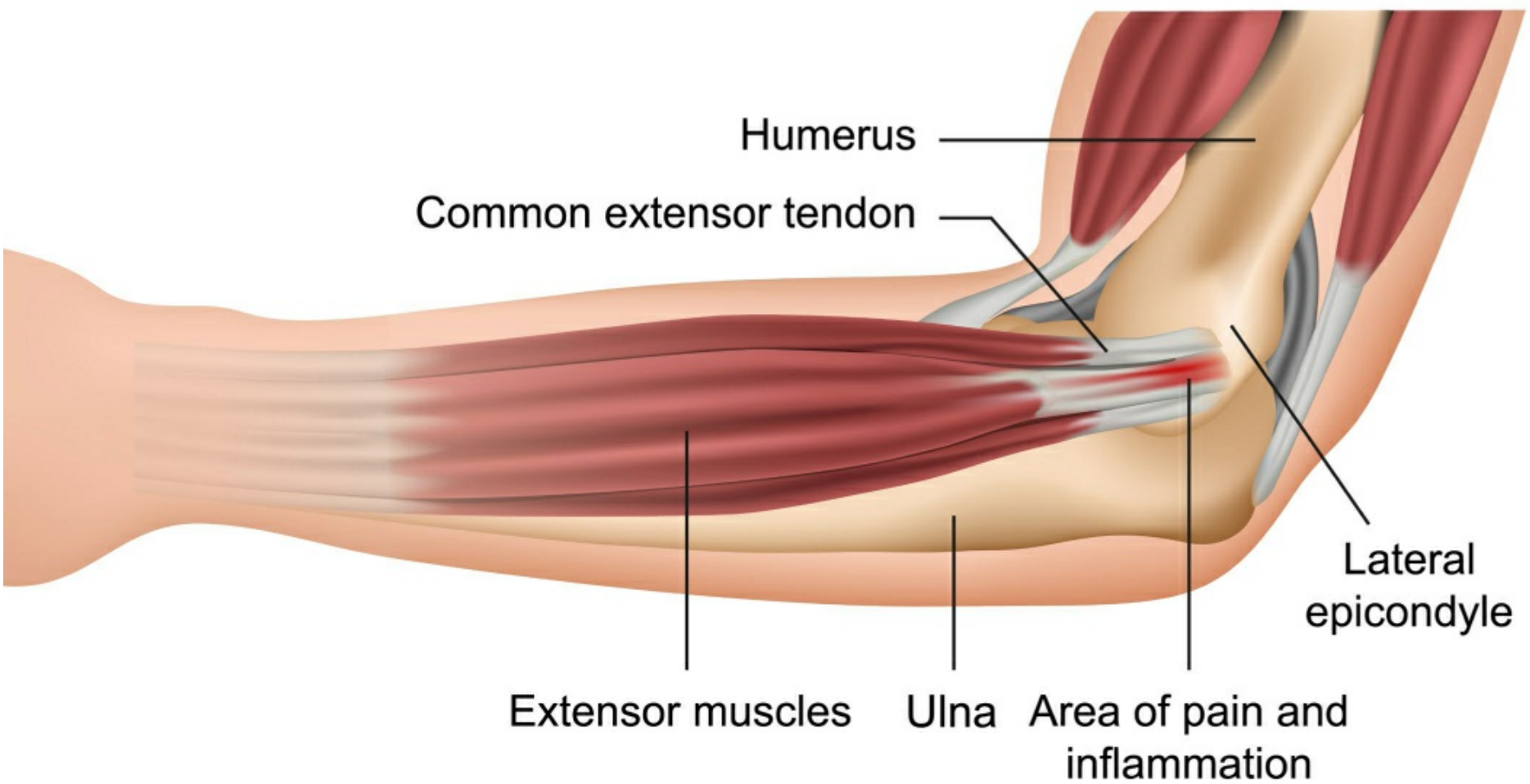
Muscle and tendon strains and ligament sprains:

	Muscle and tendon strains	Ligament sprains
Common causes	• Explosive or uncontrolled movements that are a challenge to stabilize.	• Unnatural joint movements or impacts causing overstretching of the ligament(s)
Common injuries	• Hamstrings, quadriceps, groin and calf strains. • Achilles' tendon tendinopathies. • Rotator Cuff strains.	• Inversion or eversion sprains. • Medial or lateral collateral ligament sprains. • Anterior or posterior cruciate ligament sprains.
Severity	Grade 1 (<5%), 2 (5-95%), 3 (>95%)	Grade 1 (<5%), 2 (5-95%), 3 (>95%)



OTHER COMMON INJURIES

Common injuries	Common causes
Tendinopathies including: • Golfer's elbow (medial epicondylitis). • Tennis elbow (lateral epicondylitis). • Runner's knee (iliotibial band (ITB) syndrome). • Patella tendinopathy.	• Repetitive overuse.
Frozen shoulder (shoulder impingement or adhesive capsulitis).	• Usually develop over a period of time following repetitive movements which reduce the space between bones of the shoulder joint
Low back pain (lumbago, disc herniation, sciatica).	• Back muscle strains, disc issues – often multifaceted.
Plantar fasciitis.	• Poor/worn-out footwear. • Overweight. • Repetitive overuse.



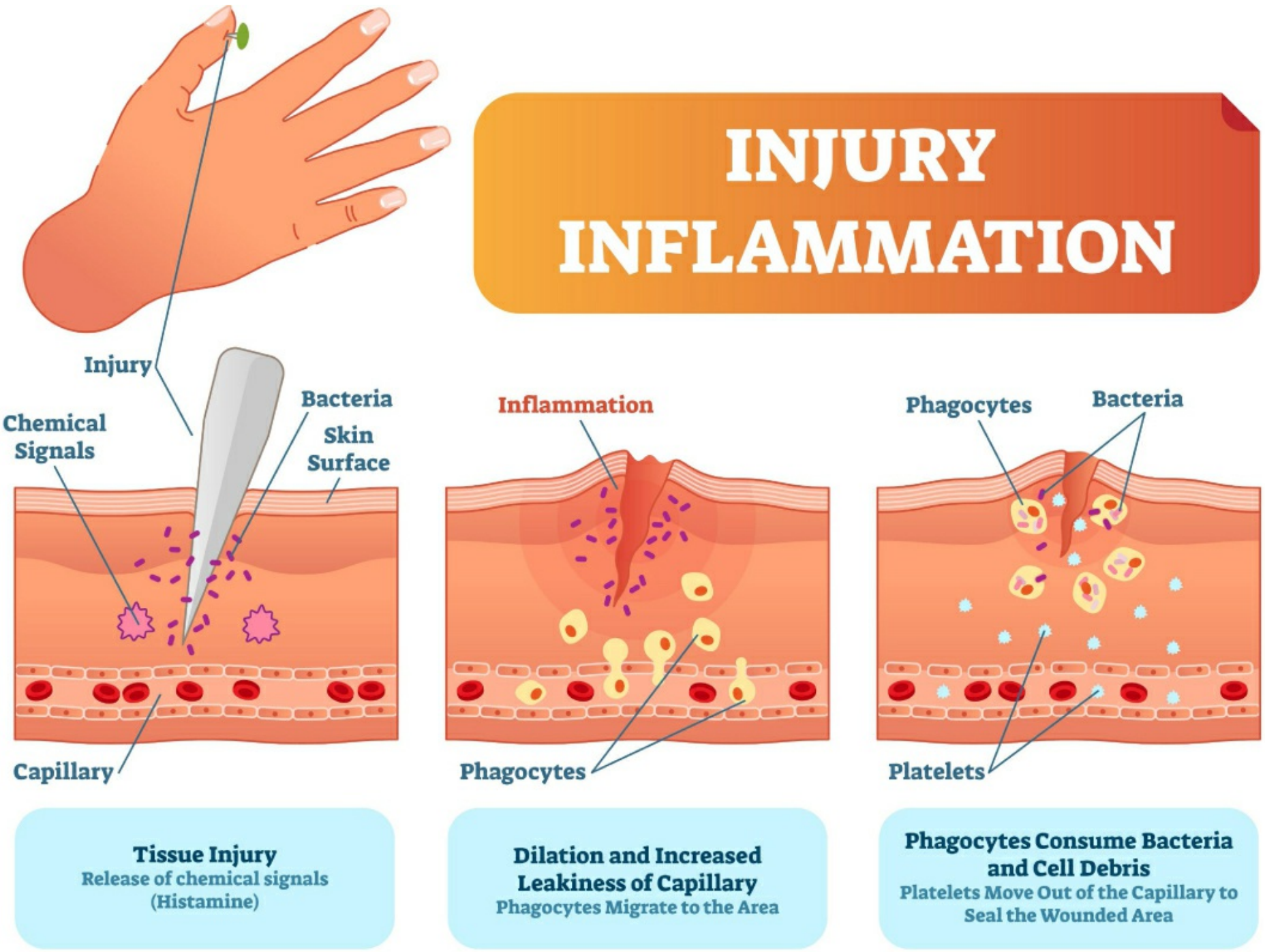
INFLAMMATION

Inflammation refers to your body's process of fighting against things that harm it, such as injuries and infections.

When something damages your cells, your body releases chemicals that trigger a response from your immune system.

It is key to understand that inflammation is a key component of recovery and should not be seen as a negative response as it often is.

However, inflammation may be excessive, and this is where medical intervention is often used.



WORKING AROUND INJURIES

Injuries and niggles are often caused by doing a little too much and overreaching a little too far in a session (a spike in training intensity) or doing a little too much of the same thing causing repetitive strain injuries (a spike in frequency/volume) – **the key is to avoid sudden spikes**.

Many injuries can be avoided by applying the principle of progressive overload – motivated individuals often have to have the discipline NOT to do that extra set. However, it's unrealistic to believe niggles and injuries can be eradicated entirely, especially when the aim is elite performance.

Rule 1 when it comes to injuries: Do not risk making it worse. If you are not qualified to diagnose the issue, refer to a doctor or physical therapist as there might be exercises that are initially contraindicated.

From there, consider the TAB Method explained on the next page.

THE TAB METHOD

The TAB Method is a system developed by Coach Curtis after years of working with athletes and the general public.

The TAB Method:

- **T**ake away aggravators – initially get rid of the things that make the injury feel worse during exercise, l and the next day (if you keep picking a scab, it will never heal).

- **A**dd in exercises that feel good – load the tissues, increase circulation and promote healing – add-in mob to reduce excessive tension.

- **B**uild resilience to the aggravators – injury prevention 101 is **build the strength to accommodate the st** initial healing has taken place, we need to progressively build resilience in the tissues – **Load Tolerance**.

FREE CONTENT

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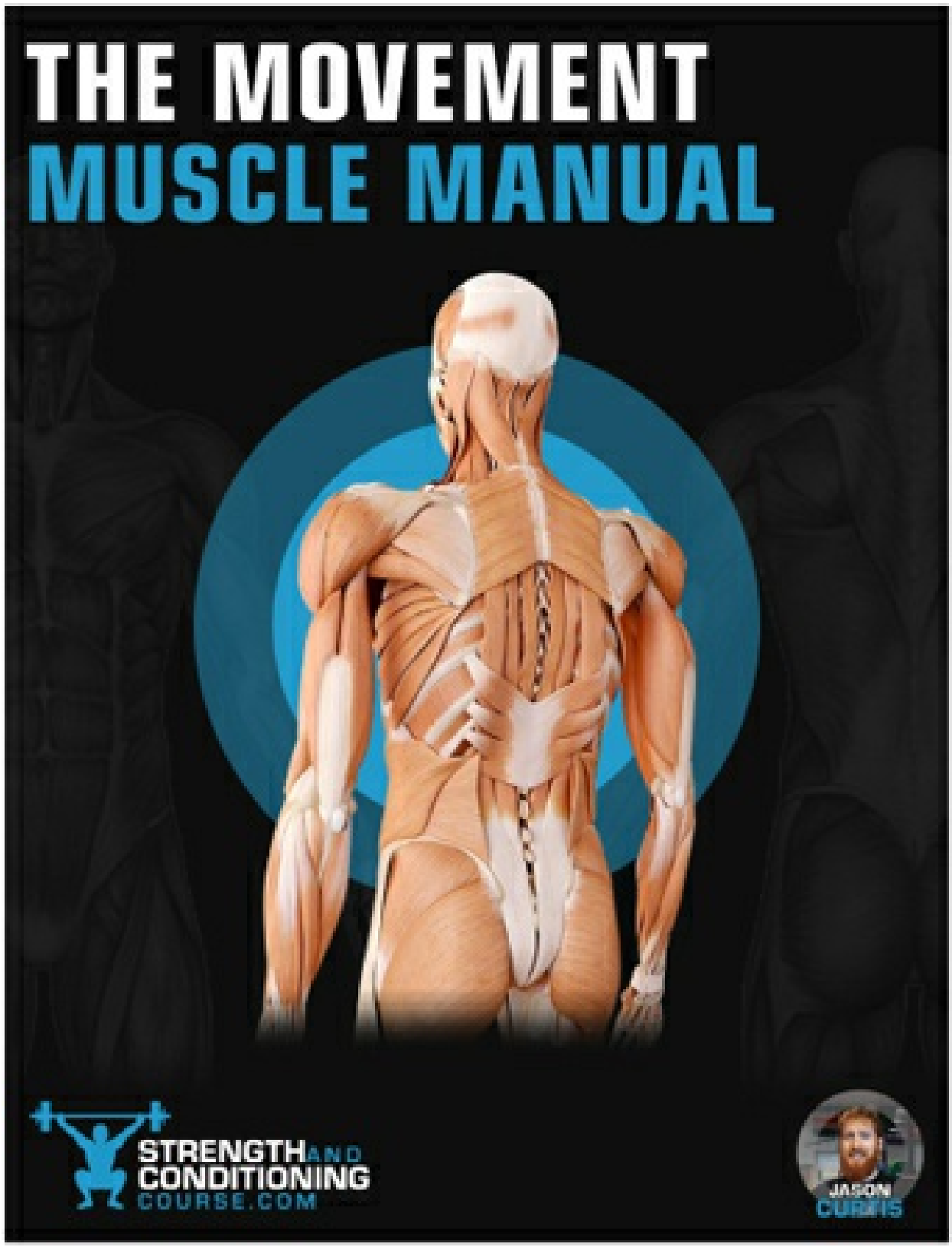
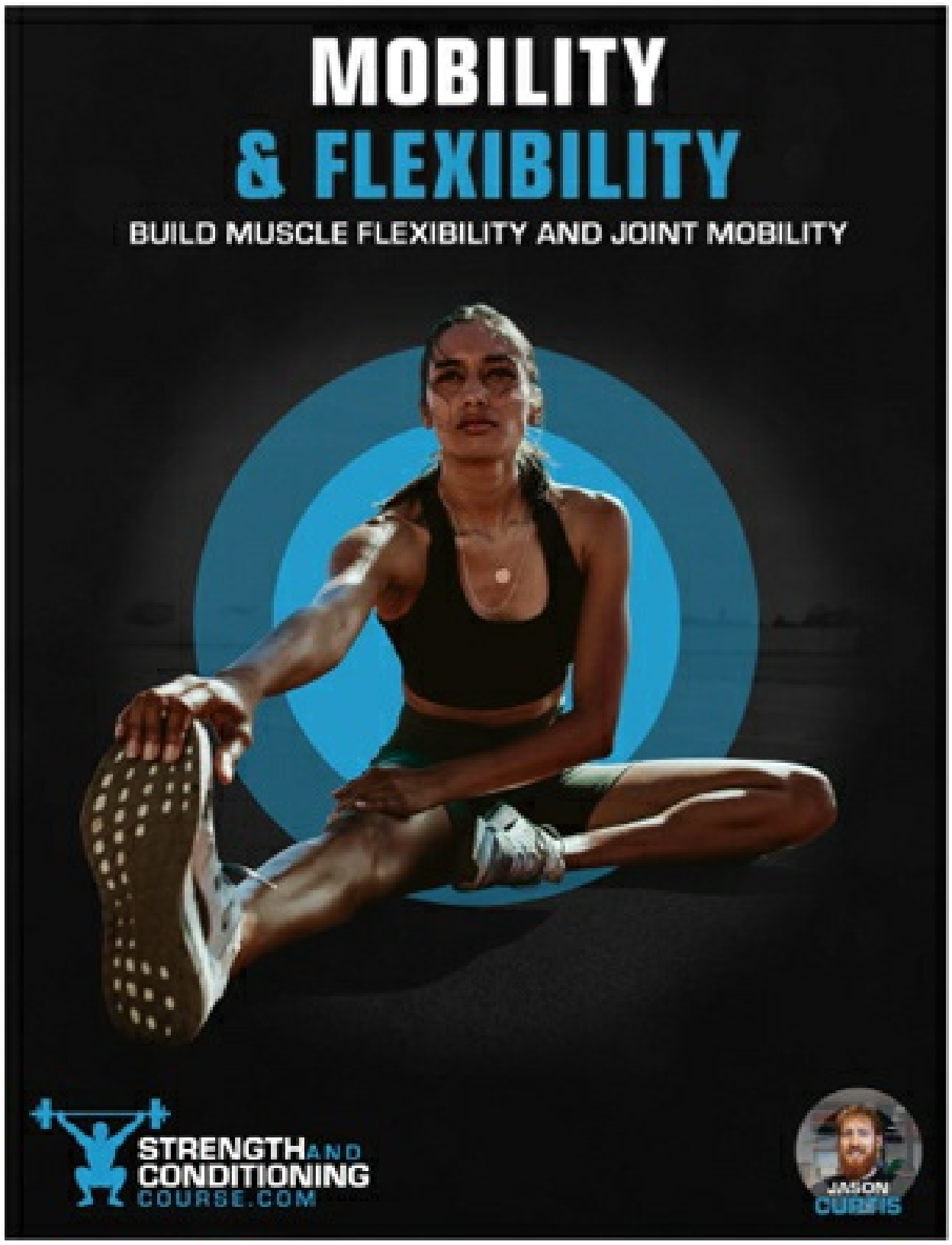


This unique muscle manual categorizes muscles by their movements, giving you a much better understanding of how muscles assist and oppose each other to perform actions.

You also get a FREE second version of the muscle manual, which lists:

- Origin.
- Insertion.
- Action.
- Antagonist.
- Innervation.
- Blood Supply.

- Daily Use.
- Gym Use.



This is a 300+ Page eBook and it is absolutely FREE!

The eBook includes:

- Over 45 Release Techniques – foam rolling, etc.
- Over 100 Stretching Techniques – static, dynamic, ballistic, PNF, band distraction, etc.

This is a must-have eBook for fitness professionals and enthusiasts who want to minimize their risk of injuries, manage previous injuries, and maximize movement and overall performance.

Become a Mobility & Flexibility Specialist (MFS).

OUR COURSES

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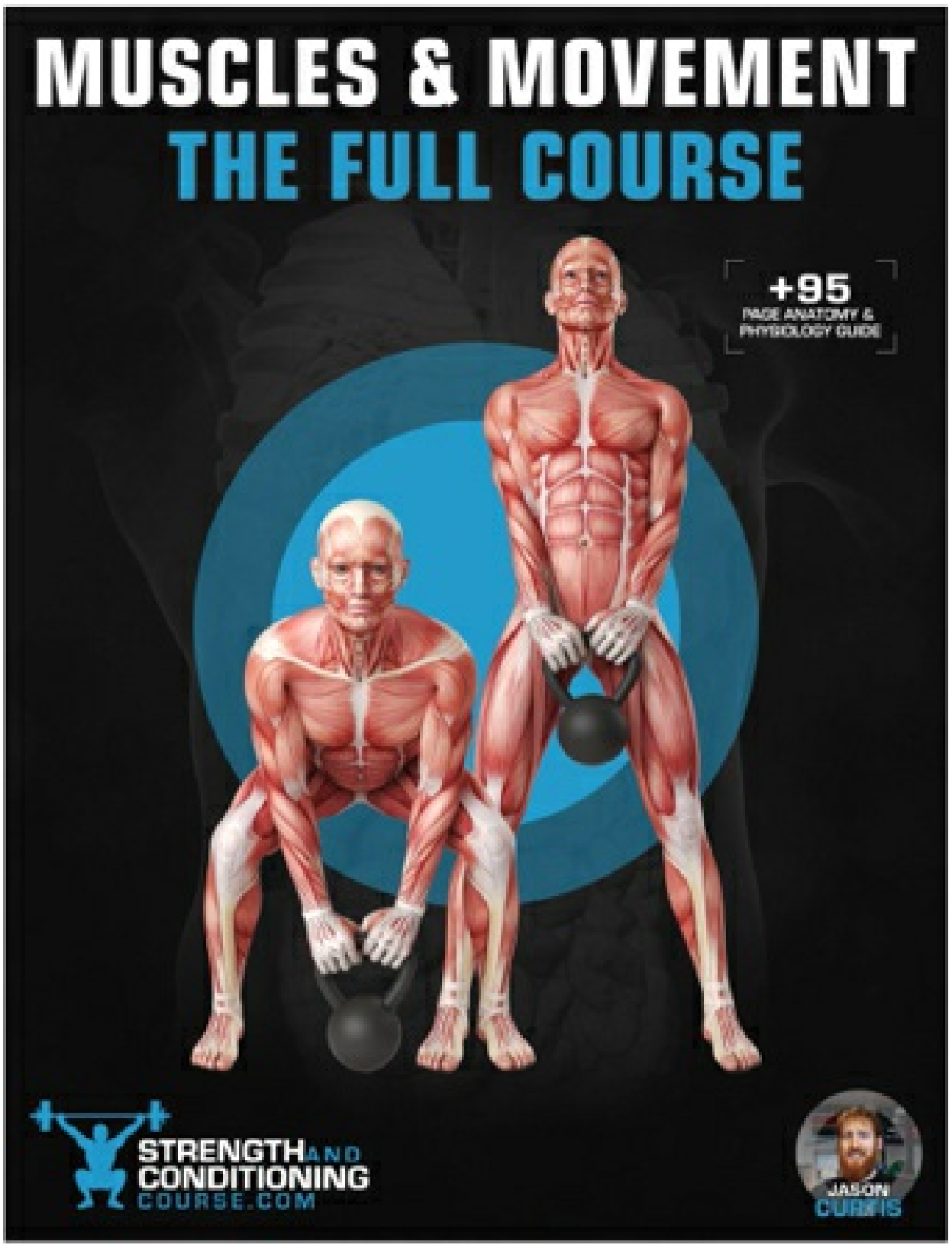
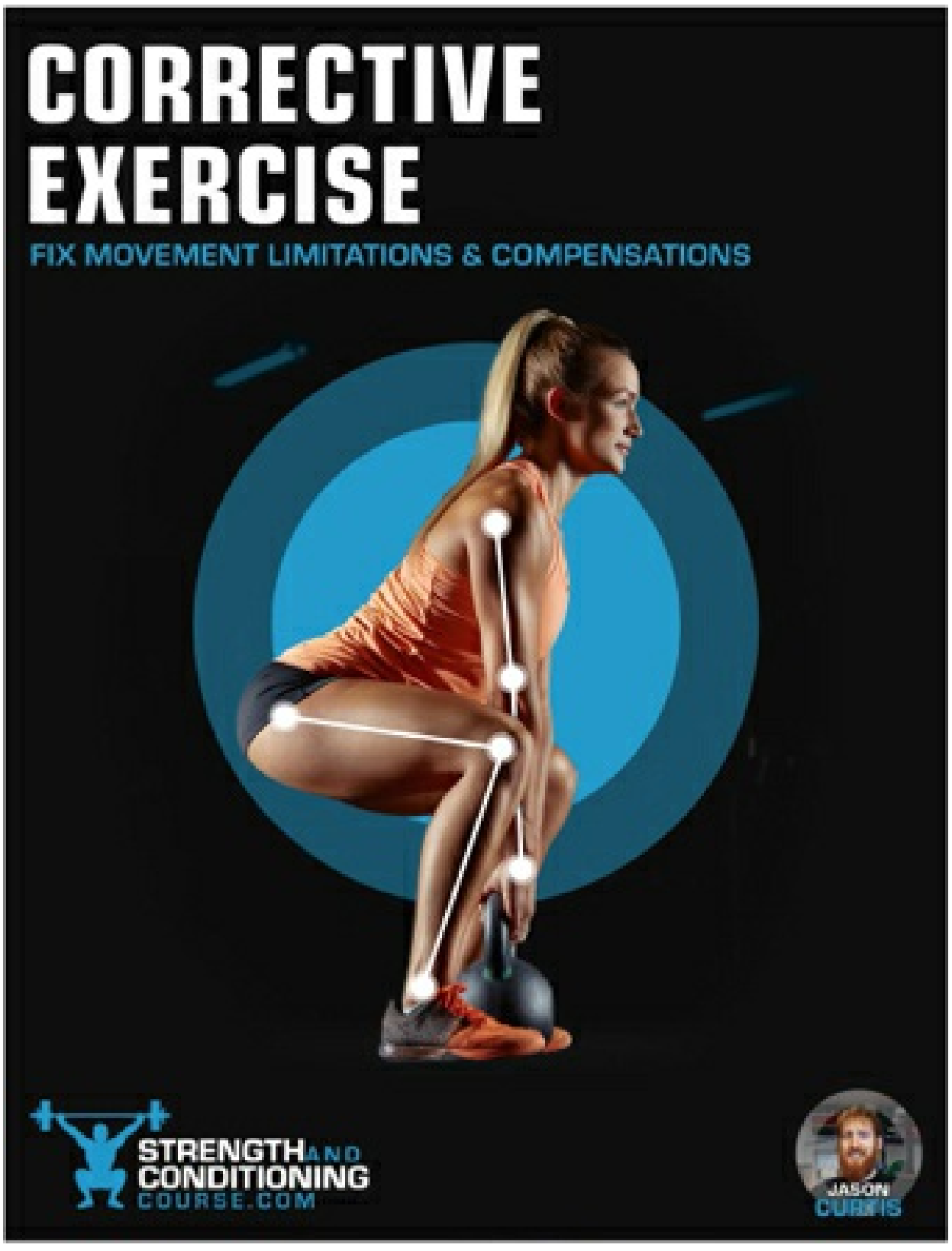


If you want to be an expert, you need an in-depth understanding of functional anatomy - the way muscles facilitate movement and how this relates to training.

In this course, Coach Curtis discusses the intricacies of each slide from his unique muscle manual and has included hours of video tutorials demonstrating how to target each area.

Become a Muscles & Movement Specialist (MMS).



This course is designed for fitness professionals and enthusiasts who want to gain an in-depth understanding of how to fix technique faults and compensation patterns caused by mobility restrictions, muscular imbalances, and asymmetries.

In this course, we look at how to teach fundamental human movements and exercises, and explain how to fix over 30 common faults.

Maximize performance and minimize your risk of injury!

Become a Corrective Exercise Specialist (CES).

OUR COURSES

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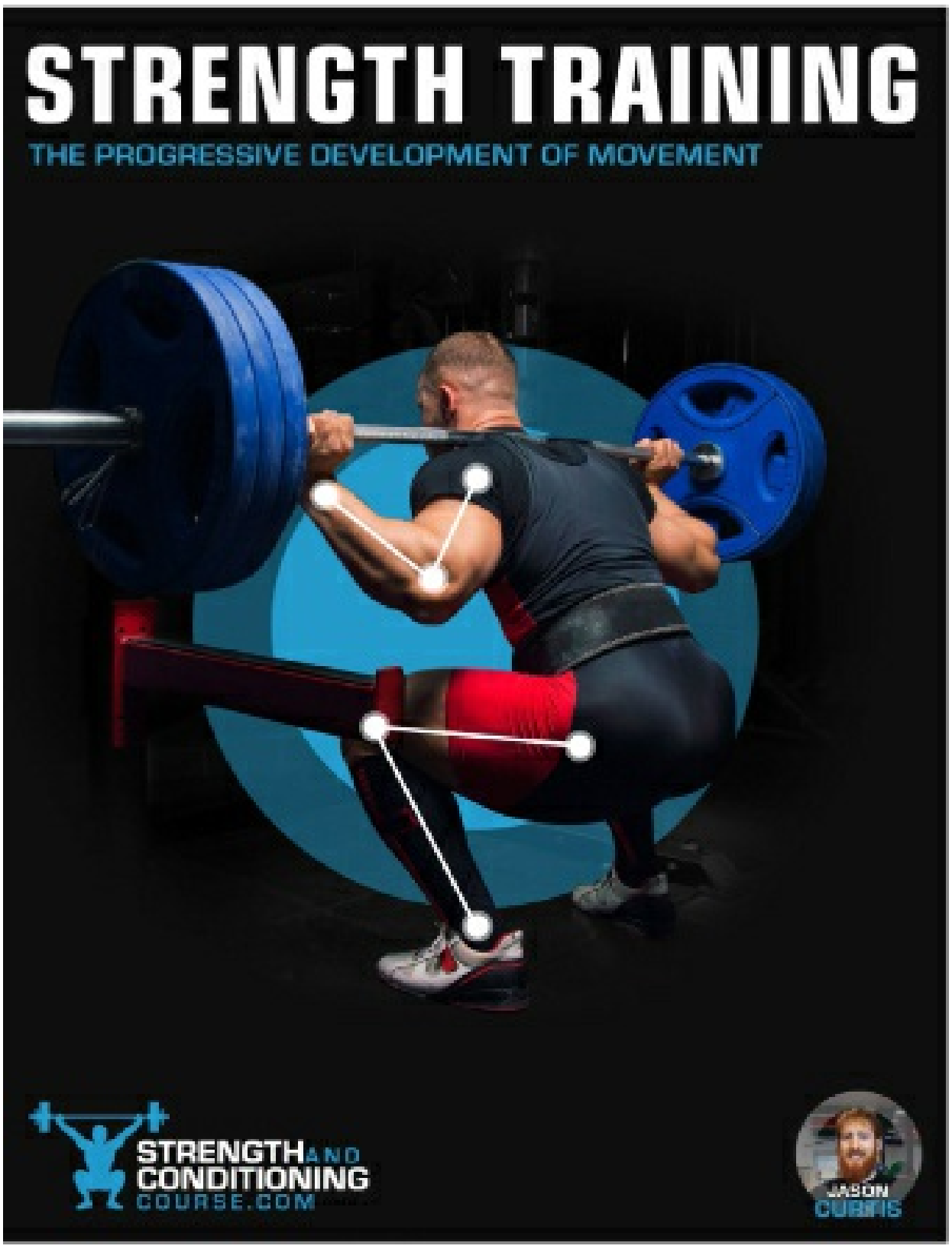
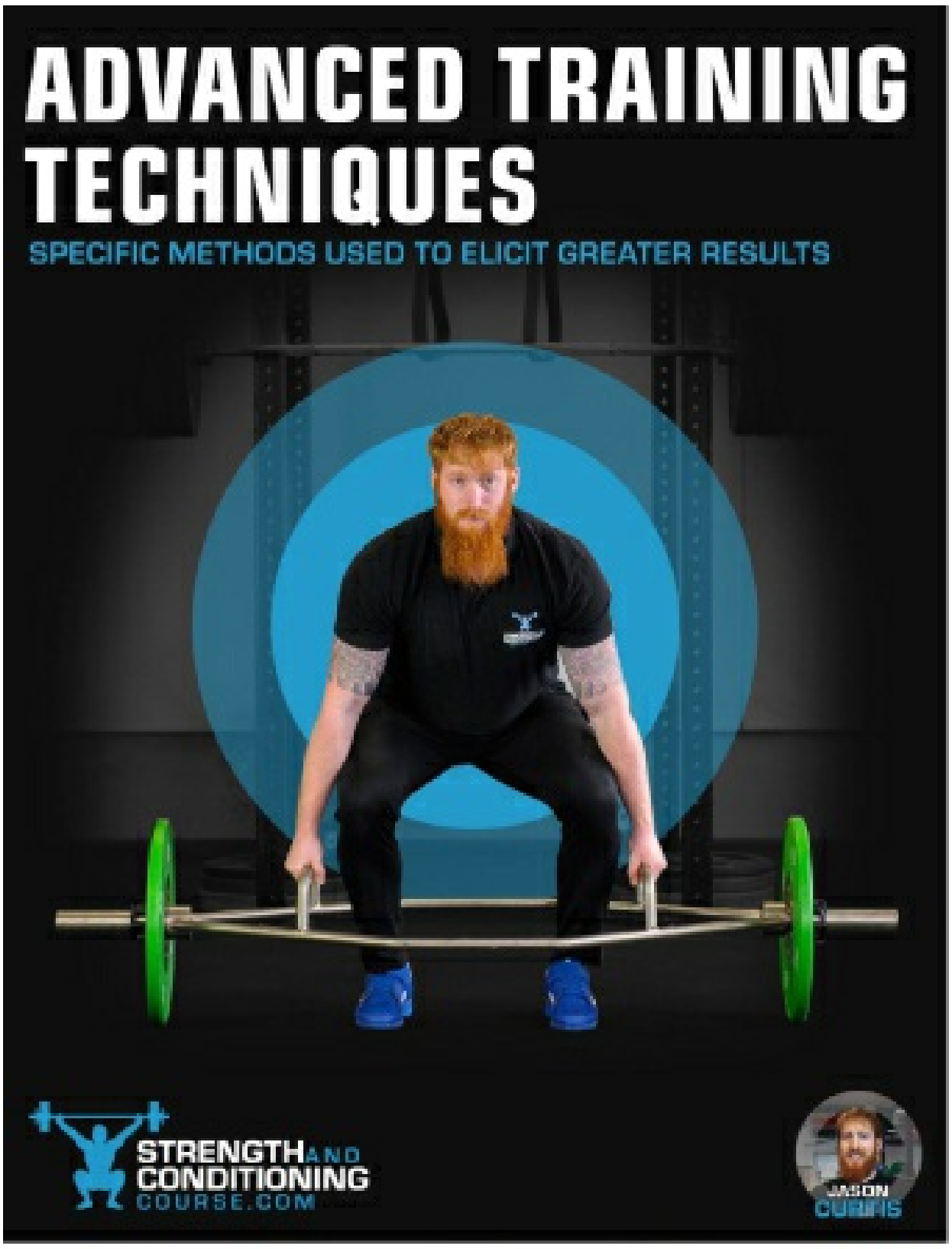


The development of strength is the foundation of physical performance because, before all else, you need the strength in your structures to support the fundamental movements that you carry out each day.

This HUGE course consists of 240+ narrated slides and 4+ hours of video tutorials for over 100 exercises.

Become a Strength Training Specialist (STS).



If you want to learn how to smash plateaus and take your training to the next level, this short course is perfect for you.

This course includes over 50 advanced training techniques, many with numerous variations.

A must for those that want greater results!

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