ORIGYM

Level 3 Certificate In Personal Training

MODULE 1:
INTRODUCTION TO LEVEL 3 PERSONAL TRAINING

CONTENTS

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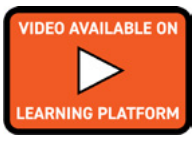
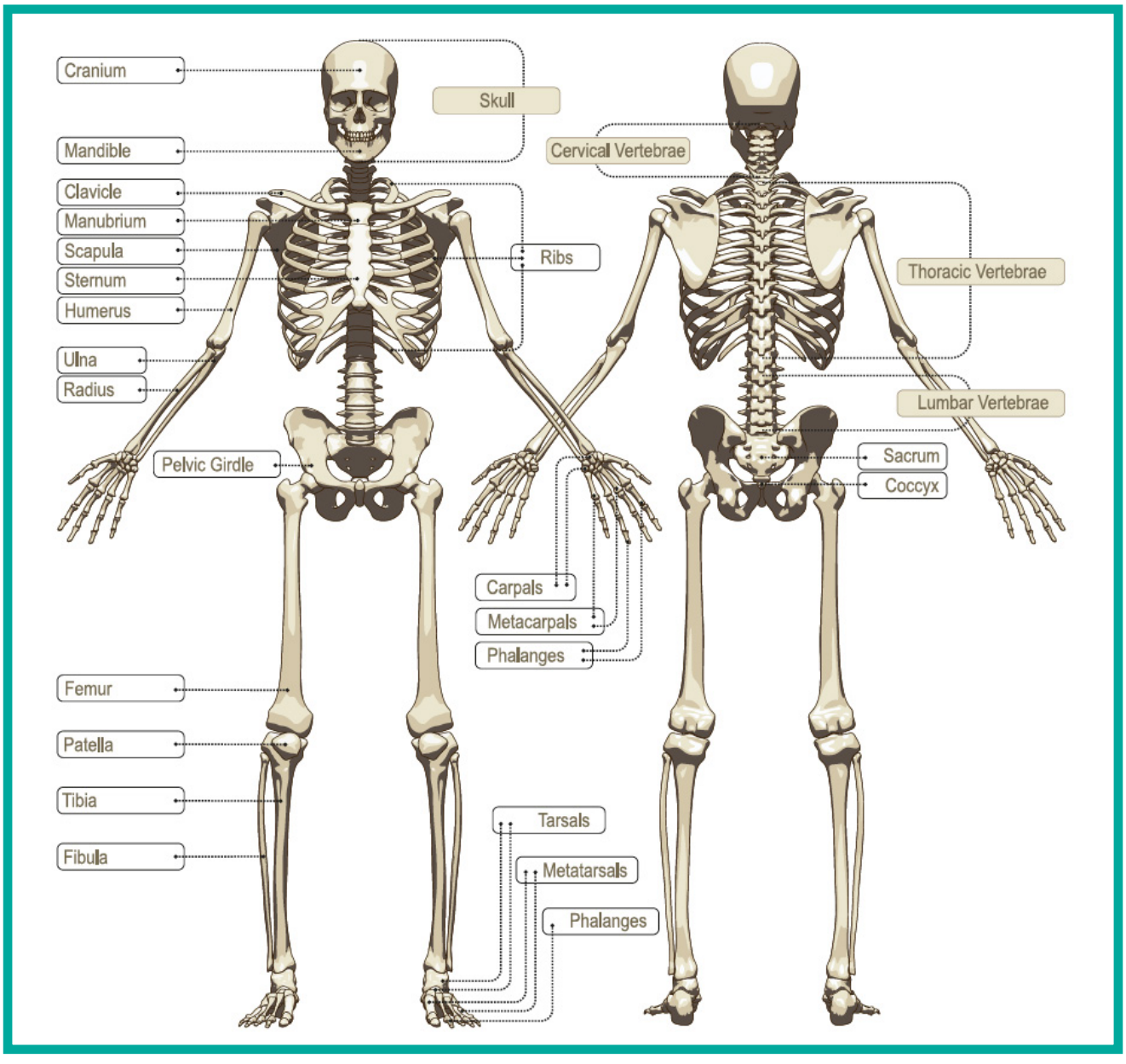


The Skeletal System

MODULE 1:
INTRODUCTION TO LEVEL 3 PERSONAL TRAINING

The Skeleton

Skeleton Diagram



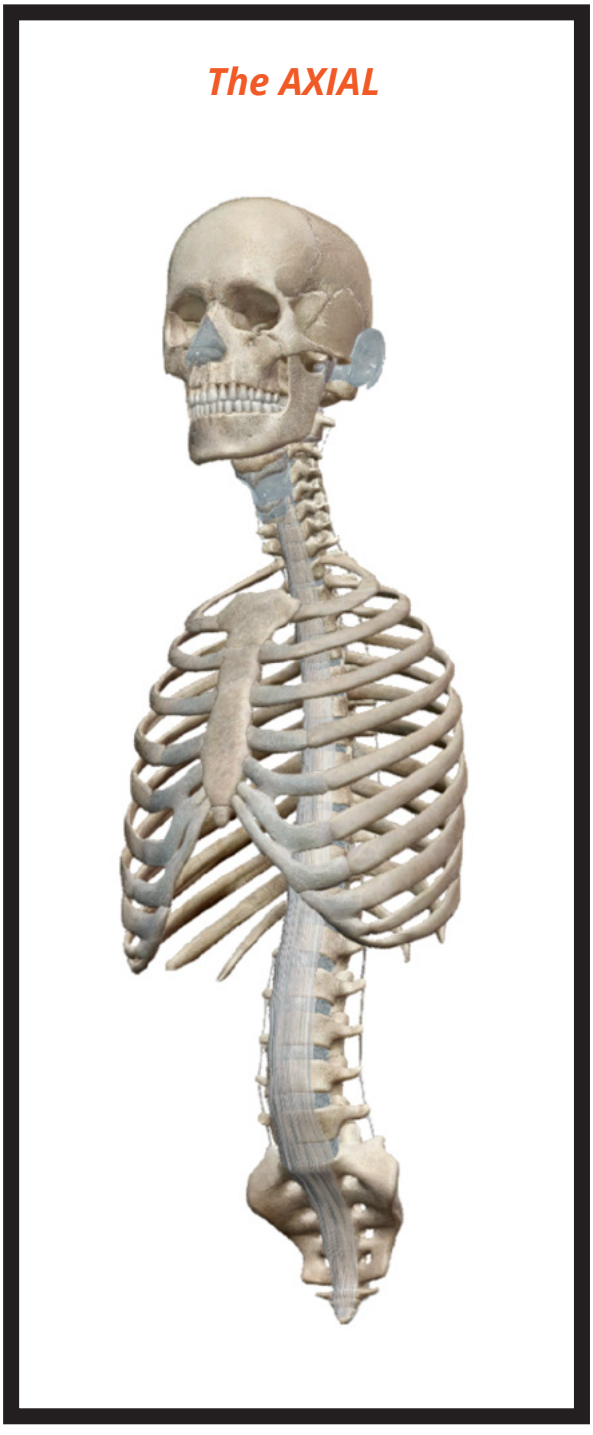
The AXIAL and APPENDICULAR Skeleton

The Skeletal System can be divided into 2 parts:

- Axial skeleton: skull, spine, ribs, and sternum.
- Appendicular skeleton: shoulder girdle, upper limbs, pelvic girdle, and lower limbs.

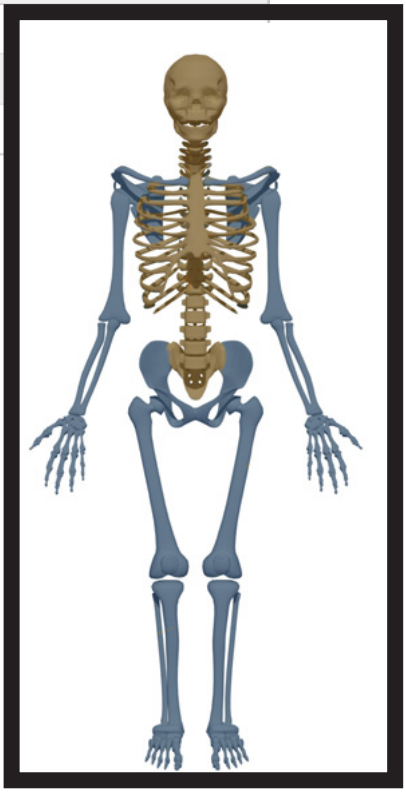
The AXIAL

Location	Bones	Number of Bones	Additional Information
Skull	Cranial	8	• Head
Spine	Cervical	7	• Neck
	Thoracic	12	• Chest
	Lumbar	5	• Lower back
	Sacral	5	• Rump (fused)
	Coccygeal	4	• Tail (fused)
Chest	Ribs (costals)	12 pairs	• Originate from the thoracic vertebrae and wrap around the body to form the chest. • The first 7 pairs attach to sternum (true ribs). • The next 3 pairs share a cartilaginous attachment to the sternum (false ribs) • The final 2 pairs are free (floating ribs)
Chest	Sternum	1	• Attachment for true ribs, false ribs and clavicle



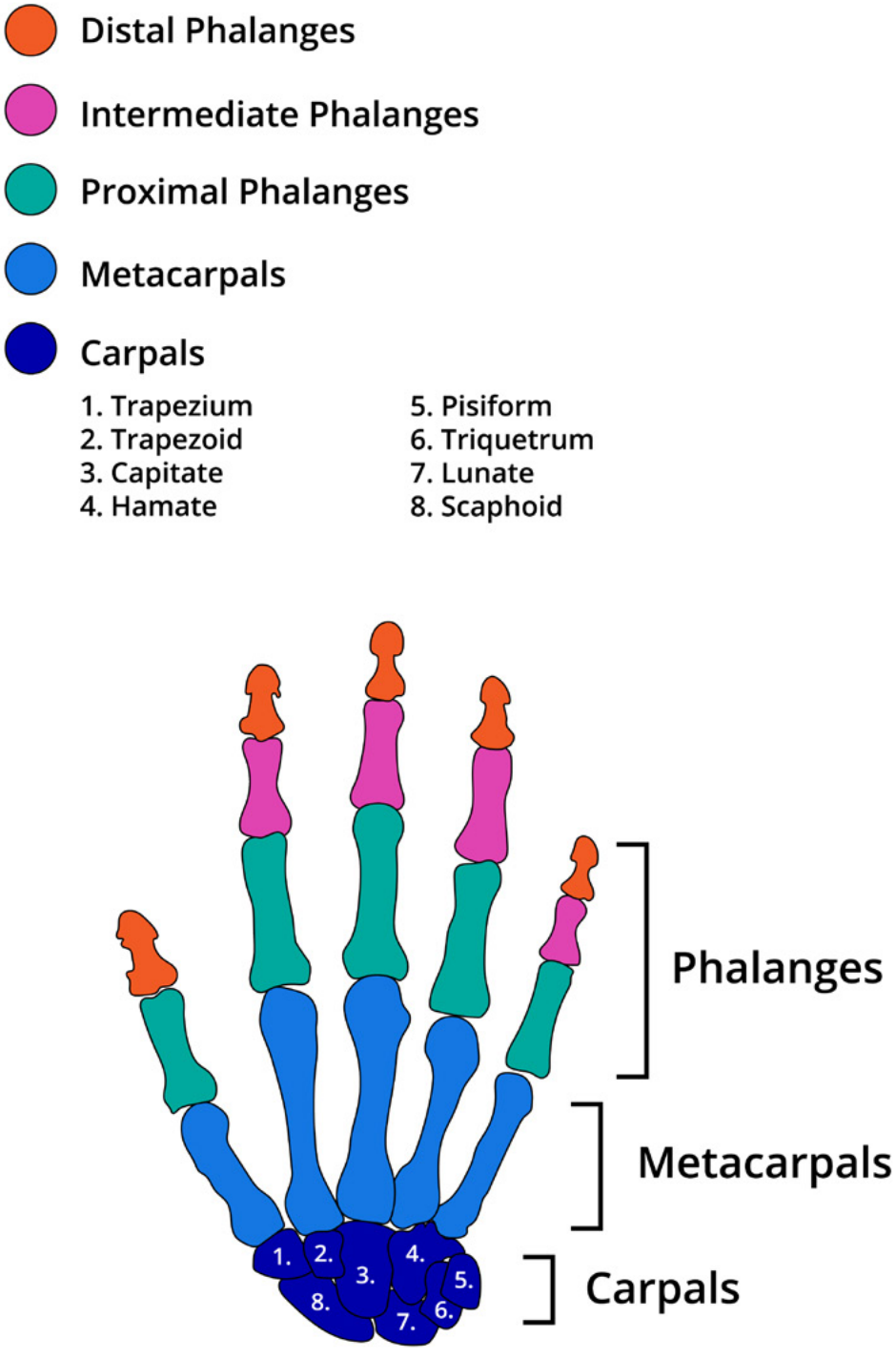
The APPENDICULAR Skeleton

Location	Bones	Number of Bones	Additional Information
Shoulder	Scapula	2	• Plural = Scapulae • Triangular bones at the rear (posterior) of the body • 'S' shaped bones above (superior) the rib cage and at the front (anterior) of the body
Arm	Humerus	2	• Upper arm
	Radius	2	• Outer and shorter bone of the forearm
	Ulna	2	• Inner and longer bone of the forearm
Hand	Carpal	16	• 2 rows of 4 bones which form the wrist
	Metacarpal	10	• Palm of the hand
	Phalange	28	• Finger bones
Pelvis	Ilium	2	• Large flat bones of pelvis
	Ischium	2	• Lower (inferior) rear of pelvis
	Pubis	2	• Lower (inferior) front of pelvis
Leg	Femur	2	• Longest bone in the body
	Patella	2	• Kneecap
	Tibia	2	• Larger and inner (medial) bone of the lower leg
	Fibula	2	• Smaller and outer (lateral) bone of the lower leg
Foot	Tarsal	14	• Bones of the ankle
	Metatarsal	10	• Bones of the foot
	Phalange	28	• Bones of the toes

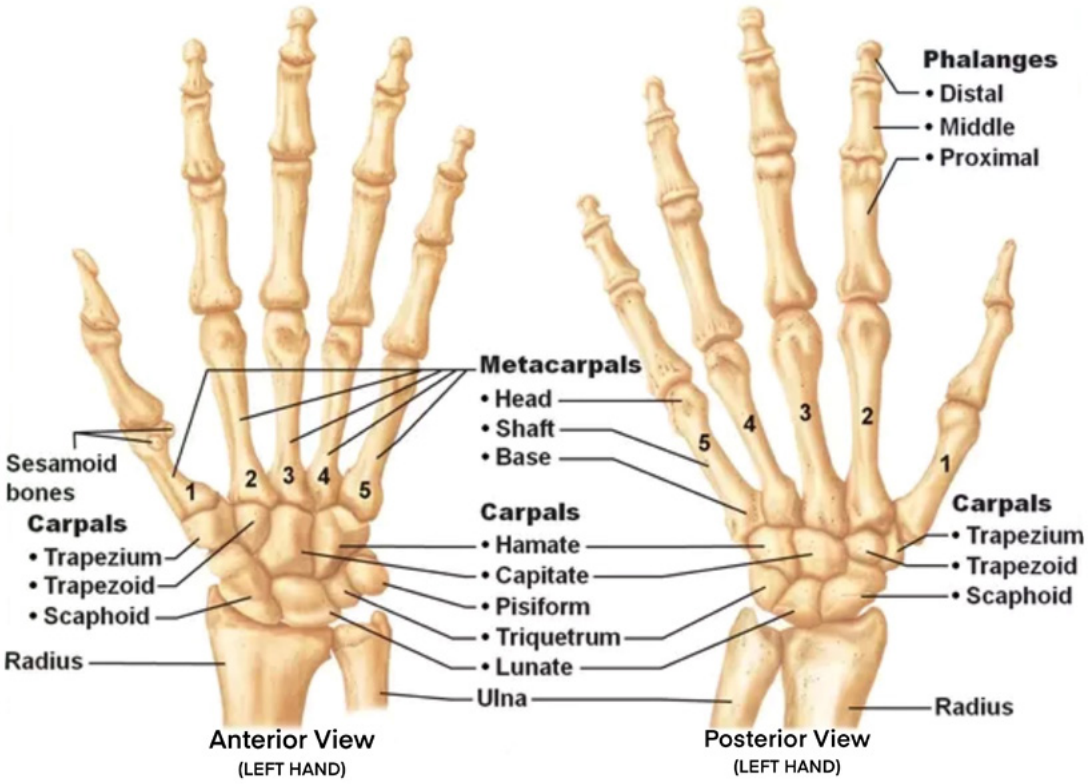


Skeleton Diagram: A Closer Look

The Hand



Carpal Bones (Bones of the Wrist)



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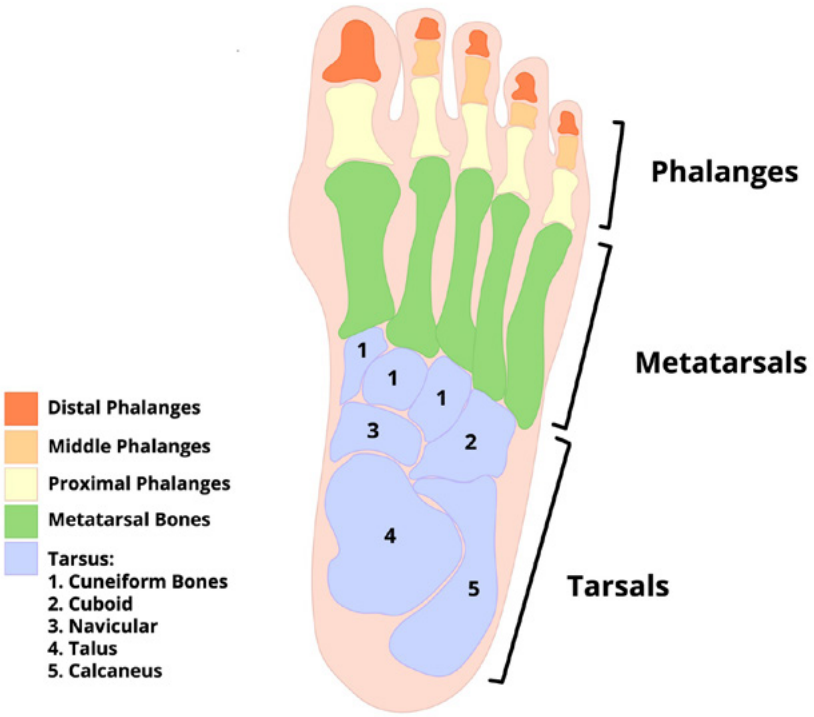
The Foot



The Tarsal Bones (The Bones of the Foot)

(Superior, Medial and Lateral View with Bony Landmarks)

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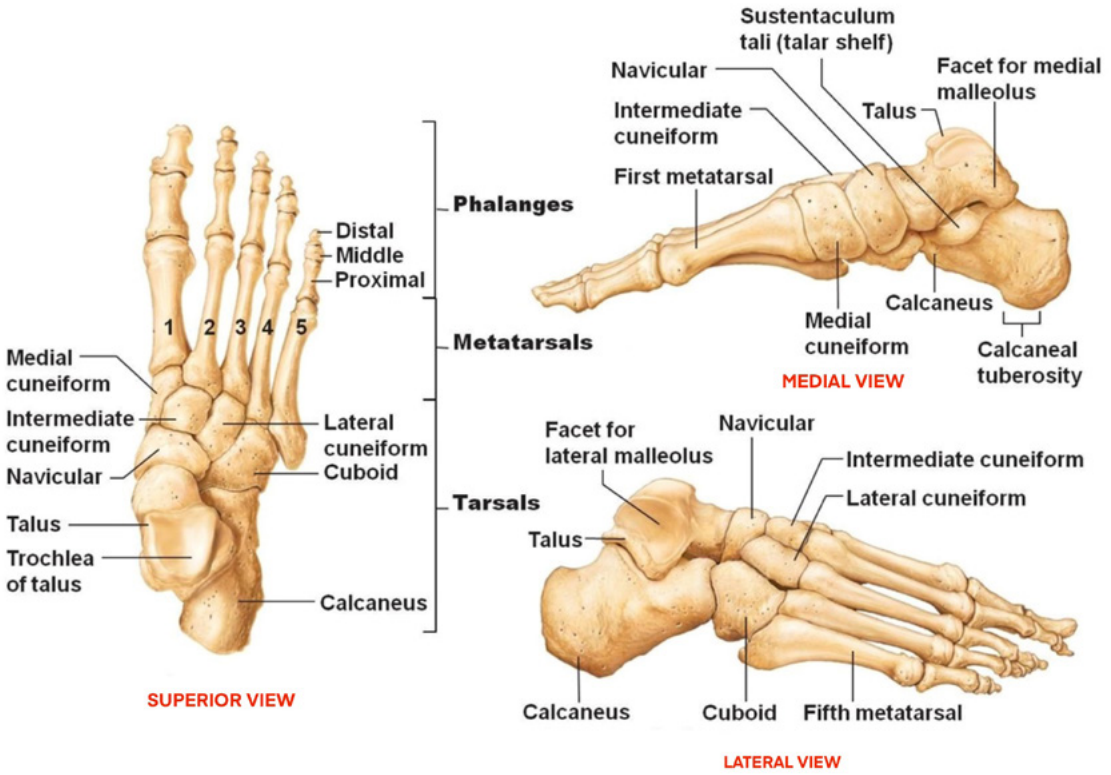


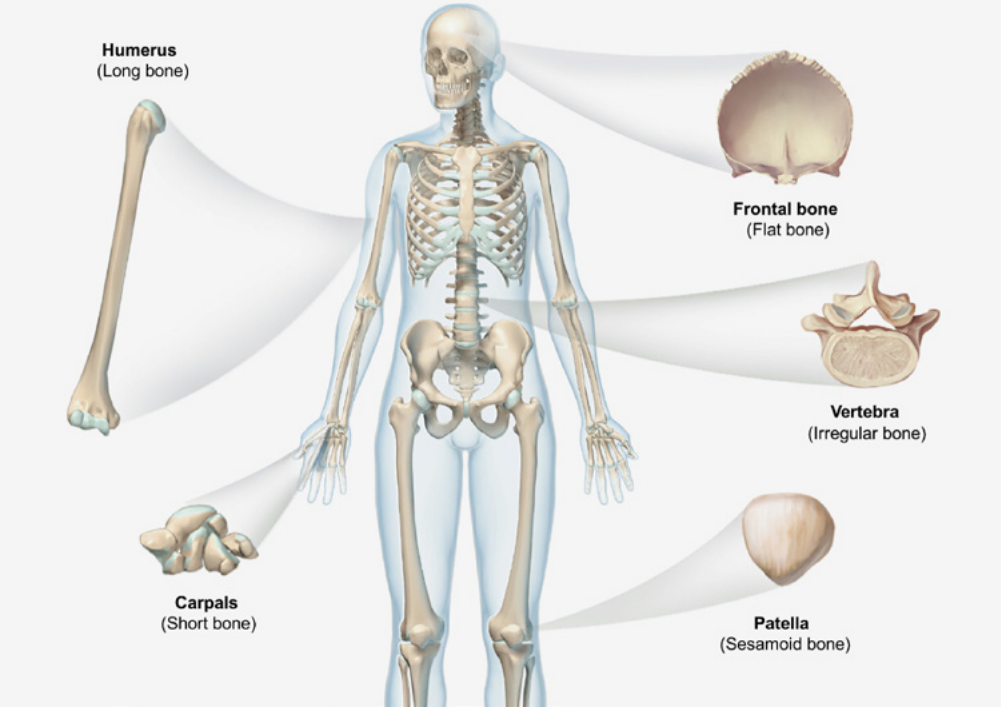
Functions of the Skeleton

Functions	Description
Framework	To provide a framework which supports the body and gives it shape.
Movement or Locomotion	Bones form joints which act as levers.
Protection	Helps protect our vital internal organs from being damaged.
Soft Tissue Attachment	Provides surfaces for the attachment of soft tissues.
Production	Certain bones produce red blood cells, white blood cells, and platelets from their bone marrow.
Storage	Stores minerals such as calcium and phosphorus to withstand powerful physical stresses. Fats are stored in yellow bone marrow.

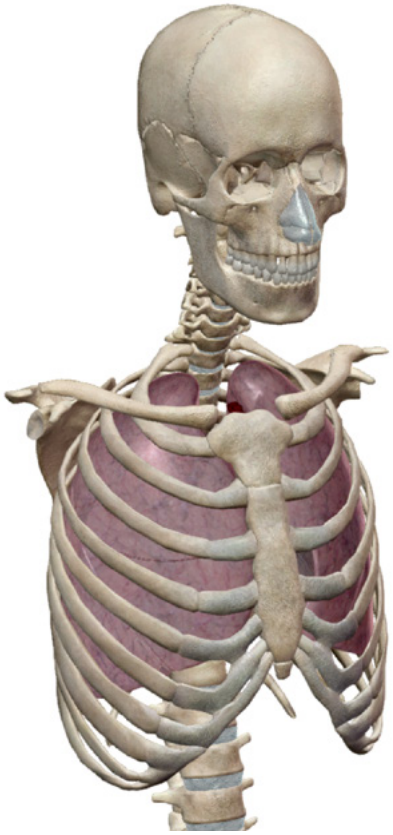
The Classification of Bones

- Bone is a calcified connective tissue that forms most of the adult skeleton.
- The skeleton consists of approximately 206 bones.

Classification	Description	Examples
Long	• Are longer than they are wide • Contain mostly compact bone in the shaft (diaphysis) • Contain cancellous bone at each end (epiphysis)	• Humerus • Radius • Ulna • Tibia • Metacarpals • Fibula • Phalanges • Metatarsals
Short	• As long as they are wide. Usually consist of mainly cancellous bone. • The above makes them strong and lightweight.	• Carpals • Tarsals
Flat	• Thin cancellous bone sandwiched between 2 layers of compact bone. • They provide large areas for muscle attachment	• Cranium • Scapula • Costals • Sternum • Illium
Irregular	• Their many different shapes prevent them from being classified in any other group.	• Vertebrae
Sesamoid	• 'Seed-like'. • Located within tendons at site of tension or friction to protect joint and aid leverage.	• Patella



Types of Bones



FLAT BONES

- Cranial bones
- Scapulae
- Sternum
- Costal bones (Ribs)

LONG BONES

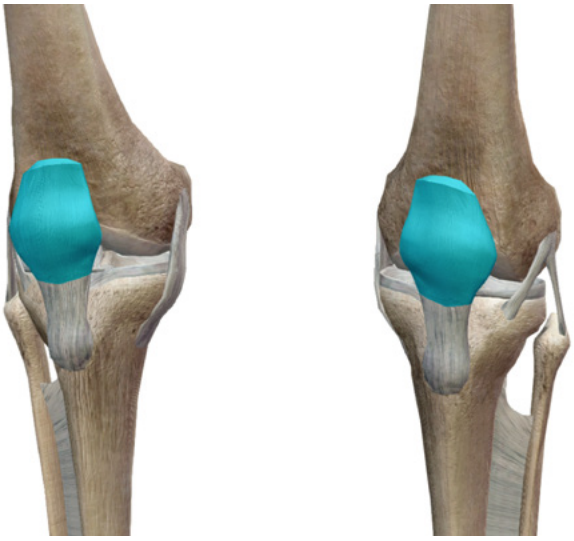
- Humerus
- Radius and Ulna
- Femur
- Tibia and Fibula
- Metacarpals and Metatarsals
- Phalanges

SHORT BONES

- Carpals
- Tarsals

IRREGULAR BONES

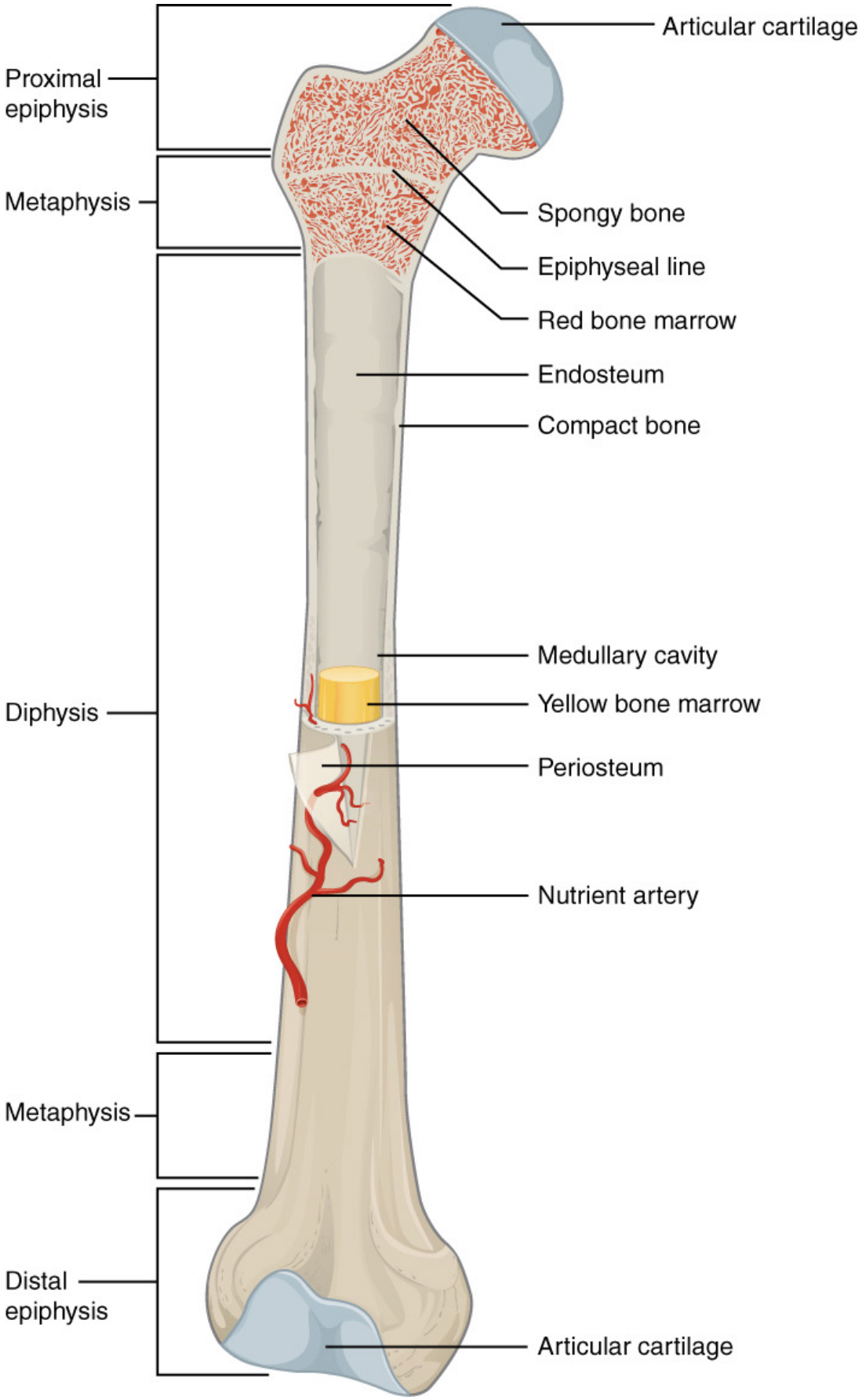
- Vertebrae
- Pelvic bones



SESAMOID

- Patella

Anatomical Features of a Long Bone



A closer analysis of a long bone is useful as it helps to highlight many of the properties and functions of the skeletal system.

Epiphysis (epiphyses): The bone ends, which are mainly comprised of cancellous bone, and house much of the red marrow involved in red blood cell production. They are also one of the primary sites for bone growth, and during growth, periods can be quite vulnerable to breakage.

Diaphysis: The shaft portion of a long bone, and in comparison to the bone ends is predominantly compact bone (although the inside of the shaft is hollow). The principal role of the diaphysis is to support.

Epiphyseal line (plates): are part of the region connecting the diaphysis to the epiphysis. It is a layer of subdividing cartilaginous cells where growth in length of the diaphysis occurs. Cartilaginous cells, which are arranged like columns of coins multiply here. They move towards the diaphysis, becoming more calcified as they go. Osteoblasts continue and complete the process of bone formation.

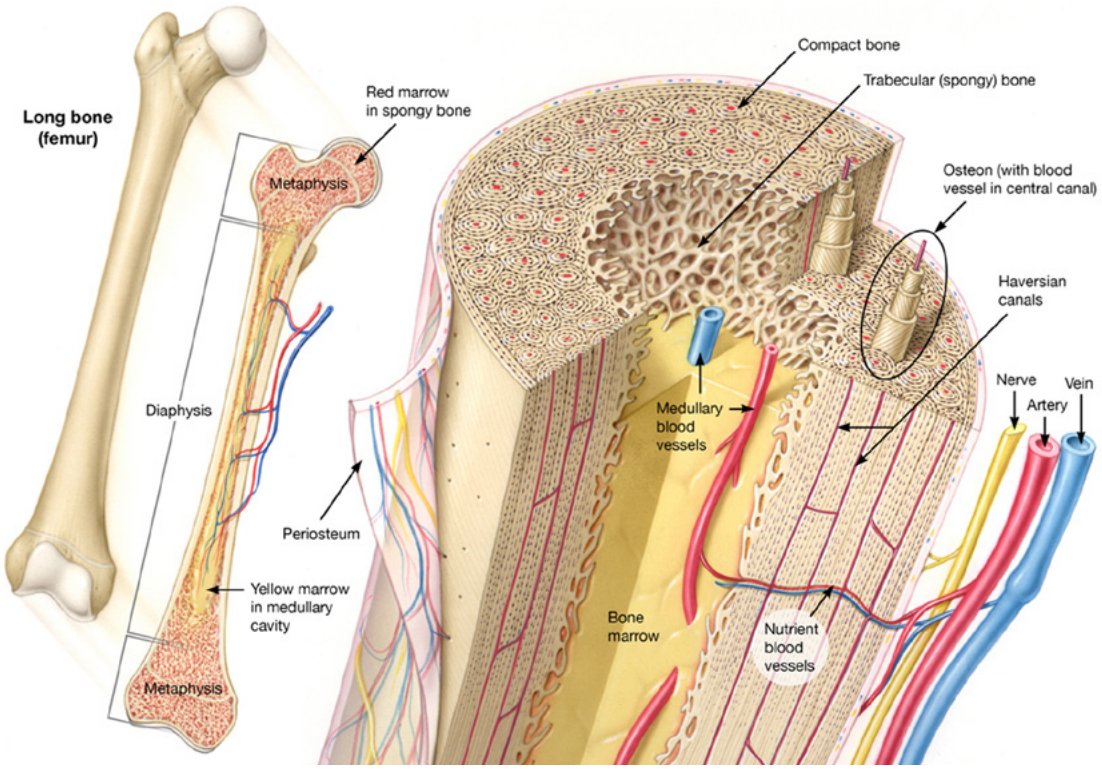
Articular (hyaline) cartilage: The ends of articulating bones are covered with articular or hyaline cartilage. It is a hard, white shiny tissue which, along with synovial fluid, helps reduce friction in freely moveable (synovial joints). The cartilage is necessary for smooth joint action.

NB: When adults finish growing the plates will harden and 'close', no further growth will take place. If the plates are damaged before growth has finished, then this may result in a shorter bone.

Types Of Bone Tissue

Compact bone (Cortical bone): is hard and heavy and therefore a dense material, especially in comparison to the cancellous bone to which it surrounds. It is the hard outer structure of the skeleton. It is comprised of units called lamellae. These lamellae are sheets of collagen aligned in parallel patterns. It is these sheets that give the bone its strength. The bony matrix is compactly filled leaving only very small spaces for lacunae that are filled with osteocytes. Compact bone is supplied with oxygen and nutrients through a blood supply within structures called Haversian canals or osteons.

Cancellous bone (Spongy bone): This bone is the less dense and softer of the two types. It makes up the ends of bones and is surrounded by compact bone. Cancellous bone is a highly vascularised and porous tissue and is where blood cells are created.

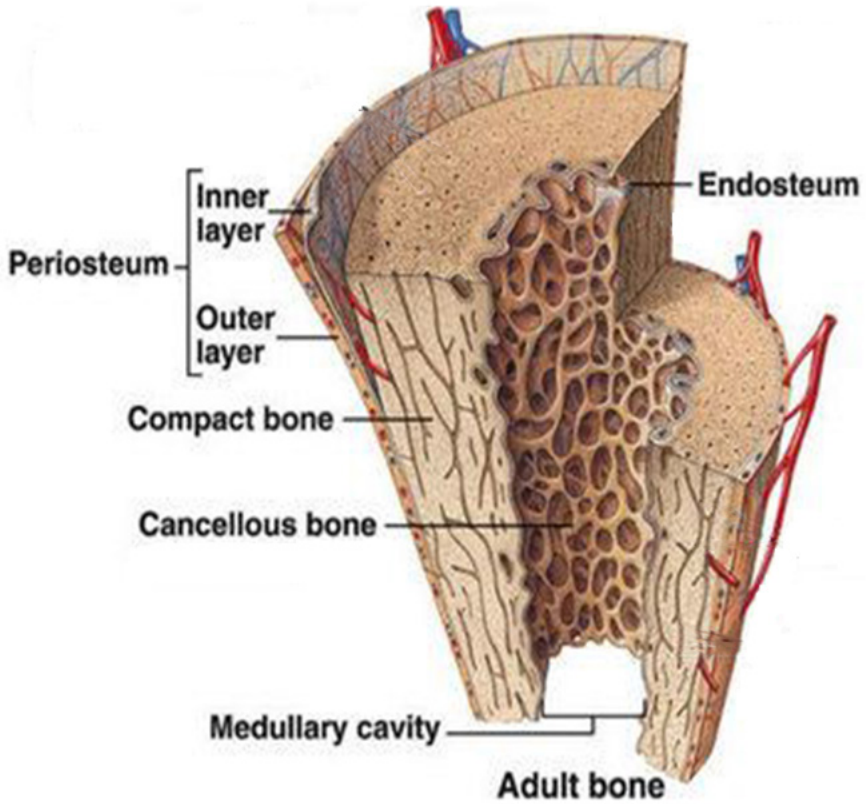


A Deeper Look

Periosteum: This forms a tough fibrous membrane which coats the bone. It contains nerves, blood vessels and bone producing cells. Its inner surface provides the materials for nutrition repair and facilitates growth in the diameter of the bone. It also provides the point of attachment for tendons.

Medullary cavity: This is the space within the centre of the diaphysis. This contains fatty yellow marrow which is predominantly composed of adipose tissue which is a useful energy reserve.

Endosteum: is essentially connective tissue deep within the bone. It is a thin vascular membrane that lines the inner surface of the bone that forms the medullary cavity.



Bone Formation

Most of the skeleton begins as cartilage, very strong fibres of collagen which are gradually replaced by compact or cancellous bone. This can be living or non-living material in a human being, both of which contribute to the evolving cycle of bone formation.

A number of cells play important roles in this process:

Osteoblasts: Bone forming cells.

Osteoclasts: Bone destroying cells.

Osteocytes: Osteoblasts which have matured into bone cells.

VIDEO AVAILABLE ON LEARNING PLATFORM

The Process of Ossification

Ossification is the creation of new bone tissue from either cartilage or stress and injury.

This process starts from birth and can be complete between the ages of 18-30.

As above there are 3 main osteo-cells used in this process, they are;

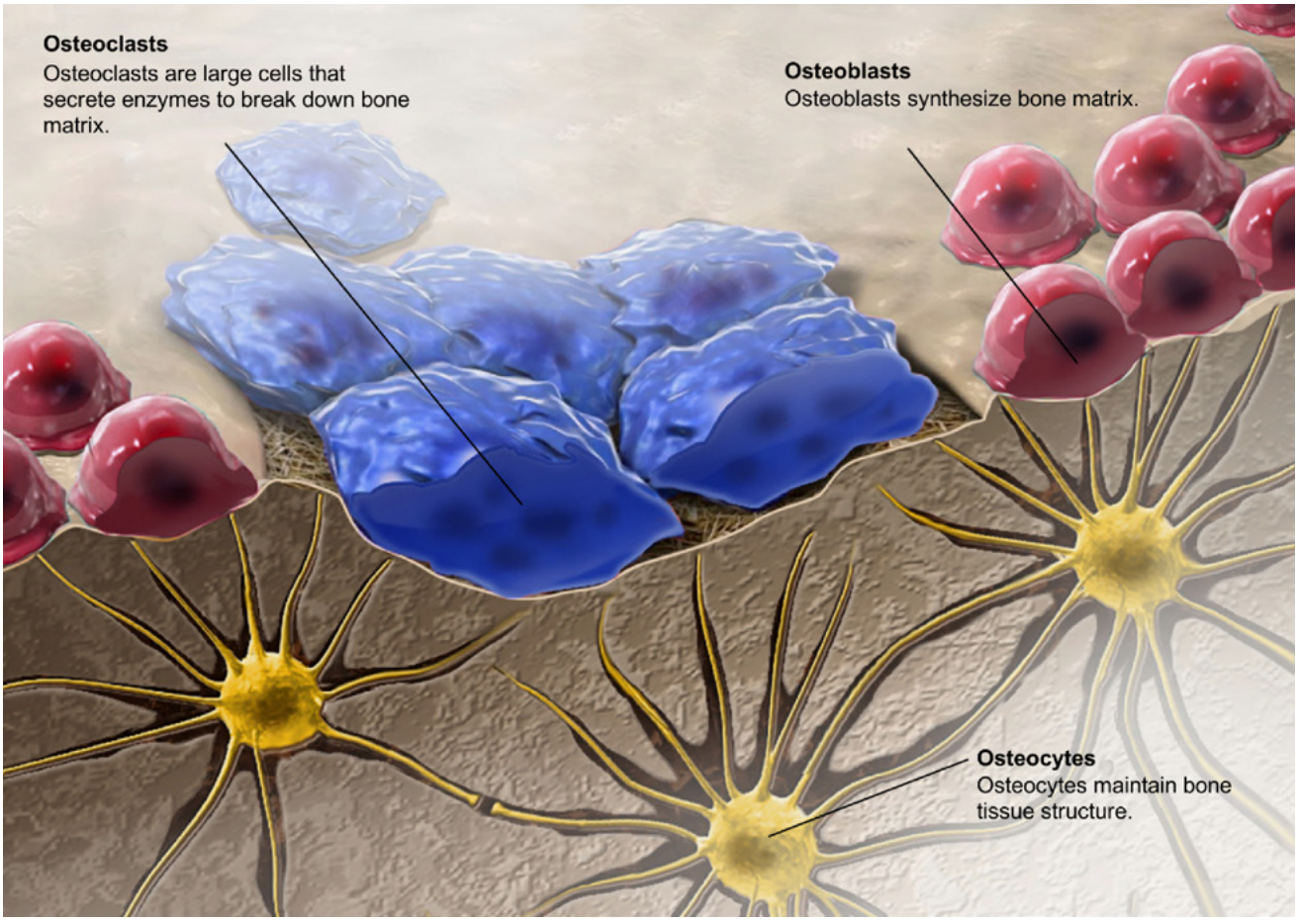
1. **Osteoblasts** - B for 'building cells' they deposit the minerals into the bone tissue
2. **Osteoclasts** - CL for clearing old tissue, by occupying cracks in the bone and dissolving surrounding damaged tissue.
3. **Osteocytes** - Mature osteoblasts that have created its own site within the bone tissue to maintain the structure.

   (See image below for a clearer depiction of this)

As bone tissue nearly always starts from cartilage (strong collagen fibres), the presence of minerals and salts is required to convert it to human skeletal tissue, one of the main minerals being calcium.

The growth and lengthening of long bones continue throughout this time. Lengthening or elongation is achieved by the expansion of epiphyseal growth plates at each end of the diaphysis (see long bone diagram on the previous slide).

These plates expand allowing new cells to form and increase the length of the shaft at both ends. The process stops when the thickness of the epiphyseal plates decreases which occurs at different rates for different bones.



THE 4 STAGES OF BONE GROWTH AND REPAIR:

1. Hematoma formation:

Blood vessels in the broken bone tear and haemorrhage, resulting in the formation of clotted blood, or a hematoma, at the site of the break. The severed blood vessels at the broken ends of the bone are sealed by the clotting process. Bone cells deprived of nutrients begin to die.

2. Bone generation:

Within days of the fracture, capillaries grow into the hematoma, while phagocytic cells begin to clear away the dead cells. Though fragments of the blood clot may remain, fibroblasts and osteoblasts enter the area and begin to reform bone. Fibroblasts produce collagen fibres that connect the broken bone ends, while osteoblasts start to form spongy bone. The repair tissue between the broken bone ends, the fibrocartilaginous callus is composed of both hyaline and fibrocartilage. Some bone spicules may also appear at this point.

3. Bony callus formation:

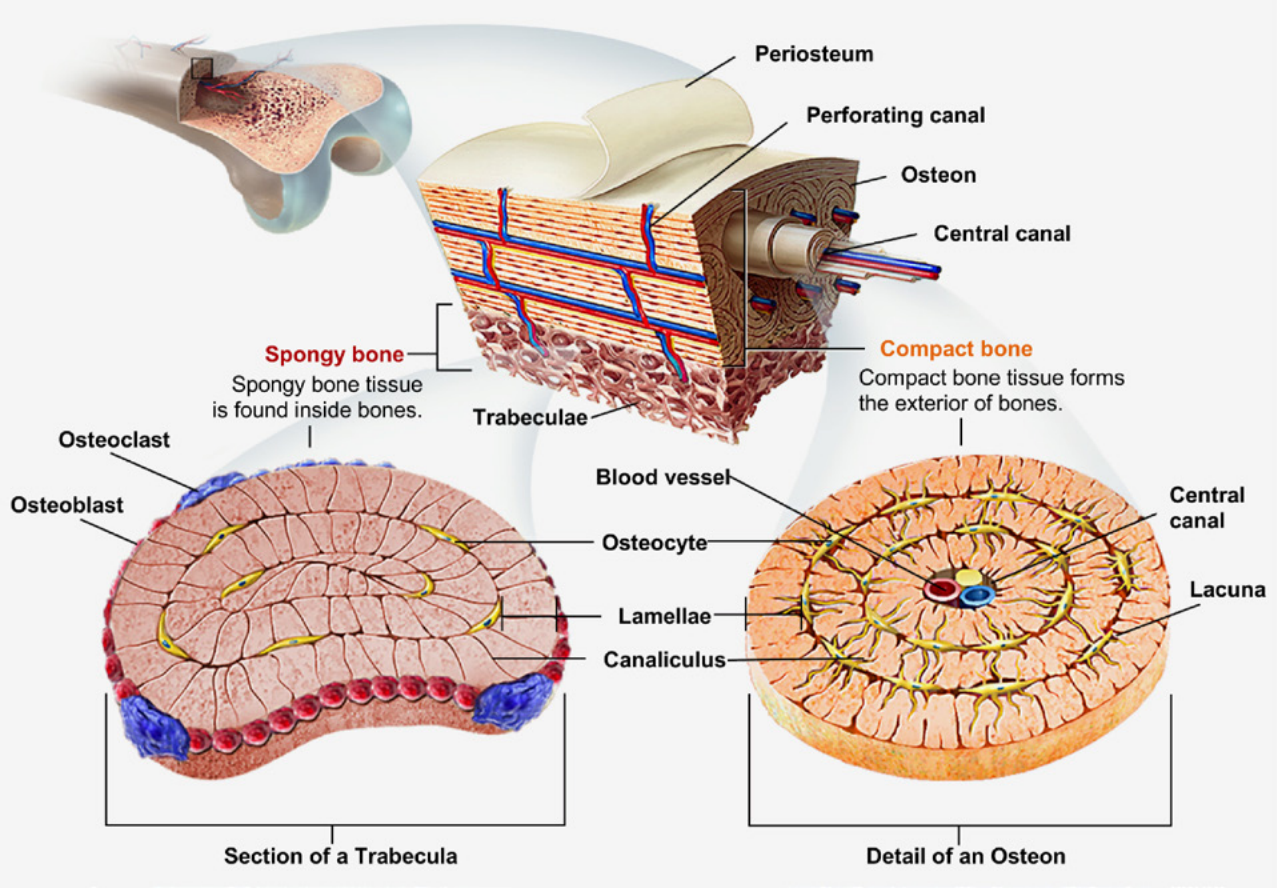
The fibrocartilaginous callus is converted into a bony callus of spongy bone. It takes about two months for the broken bone ends to be firmly joined together after the fracture. This is similar to the endochondral formation of bone, when cartilage becomes ossified; osteoblasts, osteoclasts, and bone matrix are present.

4. Bone remodelling:

The bony callus is then remodelled by osteoclasts and osteoblasts, with excess material on the exterior of the bone and within the medullary cavity being removed. Compact bone is added to create bone tissue that is similar to the original, unbroken bone. This remodelling can take many months; the bone may remain uneven for years.

Bone Physiology

Bone consists of a mixture of water, protein and mineral salts, the latter of which constitutes roughly 50% of the structure. Bone strength is the result of a combination of the hardness of these minerals combined with the tensile properties of collagen (derived from protein). Too little of one (e.g. collagen) and the bone will shatter like an eggshell, too little of the other (e.g. mineral salts) and bone will bend like a piece of rubber.



Hormonal Regulation of Bone

Bone formation, in the pre-puberty years, is predominantly regulated by human growth hormone (HGH) produced by the pituitary gland (located in the brain). At puberty, however, testosterone produced by the male testes and oestrogen produced by the female ovaries begin to exert a greater influence. In women, oestrogen promotes the growth of the skeleton and development of the unique female skeletal characteristics (i.e. the broader pelvis). Whereas testosterone, causes males to have larger more robust skeletons (McArdle et al, 2001).

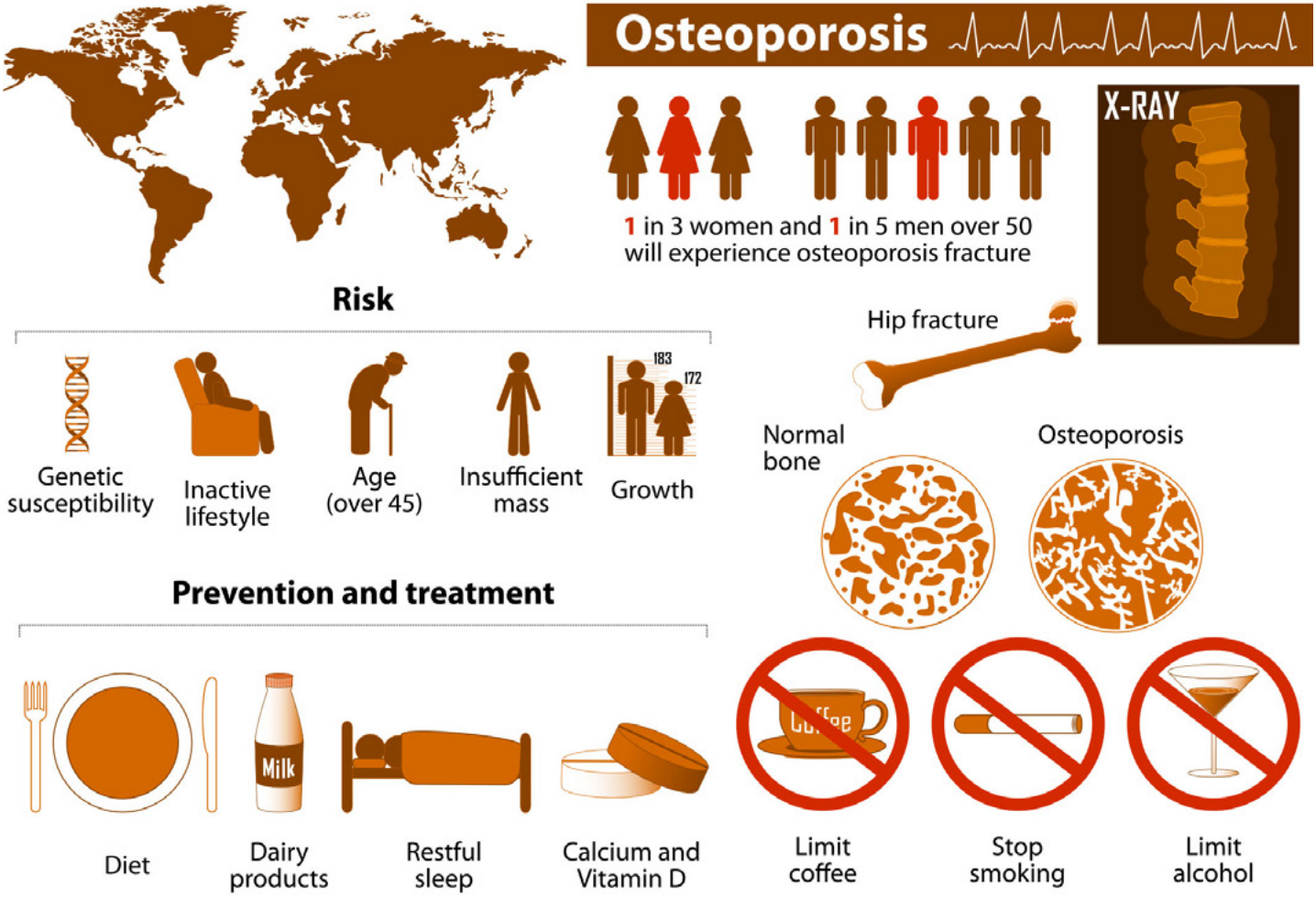
Additional aspects of bone growth are discussed below with respect to the structure of a long bone.

The Skeletal System and Calcium Regulation

Although calcium provides the skeletal system with rigidity it is also involved in a number of other important functions:

- **Muscular contraction**
- **Transmission of nervous impulses**
- **Regulating fluid balance (McArdle et al.,1996; Jones and Round,1991)**

Too much or too little calcium in the body can affect the functions above. Therefore bones act as calcium reservoirs which can either take up or release calcium depending on the needs of the body (Jones and Rounds, 1990; Tortora and Grabowski, 1996). When calcium is lacking within the body it will be withdrawn from the bones. This is why diets that are chronically low in calcium tend to increase the risk of osteoporosis.



Osteoporosis
(Brittle Bone Disease)

Bone remodelling is a delicate balance of osteoblast and osteoclast activity. An imbalance of this activity is what causes Osteoporosis. Essentially osteoblast activity decreases causing a drop in bone growth. This leads to a gradual loss in bone density and ultimately gives rise to a skeletal system that is unable to withstand the forces placed on it.

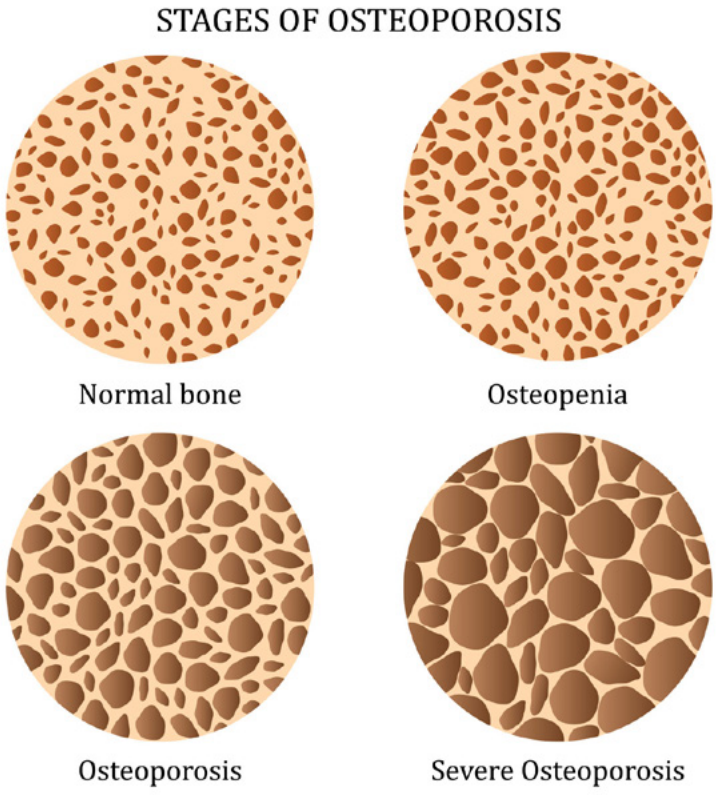
The condition may give rise from a number of causes; however one of the biggest is the drop in oestrogen levels associated with the menopause. This makes women significantly more likely to develop the condition than men. In men, a proportion of circulating testosterone is converted into oestrogen and this is thought to provide men with significant protection against loss of bone mass.

Low calorific intake and/or overtraining can also increase the risk of osteoporosis in females due to the depletion of body fat stores which are one of the primary sources of oestrogen. Poor quality diets which are lacking in minerals and vitamins or have an imbalance of the two also increase the risks by limiting the availability of calcium (Tortora and Grabowski, 1996).

The list below provides a summary of some of the risk factors associated with osteoporosis:

Osteoporosis Risk Factors

- **Female sex – due to drop in oestrogen levels (particularly at the menopause)**
- **Calcium deficiency – through poor diet**
- **Lack of exercise**
- **Smoking – causes a drop in oestrogen**
- **Family history**
- **Certain drugs, such as alcohol**
- **Low body fat**
- **Overtraining**



(McArdle et al., 2001; Tortora and Grabowski, 1996; National Institutes of Health Osteoporosis and Related Bone Disease)

Factors Affecting Bone Growth

Bone Development Is Influenced By:

- **Nutrition**
- **Hormonal excretions**
- **Exposure to sunlight**
- **Physical exercise**

Bone health may be influenced by many factors from maternal nutrition, through toddler and pre-school years, with calcium intake playing an important role. Calcium can only reach its full bone building potential if the body has enough vitamin D. Calcium helps build and maintain bones while vitamin D helps the body absorb calcium effectively. We can get most of our vitamin D from exposure to sunlight.

Hormones are made in glands and travel around the body via the bloodstream. They are important in the balance between formation and reabsorption of bone.

Physical activity causes new bone tissue to form. The stress placed on bones during weight-bearing activity has a direct influence on bone strength.

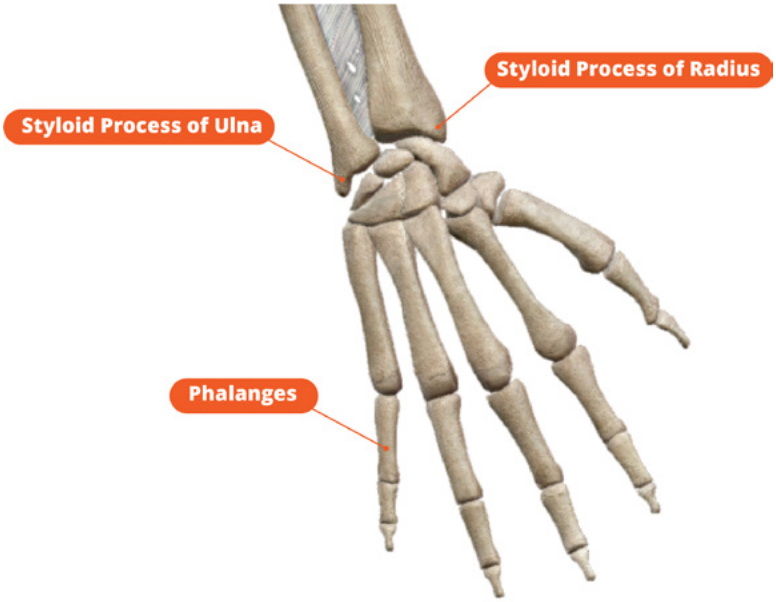
Bony Landmarks

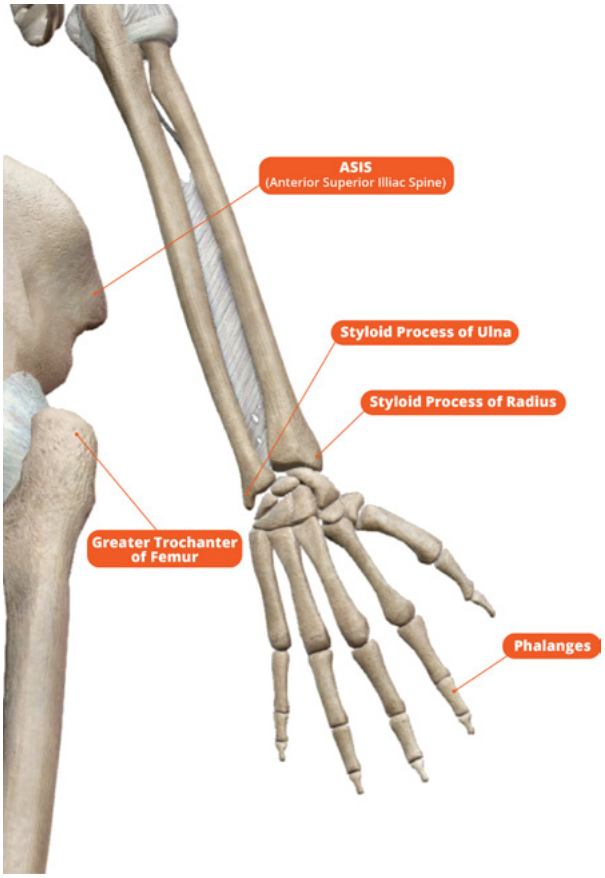
MODULE 1:
INTRODUCTION TO LEVEL 3 PERSONAL TRAINING

Definition:

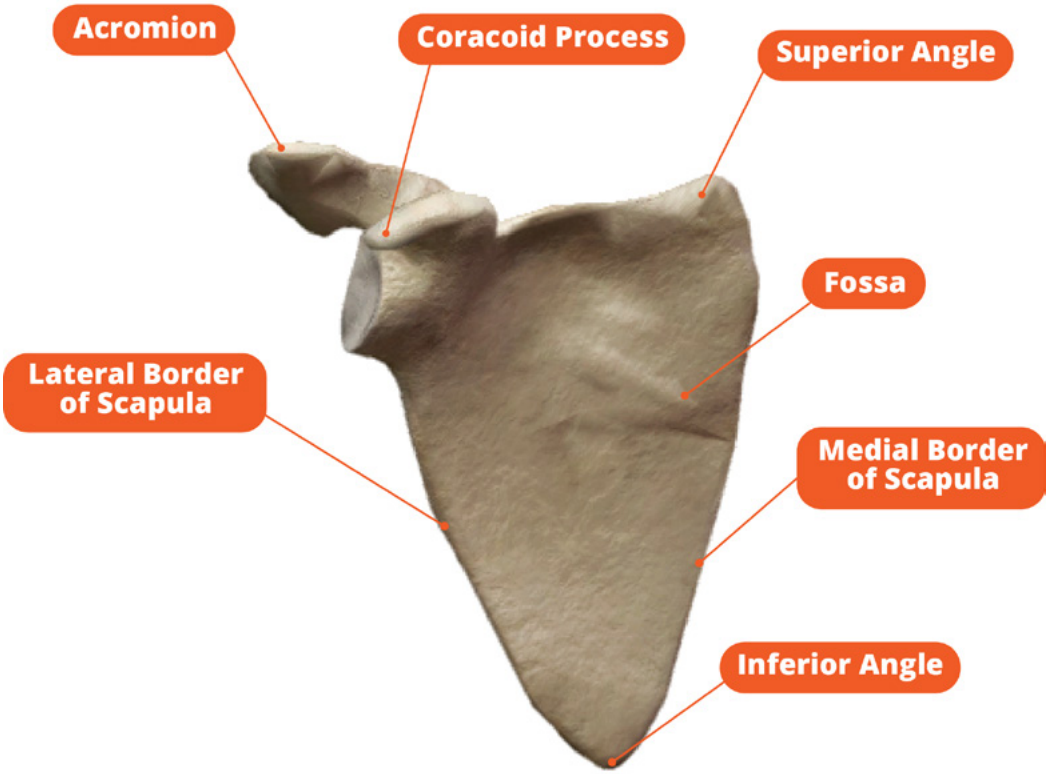
Any place on the skin surface where the underlying bone is normally close to the surface and easily palpable. They are also often attachment sites for muscles.

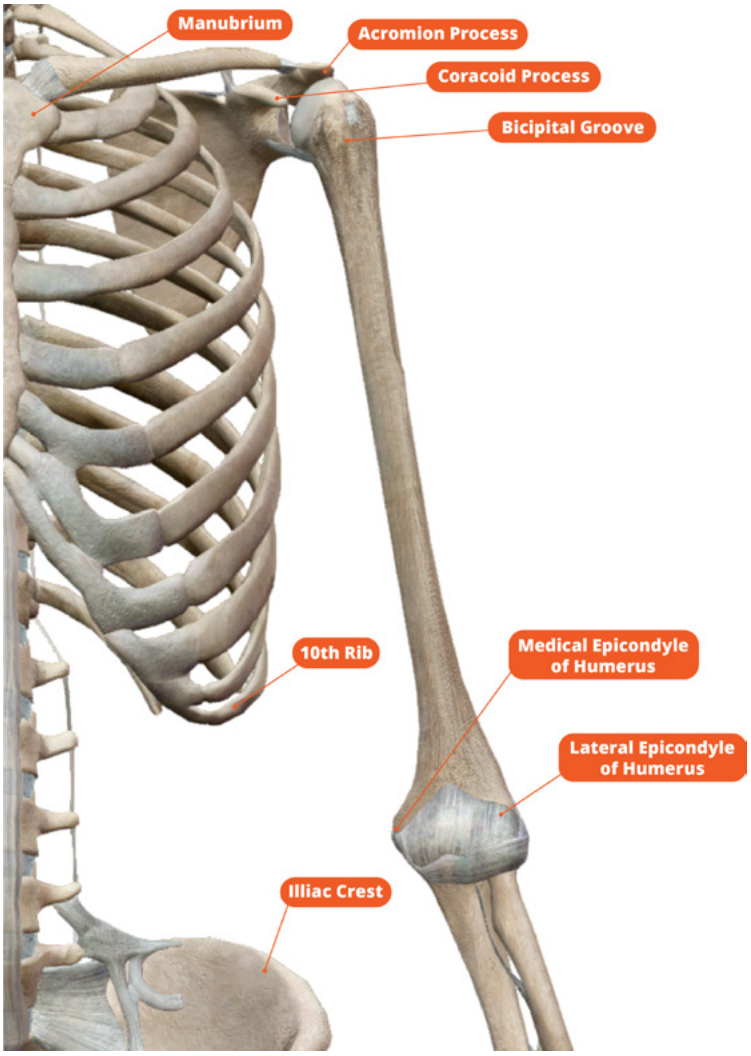
Bony Landmarks: Hand and Arm

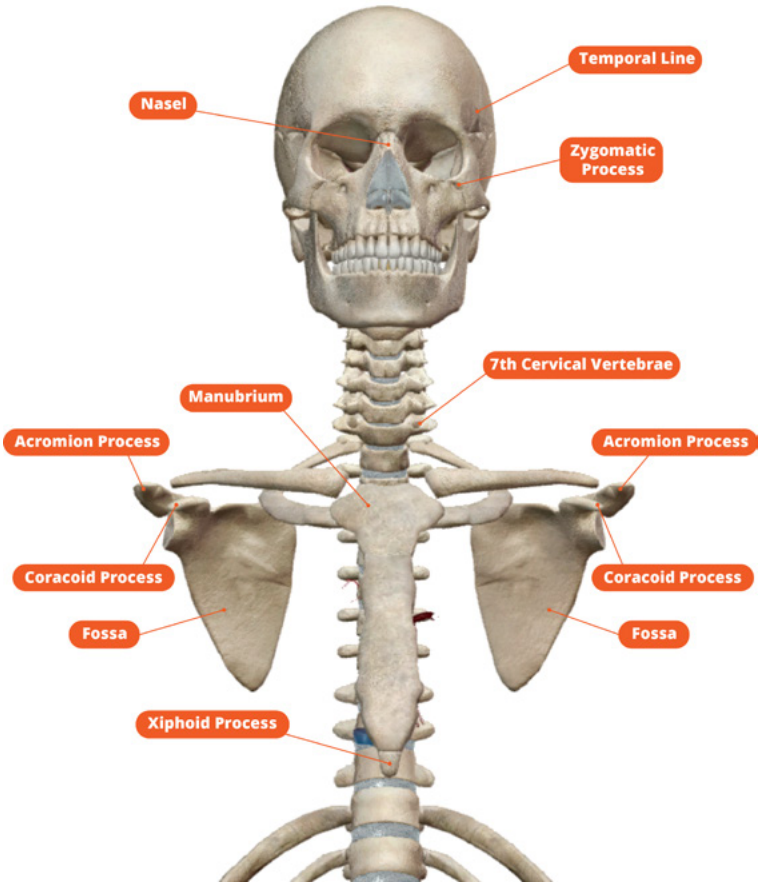


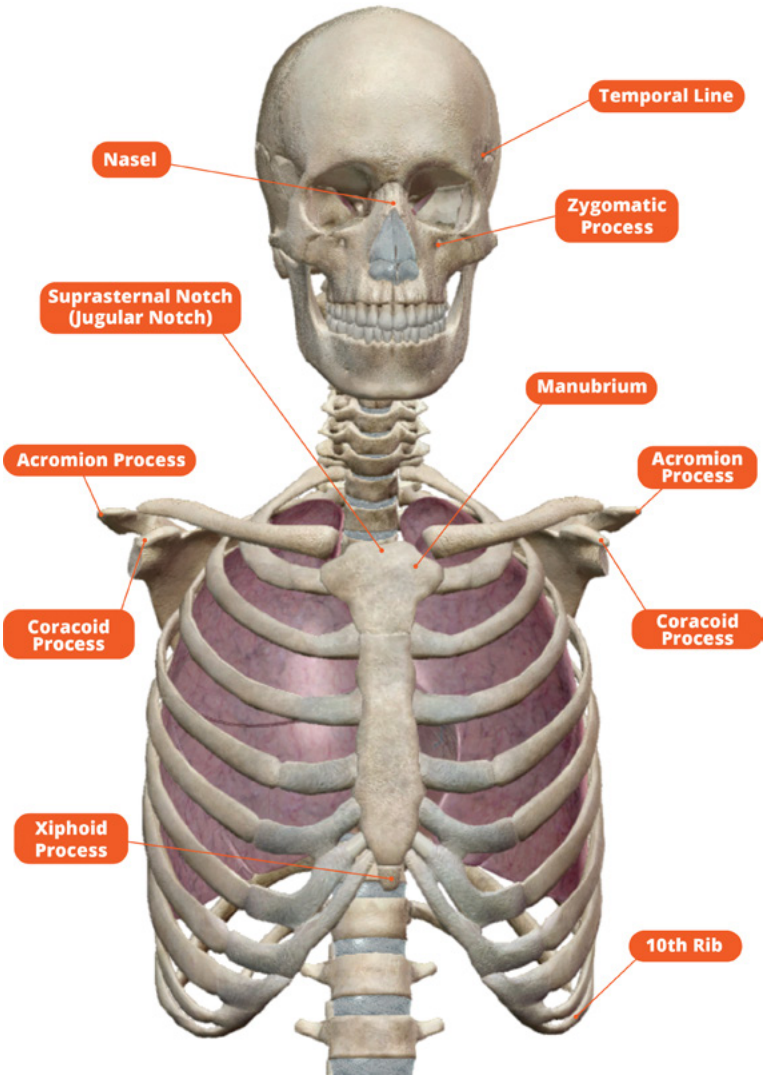


Bony landmarks: Upper anterior

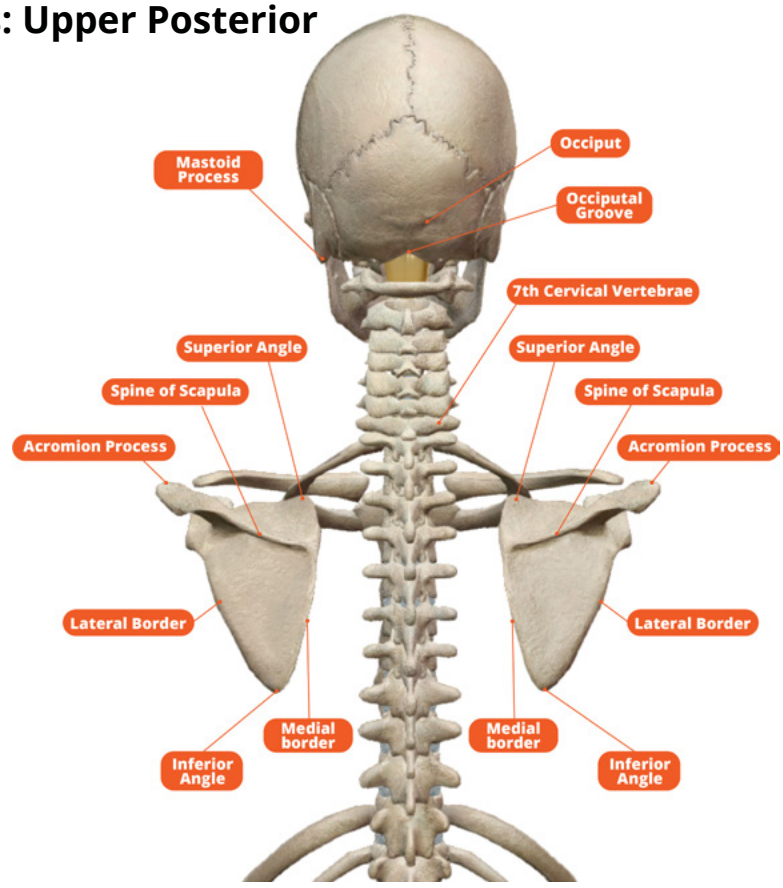


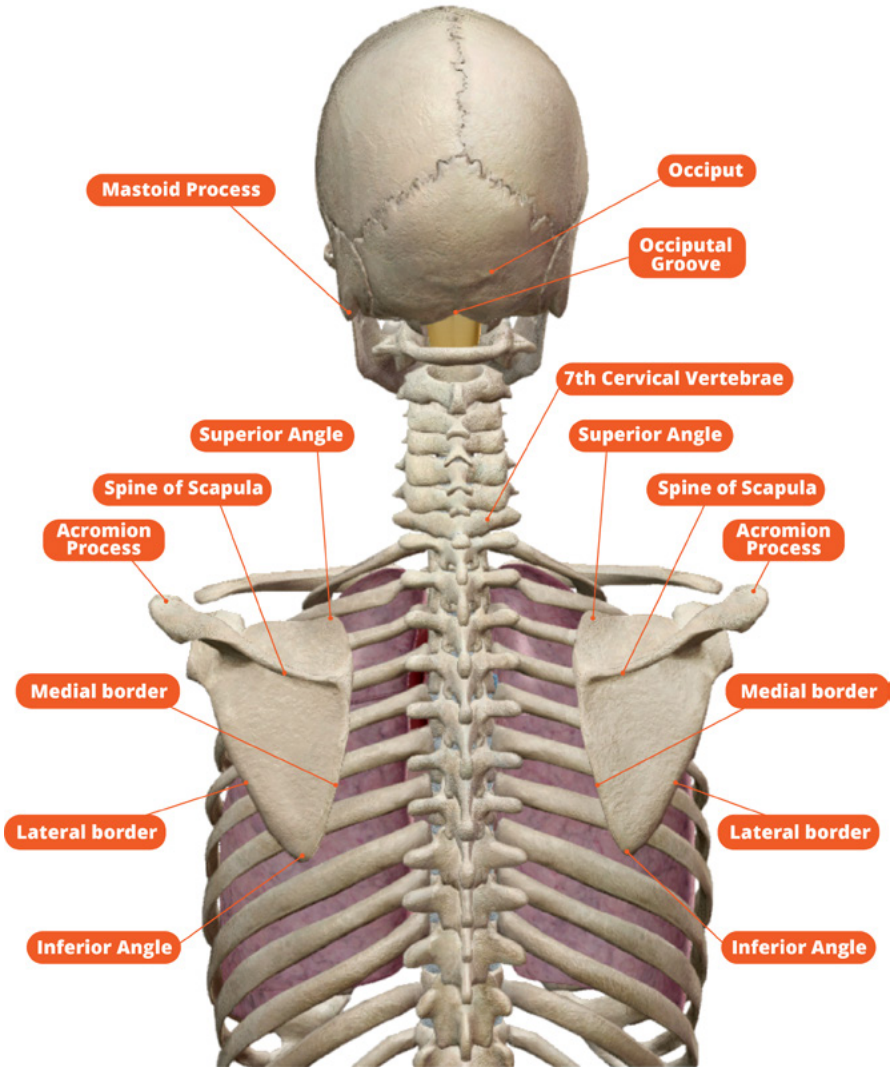

Manubrium
Acromion Process
Coracoid Process
Bicipital Groove
10th Rib
Medical Epicondyle of Humerus
Lateral Epicondyle of Humerus
Illiac Crest

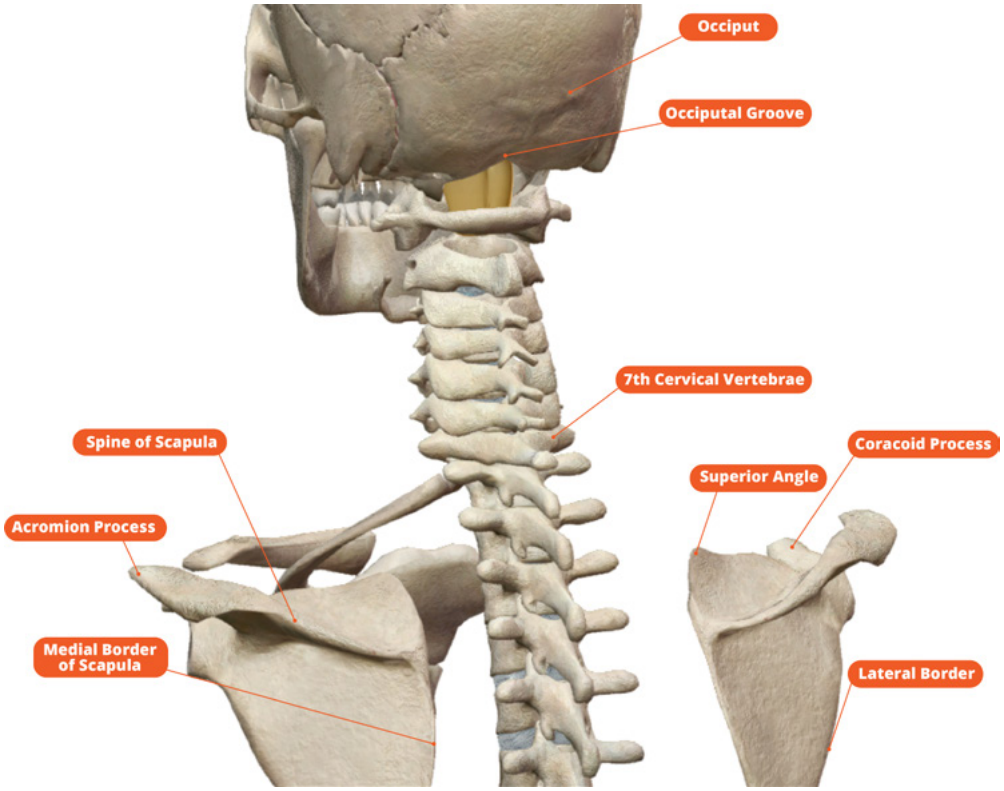

Temporal Line
Nasel
Zygomatic Process
7th Cervical Vertebrae
Manubrium
Acromion Process
Acromion Process
Coracoid Process
Coracoid Process
Fossa
Fossa
Xiphoid Process



Bony landmarks: Upper Posterior

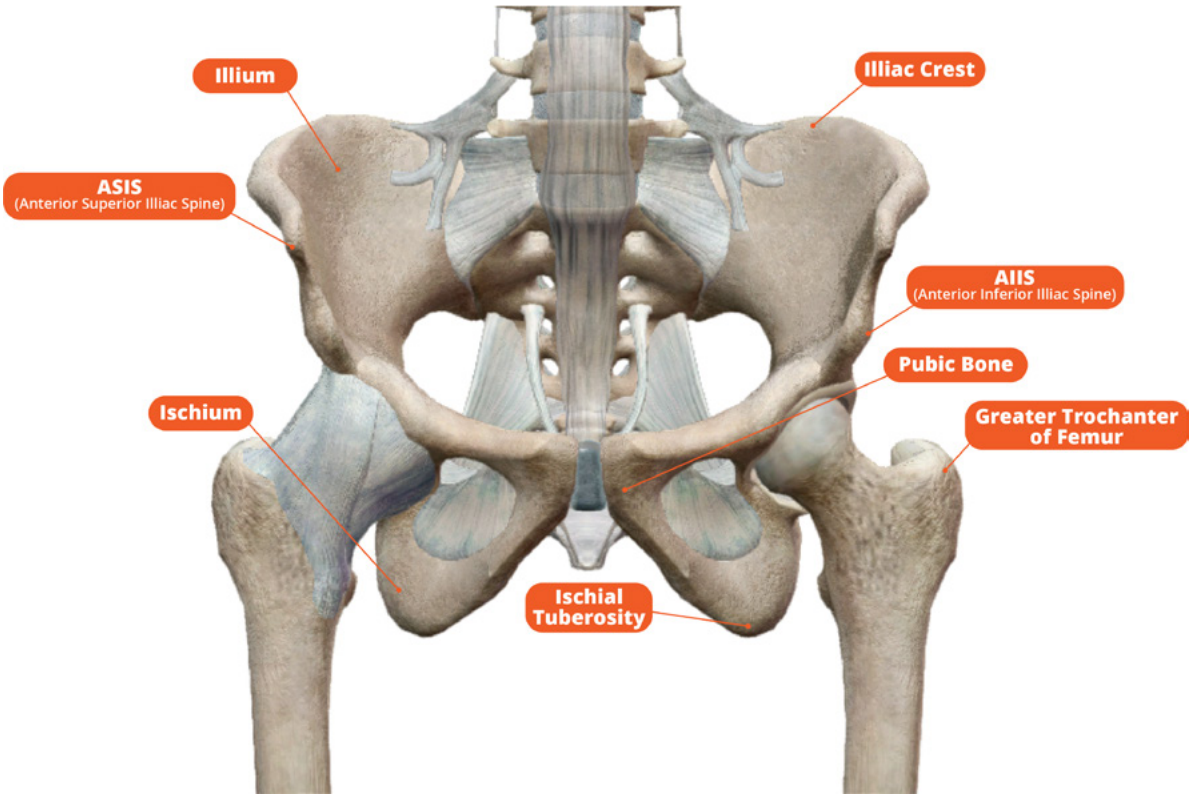



Mastoid Process
Occiput
Occiputal Groove
7th Cervical Vertebrae
Superior Angle
Superior Angle
Spine of Scapula
Spine of Scapula
Acromion Process
Acromion Process
Medial border
Medial border
Lateral border
Lateral border
Inferior Angle
Inferior Angle

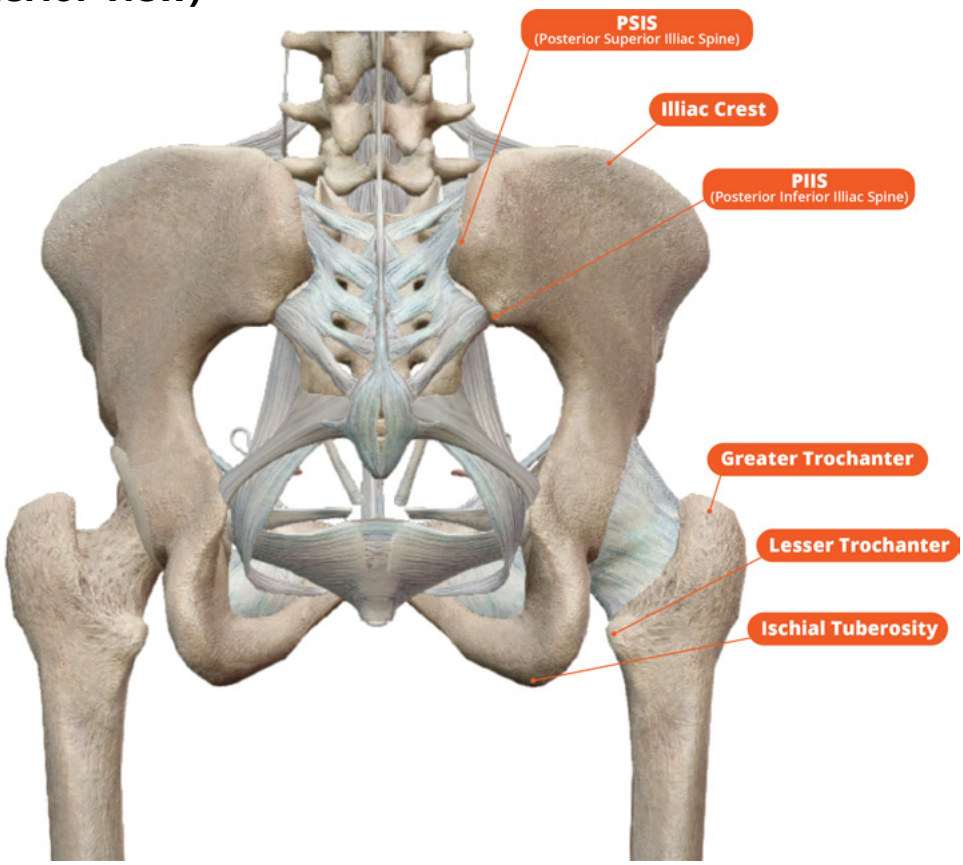

Occiput
Occiputal Groove
7th Cervical Vertebrae
Spine of Scapula
Coracoid Process
Superior Angle
Acromion Process
Medial Border of Scapula
Lateral Border

Bony landmarks: The Pelvis

The Pelvis (Anterior view)

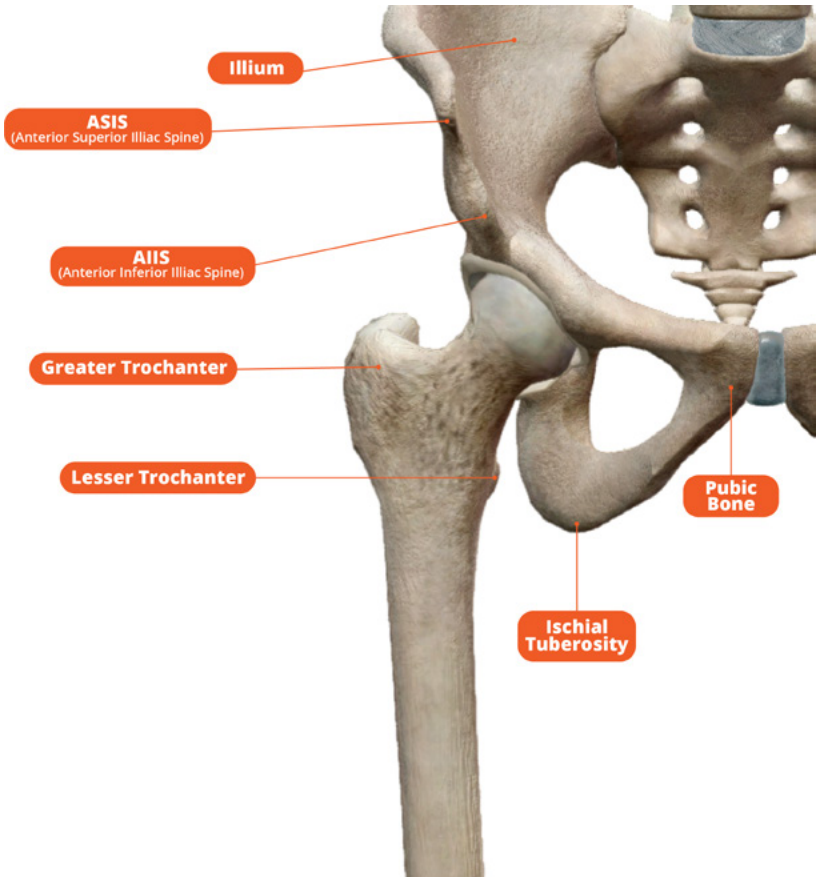


The Pelvis (Posterior view)

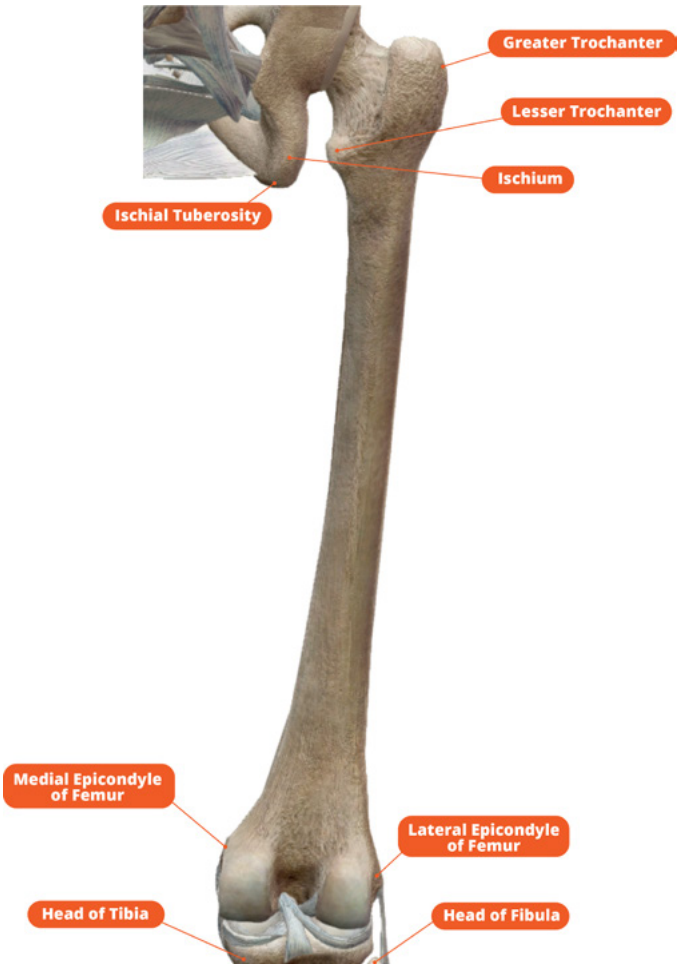


Bony landmarks: Pelvis and Femur

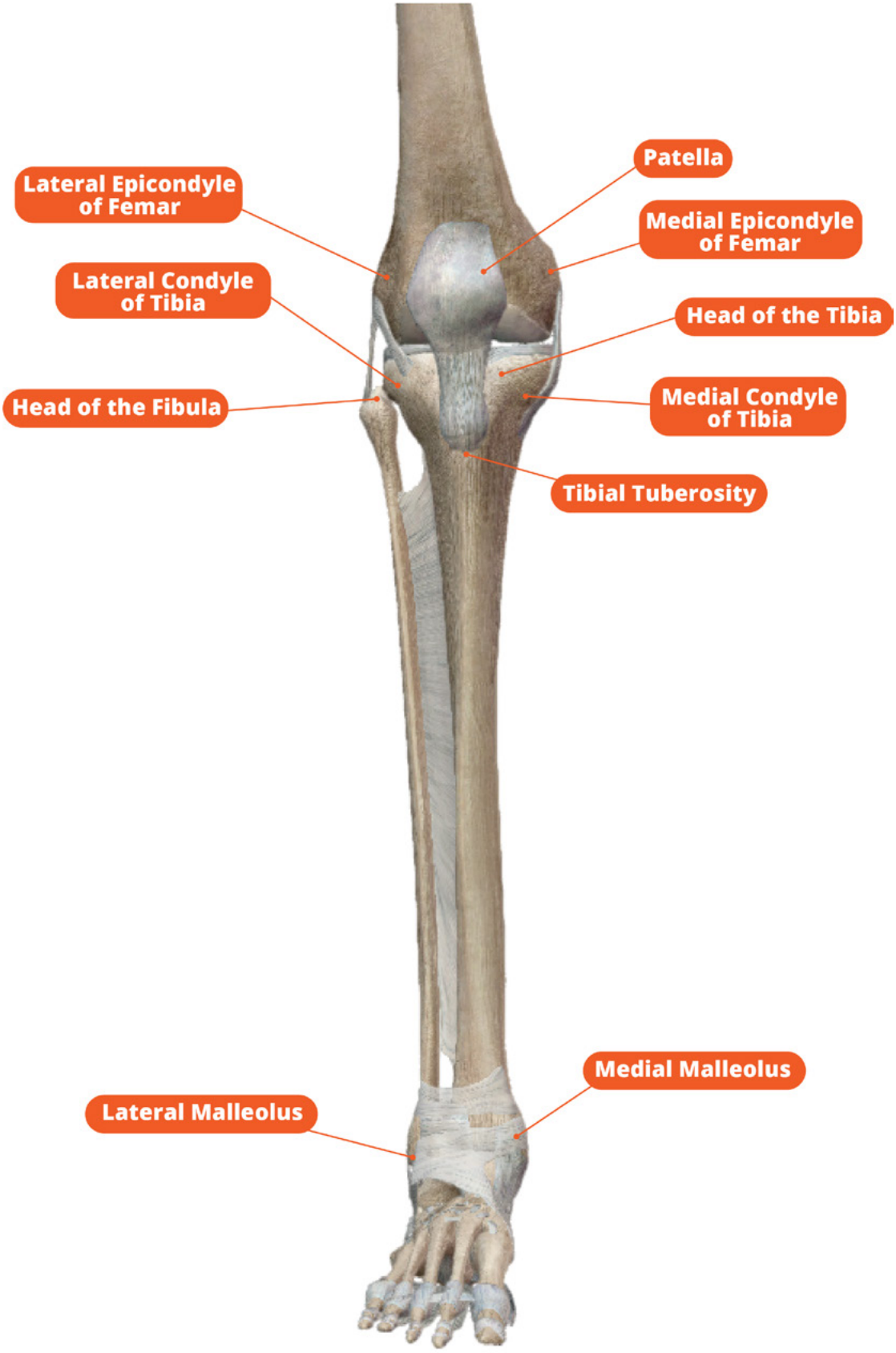
Anterior:



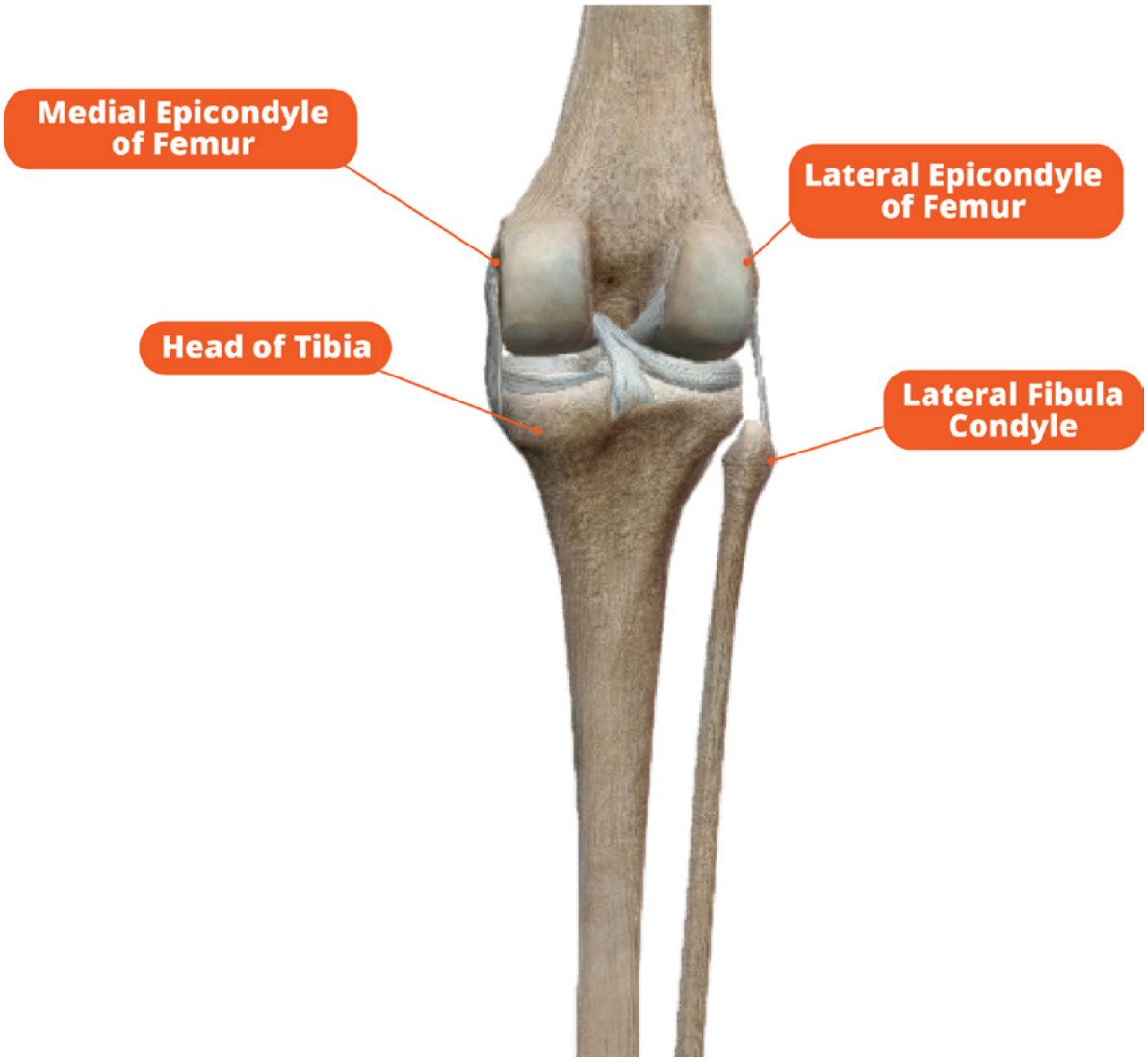
Posterior:



Bony Landmarks: Knee and Lower Leg (Anterior)



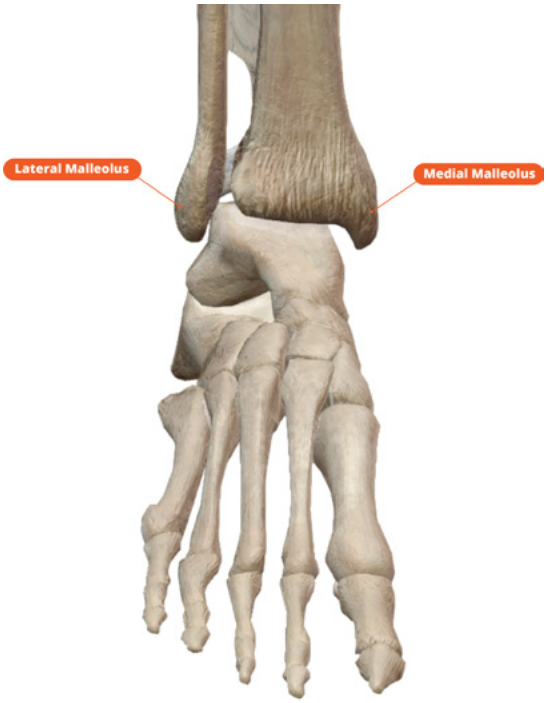
Bony Landmarks: Knee and Lower Leg (Posterior)



Bony Landmarks: The Foot and Ankle

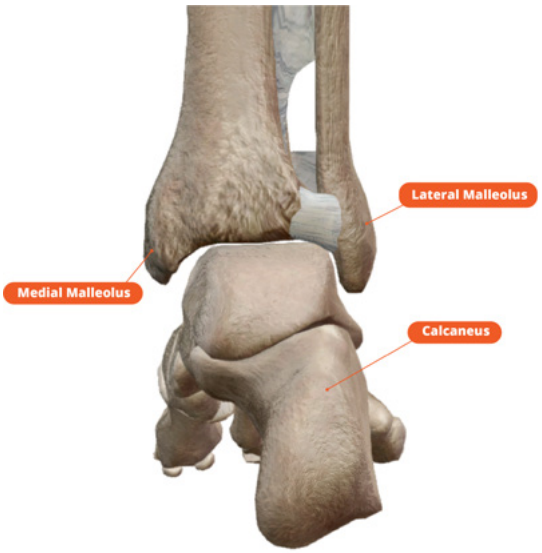
Medial View:

Anterior:



Lateral View:

Posterior:



Bony Landmark Guide

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ON LEARNING PLATFORM

Types of Joints

MODULE 1: INTRODUCTION TO LEVEL 3 PERSONAL TRAINING

Introduction

TYPES OF JOINTS

A joint is a location at which bones connect. This can be a junction between two or more bones. The purpose of joints is to allow movement. Joints are classified according to how the bones connect to each other and by the degree of movement available at that joint.

There are three types of joint:

1. Fibrous

2. Cartilaginous

3. Synovial

FIBROUS

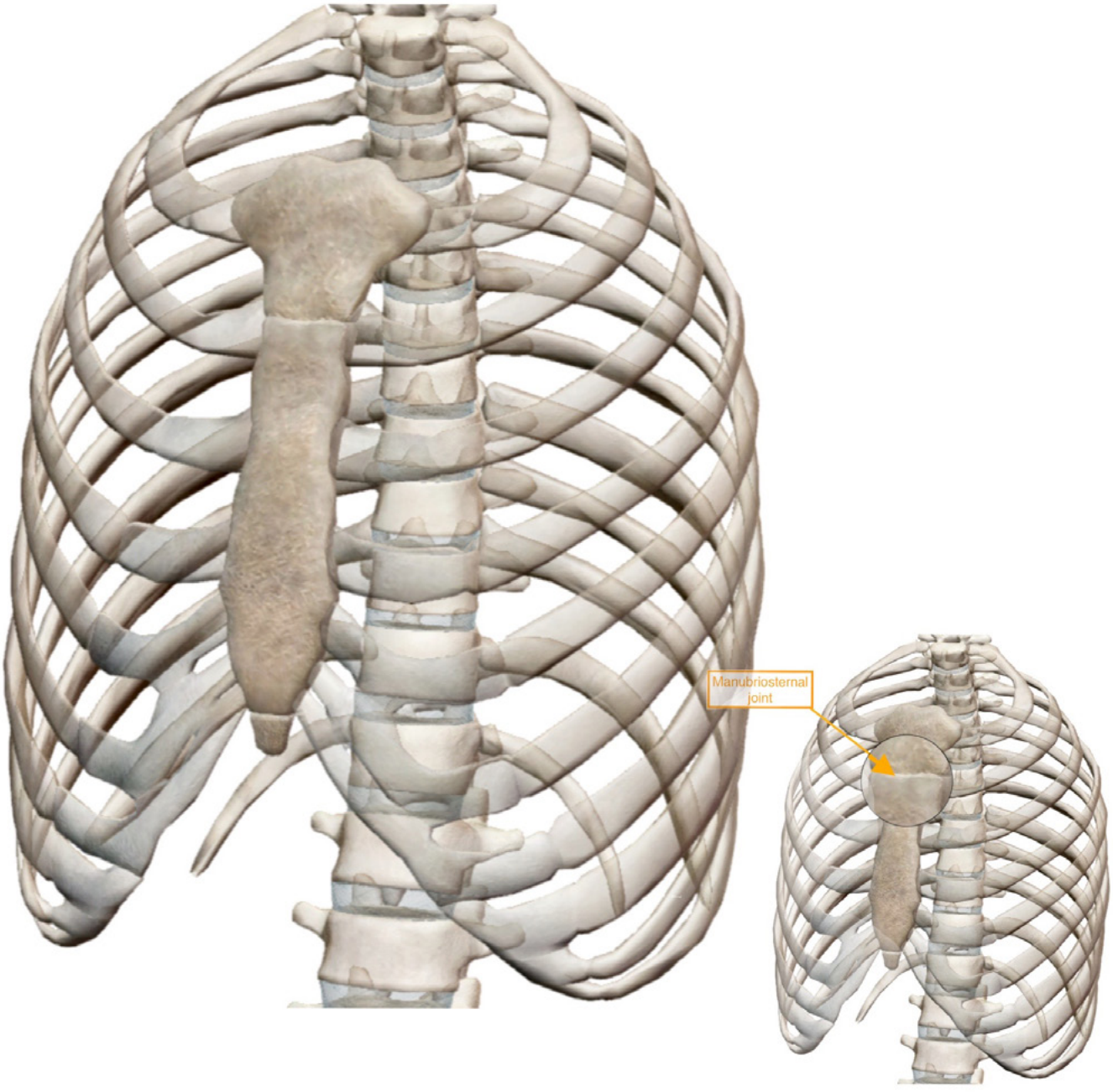
Fibrous joints are immovable and interlocking bones joined by fibrous tissue that is rich in collagen fibres.

The image shown is an example of a fibrous joint:
The Cranium (skull bones)

CARTILAGINOUS

Cartilaginous joints are slightly moveable, and the bones are joined together by cartilage.

The image shown is an example of a cartilaginous joint:
The Manubriosternal joint



SYNOVIAL

Synovial joints are freely moveable and are the most common type of joint in the body. It is the synovial joints that we will take a deeper look at in the next section.

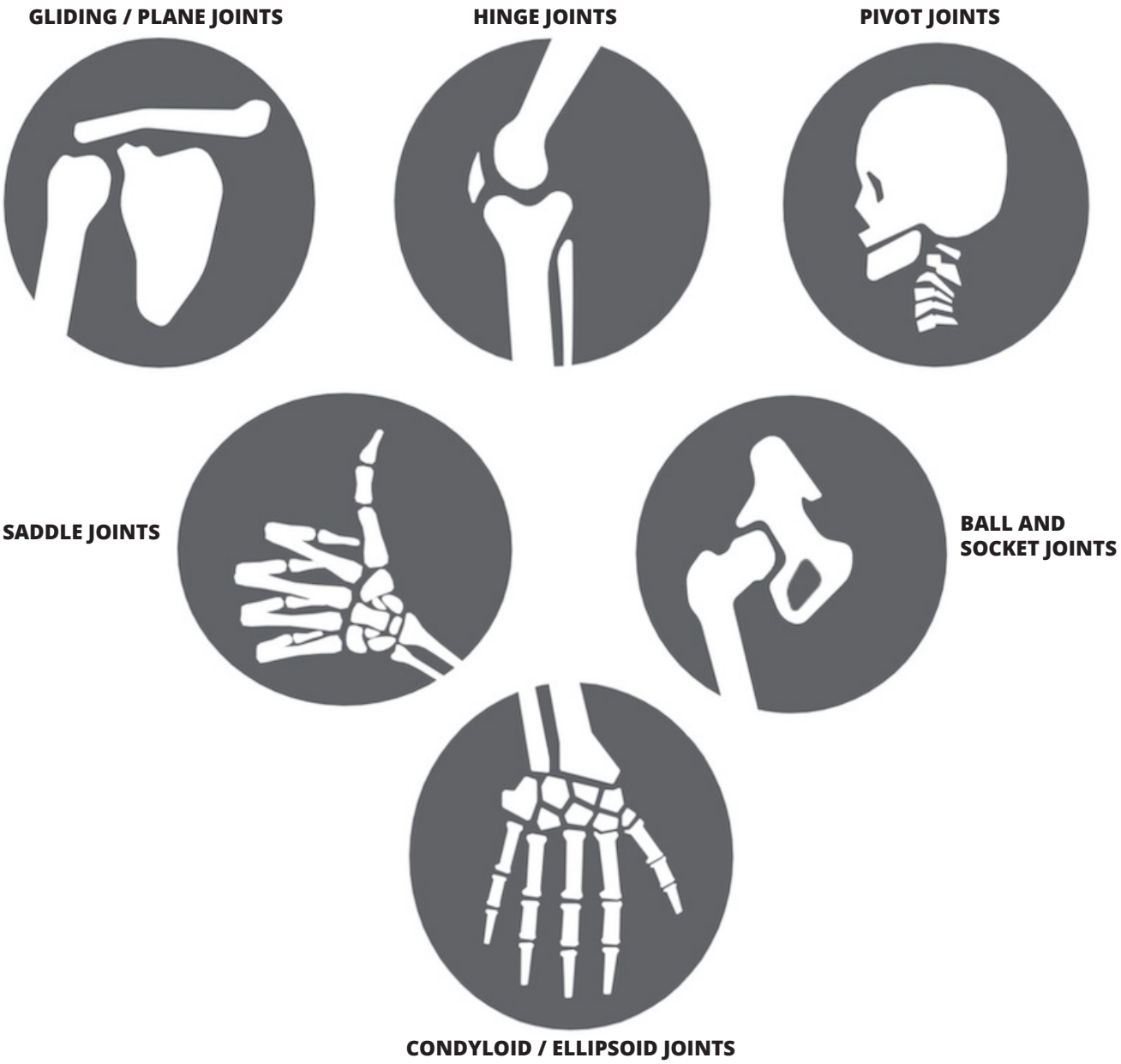
The image shown is an example of a synovial joint:
The Patellofemoral (knee)

Types of Synovial Joints

The following are characteristics of synovial joints:

1. **Ends of bones are covered with hyaline cartilage.**
2. **Surrounded by a fibrous capsule.**
3. **Capsule lined by a synovial membrane that secretes synovial fluid for lubrication.**
4. **Enclosed by ligaments for stability.**

There Are 6 Types Of Synovial Joint:



Synovial Joint Structure

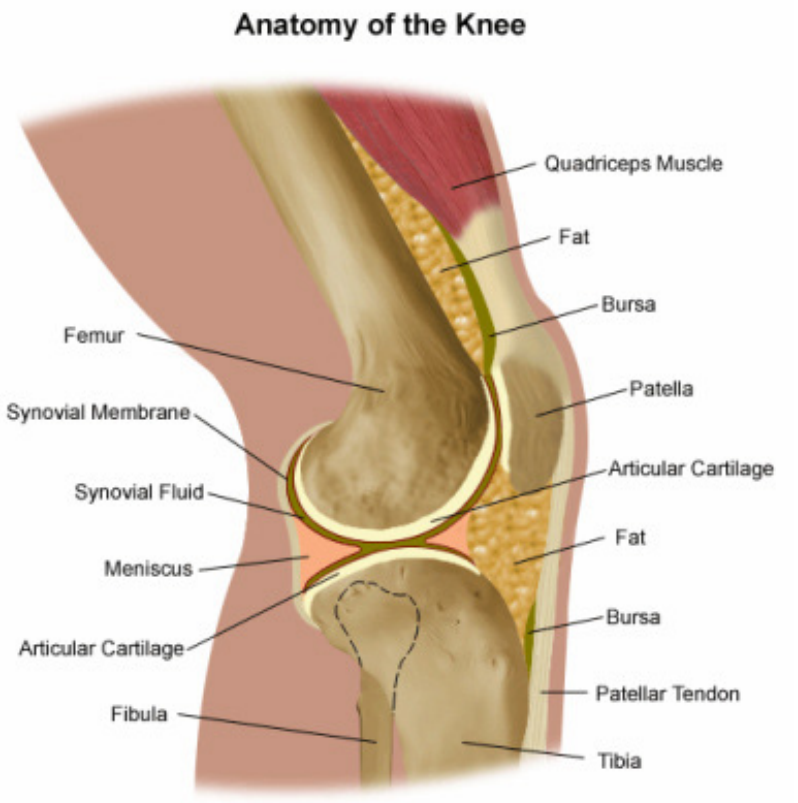
A synovial joint, also known as a diarthrosis, it is the most common and most movable type of joint in a mammal's body. Diarthroses are freely movable articulations. In these joints, the contiguous (bones that share a common border) bony surfaces are covered with articular cartilage and connected by ligaments lined by synovial membrane. The joint may be divided, completely or incompletely, by an articular disc or meniscus, the periphery of which is continuous with the fibrous capsule while its free surfaces are covered by synovial membrane.

The articular capsule is fibrous and continuous with the periosteum of articulating bones, surrounding the diarthrosis and uniting the articulating bones.

The Articular Capsule Also Consists Of Two Layers:

1. **The outer fibrous membrane that may contain ligaments.**
2. **The inner synovial membrane that secretes the lubricating, shock-absorbing, and joint nourishing synovial fluid.**

The bones of a synovial joint are covered by a layer of hyaline cartilage that lines the epiphysis (ends of bone) with a smooth, slippery surface to not bind them together. This articular (joint) cartilage functions to **absorb shock and reduce friction** during movement.



A synovial membrane (or synovium) is the soft tissue found between the articular capsule (joint capsule) and the joint cavity of synovial joints. Synovial fluid is the clear, viscid, lubricating fluid secreted by synovial membranes. The morphology of synovial membranes may vary, but it often consists of two layers. The outer layer, or subintima, can be fibrous, fatty, or loosely areolar. The inner layer, or intima, consists of a sheet of cells thinner than a piece of paper.

Where the underlying subintima is loose, the intima sits on a pliable membrane called the synovial membrane. This membrane, together with the cells of the intima, acts like an inner tube, sealing the synovial fluid from the surrounding tissue and effectively stopping the joints from being squeezed dry when subjected to impact (such as when running). As with most other joints, synovial joints achieve movement at the point of contact of the articulating bones. The main structural differences between synovial and fibrous joints are the existence of capsules surrounding the articulating surfaces of a synovial joint and the presence of lubricating synovial fluid within those capsules (synovial cavities).

Synoviocytes

The intimal cells are termed synoviocytes and can be either Macrophagic (type A synoviocytes)or Fibroblastic (type B synoviocytes). Both types have differences from similar cells in other tissues. The type B synoviocytes manufacture a long-chain sugar polymer called hyaluronan, which combines with a molecule called lubricin to give the synovial fluid a stringy, egg-white consistency. The water component of synovial fluid is effectively trapped in the joint space by the hyaluronan due to its large, highly negatively charged moieties. The macrophages (type A) are responsible for the removal of undesirable substances from the synovial fluid.

Structure of Synovium

The surface of the synovium (synovial membrane) may be flat or covered with finger-like projections (villi) to allow the soft tissue to change shape as the joint surfaces move on one another. Just beneath the intima, most synovia have a dense net of small blood vessels that provide nutrients for the synovia and the avascular cartilage.

In any one position, much of the cartilage is close enough to get nutrition directly from the synovium. Some areas of cartilage have to obtain nutrients indirectly and may do so either from diffusion through cartilage or by the stirring of synovial fluid.

Synovial Bursa

The synovial bursa is a small, fluid-filled sac lined by a synovial membrane containing synovial fluid. It provides a cushion between bones and tendons and/or muscles around a joint.

A Gliding/Plane Joint

Gliding or Plane Joint examples:

- Acromioclavicular Joints
- **Carpal Joints**
- Tarsal Joints
- Inter-vertebral Joints

VIDEO AVAILABLE ON LEARNING PLATFORM

Highlighted example: Carpal Joint

- **Location:** the wrist and specific to articulation the Carpal Bones.
- **Joint actions:** Flexion, Extension, Abduction and Adduction.
- **Common injuries:** Fractures, Sprains, DeQuervain's Syndrome, Extensor carpi ulnaris (ECU) tendonitis.

A Hinge Joint

Hinge Joint examples:

- **Patellofemoral Joint** (Knee - Patella and Femur).
- Tibiofemoral Joint (Knee - Tibia and Femur).

VIDEO AVAILABLE ON LEARNING PLATFORM

Highlighted example: Patellofemoral Joint

- **Location:** at the knee and specific to articulation of the Femur and Patella bones.
- **Joint actions:** Flexion and Extension.
- **Common injuries:** Fractures, Sprains, Dislocations, Knee Bursitis, Patella Tendinitis

A Pivot Joint

Pivot Joint example:

- **Atlanto-Axial Joint** (C1-C2) (Neck)

VIDEO AVAILABLE ON LEARNING PLATFORM

Highlighted example: Atlanto-axial joint

- **Location:** the neck and specific to the articulation of the C1 and C2 bones.
- **Joint actions:** Rotation.
- **Common injuries:** Fractures, Sprains, Herniated Disk, Pinched Nerve

A Condyloid or Ellipsoid Joint

Condyloid or Ellipsoid Joint examples:

- **Metacarpophalangeal Joint** (Knuckles)
- Radio-carpal Joint (Forearm - wrist)

VIDEO AVAILABLE ON LEARNING PLATFORM

Highlighted example: Metacarpophalangeal joint

- **Location:** the knuckles of the hand and specific to articulation of the Metacarpal and Phalanges bones.
- **Joint actions:** Flexion, Extension, Abduction, Adduction and limited Circumduction.
- **Common injuries:** Fractures, Dislocation, Sprains.

A Saddle Joint

Saddle Joint example:

- **Carpometacarpal Joint (Thumb)**

VIDEO AVAILABLE ON LEARNING PLATFORM

Highlighted example: Carpometacarpal joint

- **Location:** the thumb joint of the hand.
- **Joint actions:** Flexion, Extension, Abduction, Adduction and limited Circumduction.
- **Common injuries:** Fractures, Dislocation, Sprains, Texters Thumb (form of tendinitis)

A Ball and Socket Joint

Ball and Socket Joint examples:

- Acetabulofemoral Joint (Hip)
- **Glenohumeral Joint (Shoulder)**

VIDEO AVAILABLE ON LEARNING PLATFORM

Highlighted example: Glenohumeral joint

- **Location:** the shoulder and specific to the articulation humerus and the glenoid fossa of the scapula.
- **Joint actions:** Flexion, Extension, Abduction, Adduction, Circumduction, Lateral Rotation, Medial Rotation.
- **Common injuries:** Dislocation, Separation, Fracture, Frozen shoulder, Impingement, Osteoarthritis, Tendinitis.

A Downloadable Synovial Joint Table

DOWNLOADABLE RESOURCE AVAILABLE
ON LEARNING PLATFORM

Joint Type	Mechanical Diagram	Example	Function
Gliding or Plane		Acromioclavicular	Allow two bones to slide past each other
Hinge		Knee	Bones can only move through flexion and extension
Pivot		Atlas-axis (C1-C2)	Allows rotation around an axis
Ball and socket		Hip	Allows movement in almost any direction. The greatest amount of joint movement in the body
Condyloid or Ellipsoid		Metacarpophalangeal (knuckles)	Similar to ball and socket joint but allow a lesser degree of movement
Saddle		Carpometacarpal (thumb)	Similar to ball and socket/saddle joints without rotational movement

Introduction To Nutrition

MODULE 1:
INTRODUCTION TO LEVEL 3 PERSONAL TRAINING

Nutrition is the study of food and how it affects your body. From the cradle to the grave, your body needs and uses food for energy, for growth, repair and development and for maintaining good health. It's commonly accepted that healthy food is essential for a healthy body and everyone needs to consume a "balanced diet" however because there is often so much contradictory information available as to what constitutes a balanced diet, many people are confused and have no real idea as to what they should be eating.

The media doesn't help and most newspapers and magazines happily champion the latest fad diet seemingly oblivious to the fact that they are completely contradicting the information that they published previously.

A balanced diet should reflect the needs of the individual and address health, performance and weight management. The word balanced implies that all food groups should be included and that the exclusion of food groups (e.g. carbohydrates or fats) would lead to an unbalanced diet.

Unfortunately, nutrition is not that cut and dry but following a balanced diet is much better than eating too much of the junk food that now weighs down the shelves of every major supermarket.

The word diet deserves some consideration also; for many, it's a four-letter word meaning a period of reduced food intake specifically for weight loss as in "I'm going on a diet". However, **diet is more accurately the sum total of the food you eat – restricted or otherwise**. A diet can be good, bad, balanced, unbalanced, healthy, unhealthy, fattening or lead to weight – it all depends on what foods make up the diet.

Personal Trainers Need To Understand The Importance Of Nutrition For Several Reasons:

- **A healthy diet underpins everything that happens in the body**
- **A lack of the correct balance of nutrients can significantly inhibit fitness gains**
- **Lack of fitness gains will often be blamed on the program or the trainer**
- **A large percentage of clients are exercising specifically for weight loss**
- **Exercise will be all but ineffective for weight loss without addressing diet**
- **Dietary advice provides an additional revenue stream for personal trainers**
- **Correct nutrition can make your clients healthier and happier**
- **Happy and healthier clients are great adverts and a source of referrals**
- **With so much misinformation around, personal trainers are in a great position to educate clients about the importance of nutrition. Everybody, whether they are fit or fat, likes to talk about food and nutrition!**

You Are What You Eat

While it's not clear who first uttered the words "you are what you eat" you can guarantee it was someone well ahead of their time and it's a nutritional truism that is worth remembering. The food we consume is broken down and either become part of us or is used for fuel and anything that isn't used passes through our digestive tracks to be excreted. Our bodies have a very intimate relationship with the food we eat and so the type and quality of the food consumed is of paramount importance as food affects our bodies' at the most fundamental level.

To fully comprehend "you are what you eat", consider the basic organisation of life:

Food > Chemicals > Cells > Tissues > Organs > Systems > The human body

Alternatively, consider how protein is used in the body:

Protein > Amino acids > Actin > Muscle fibres > Muscles > Muscular system

Other Systems To Which The Same Organisation Applies Include:

- **Skeletal system**
- **Nervous system**
- **Digestive system**
- **Respiratory system**
- **Circulatory system**
- **Lymphatic system**
- **Endocrine system**
- **Reproductive system**

Macronutrients and Micronutrients

Macronutrients

Macronutrients are needed in larger quantities (in gram range). They normally include water, carbohydrates, fat and protein. Macronutrients (except water) are also called energy-providing nutrients. Energy is measured in calories and is essential for the body to grow, repair and develop new tissues, conduct nerve impulses and regulate life process.

Carbohydrates: are required for energy and provide body's main source of energy (4 calories per gram); they form the major part of stored food in the body for later use of energy and exist in three forms: sugar, starch and fibre. The brain works entirely on glucose alone. When in excess, it is stored in the liver as Glycogen. Carbohydrates are also important for fat oxidation and can also be converted into glucose.

Fats: are used in making steroids and hormones and serve as solvents for hormones and fat-soluble vitamins. Fats have the highest caloric content and provide the largest amount of energy when burnt. When measured by a calorimeter, fats provide about 9 calories per gram of fat, making them twice as energy-rich than protein and carbohydrates. Extra fat is stored in adipose tissue and is burnt when the body has run out of carbohydrates.

Proteins: they provide amino acids and make up most of the cell structure including the cell membrane. They are the last to be used of all macronutrients. In cases of extreme starvation, the muscles in the body, that are made up of proteins, are used to provide energy. This is called muscle wasting. As for carbohydrates, proteins also provide 4 calories per gram.

Hydration

Water: makes up a large part of our body weight and is the main component of our body fluids. The body needs more water every day than any other nutrient and we replenish it through foods and liquids we eat and drink. Water serves as a carrier, distributing nutrients to cells and removing wastes through urine. It is also a compulsory agent in the regulation of body temperature and ionic balance of the blood. Water is completely essential for the body's metabolism and is also required for lubricant and shock absorber.

Micronutrients

These nutrients include minerals and vitamins. Unlike macronutrients, these are required in very minute amounts. Together, they are extremely important for the normal functioning of the body. Their main function is to enable the many chemical reactions to occur in the body. Micronutrients do not function for the provision of energy.

Vitamins: are essential for normal metabolism, growth and development, and regulation of cell function. They work together with enzymes and other substances that are necessary for a healthy life. Vitamins are either fat-soluble or water-soluble. Fat-soluble Vitamins can be stored in the fatty tissues in the body when in excess. Water-soluble vitamins are excreted in urine when in excess and so need to be taken daily. Water-soluble vitamins include Vitamin B and C. Green leafy vegetables are rich in Vitamin B, whereas Vitamin C is found abundantly in citrus fruits. Fat-soluble vitamins are Vitamin A, D, E and K. Green leafy vegetables, milk and dairy products and plant oils provide these vitamins.

Minerals: are found in an ionised form in the body. They are further classified into macro-minerals and micro-minerals (or trace minerals). Macro-minerals present in the body include Calcium, Potassium, Iron, Sodium and Magnesium to name a few. Iron is a constituent of Hemoglobin which is present in the blood. Macro-minerals are needed in more amounts, as compared to micro-minerals. Micro-minerals include Copper, Zinc, Cobalt, Chromium and Fluoride. They are mostly co-factors, and are necessary for the function of enzymes in the body, but are needed only in minor quantities. Approximately 4% of the body's mass consists of minerals.

Micronutrients

MODULE 1:
INTRODUCTION TO LEVEL 3 PERSONAL TRAINING

IN THIS SECTION YOU WILL LEARN THE FOLLOWING:

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

Introduction

Vitamins and minerals are the very sparkplugs your body needs for life. In fact, if your diet is deficient in vitamins and/or minerals, ill health is likely to be the result. Whilst vitamins and minerals don't contain any meaningful energy themselves, they allow your body to unlock energy within the macronutrients and also act as biological catalysts in the myriad reactions that occur in your body. A diet that is lacking in vitamins and minerals results in sluggish or even a complete absence of life-sustaining reactions. For example, it is common knowledge that vitamin C can help you ward off a cold. This is because vitamin C plays an important role in immune system function. Ironically, many people only worry about their vitamin C intake when they actually get a cold, by which time it's too late!

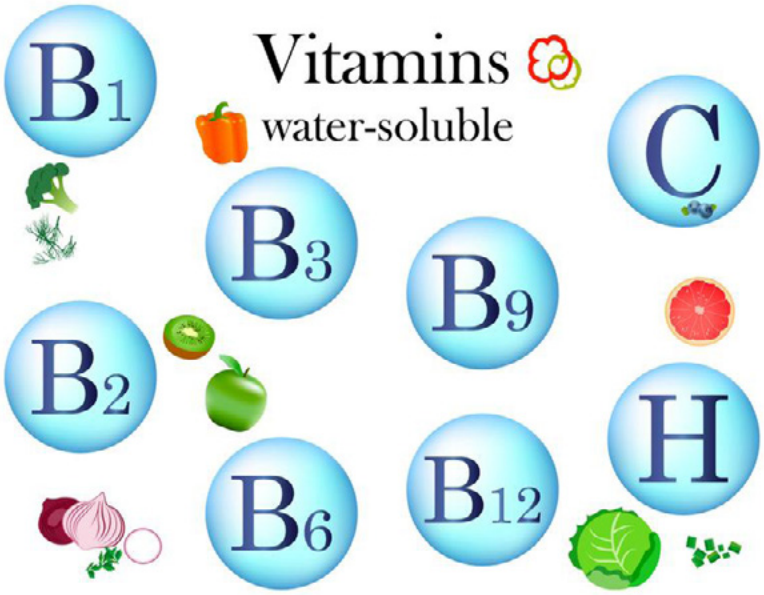
Selected Vitamins and Their Uses

We get vitamins from plant foods or from animals that have eaten plant foods. We also synthesise a small number of vitamins in our digestive tracts. We also get vitamins from substances called pro-vitamins. Provitamins are organic compounds that can be synthesized into vitamins once eaten. For example, the pro-vitamin beta-carotene converted into vitamin A. Vitamins are organic compounds that can be classed as water or fat-soluble.

Vitamin uses

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

Fat and Water Soluble

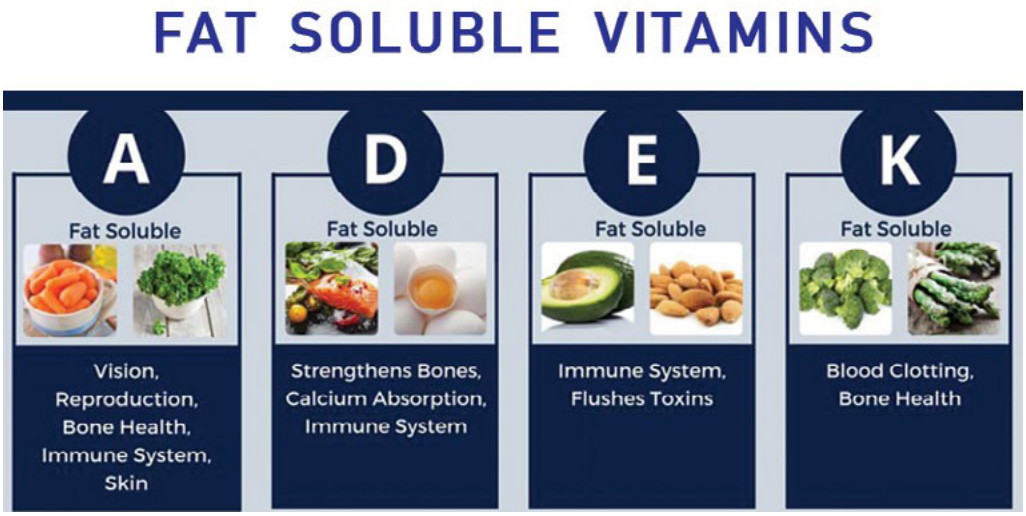


Water Soluble

Vitamins B and C are soluble in water. This means that you **need to consume them on a daily basis as your body is unable to store them** in any meaningful amounts. Any e**xcess is eliminated in your urine** which is why high doses of vitamin C can turn your urine bright green!

Too much **vitamin B and C are seldom toxic** as your body simply flushes away the surplus but that doesn't mean you should go overboard. **Too much vitamin C** can increase the acidity levels in your digestive and urinary system and **cause an upset stomach. Some B vitamins**, specifically biotin and riboflavin, are also **produced by the bacteria in the digestive tract.**

Fat Soluble



Vitamins A, D, E and K are transported and utilized in the presence of fat. Subsequently, they **do not have to be eaten every day as you can store them in your body.** Because you can build up high levels of these micronutrients, **it is possible, albeit unlikely, to reach toxic levels** if you consume a large amount. **A diet low in fat can lead to a deficiency in the fat-soluble vitamins.** The manufacture of steroid hormones (testosterone, oestrogen and cortisol) from cholesterol requires a plentiful supply of vitamin A.

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

Selected Minerals and Their Uses

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

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

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

Minerals

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

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

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

Micronutrients Requirements

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

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

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

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

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

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

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

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

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

Vitamin And Mineral Supplements

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

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

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

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

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

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

Micronutrient Summary

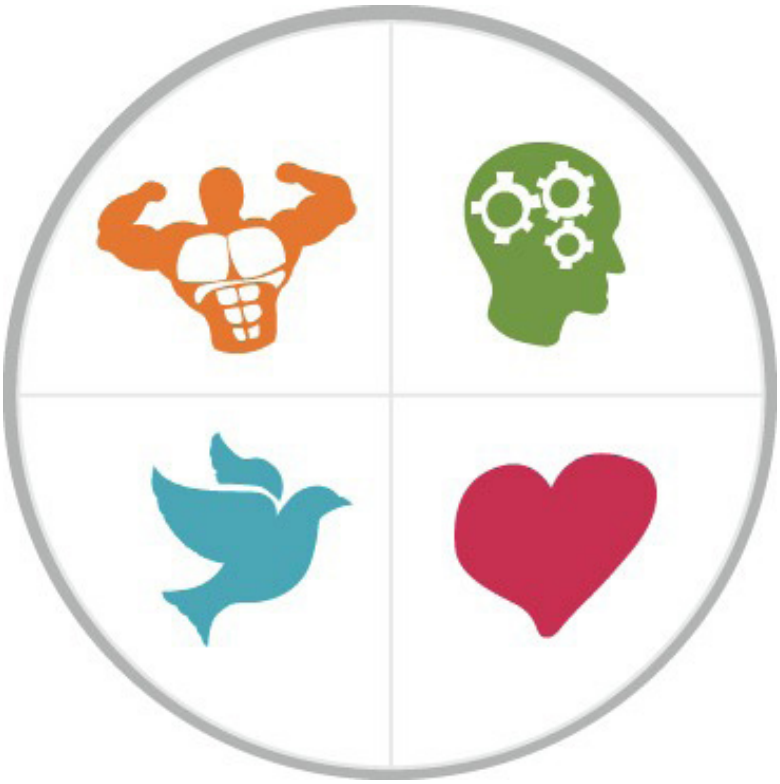
With a basic understanding of the micronutrients and their effect on the body, a personal trainer should be able to provide some general food recommendations so that clients can adapt their diet for improved health and performance. These recommendations should include:

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

Types of Fitness

MODULE 1: INTRODUCTION TO LEVEL 3 PERSONAL TRAINING

Total Fitness



Total fitness is made up of six components and while the physical aspect of fitness is usually the focus of an exercise program, the other components are equally important:

1. **Physical fitness i.e. muscular strength, endurance, flexibility etc.**
2. **Skill-related fitness i.e. balance, coordination etc.**
3. **Mental and emotional fitness i.e. a positive, stress-free mental state.**
4. **Medical fitness an absence of illness and disease.**
5. **Nutritional fitness following a healthy, nutritious diet.**
6. **Social fitness being able to interact with others.**

A fitness instructor can have a positive influence on all of the above components however their main area of professional responsibility are physical, nutritional and skill-related fitness.

Physical Fitness

Physical related fitness refers to the ability of the systems of the body to work together efficiently to allow you to be healthy and perform activities of daily living.

THERE ARE 5 BROAD COMPONENTS OF PHYSICAL-RELATED FITNESS:

1. CARDIOVASCULAR FITNESS

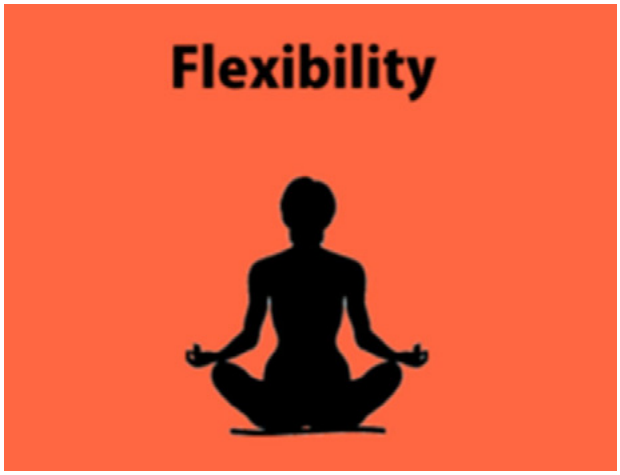
Pertaining to the ability of the lungs and heart to take in, transport and utilise oxygen, cardiovascular fitness can be improved by performing activities such as jogging and swimming at low to moderate intensities for extended periods of time. Cardiovascular fitness is inextricably linked to cardiovascular health.

2. MUSCULAR STRENGTH

Strength is the ability to generate force. Strength is important because stronger muscles make strenuous everyday tasks easier and the pursuit of strength has a positive influence on bone mass.

3. MUSCULAR ENDURANCE

Muscular endurance is the ability of the muscles to generate low levels of force for an extended period of time e.g. the demand on the leg muscles when climbing a long flight of stairs. A good level of muscular endurance can make many daily tasks easier including gardening, high-repetition exercise and maintaining good posture.



4. FLEXIBILITY AND MOBILITY

The ability to move a joint or joints through a wide, healthy range of movement is defined as flexibility. Whereas the health and fluidity of movement of a joint is defined as mobility. Flexibility and mobility are essential for optimal muscular and skeletal function as well as health. Poor flexibility and/or mobility can make many every day and sporting activities difficult and can lead to postural issues.

5. BODY COMPOSITION

Describing the relationship between fat and lean body weight, body composition is much more important than body weight and all exercisers should strive to achieve optimal body composition. Body composition is influenced by exercise, diet and general lifestyle and a high level of body fat will not only damage fitness levels; it can also damage health.

Skill Related Fitness

Skill-related fitness refers to the interaction between the nervous system and the muscular system.

THERE ARE 7 COMPONENTS OF SKILL-RELATED FITNESS:

1. SPEED

Speed as about quickness of movement whether it is running speed or the ability to throw a quick jab in boxing. Speed is part of virtually every sport and can be developed through training although top-end speed is limited by genetics and dominance of muscle fibre type.

2. POWER

Power is force developed quickly. Where strength has no real speed component, power does. For example, a very heavy squat, where the weight moves slowly, is an example of strength while an explosively performed vertical jump is an example of power. Power is an important part of many sports and activities.

3. REACTION TIME

The ability to respond quickly to a stimulus, such as a starter's pistol, is called reaction time but is sometimes called reflex time. Reaction time is dependent on the speed of sensory and motor nerves working together and can be trained.

4. BALANCE

Defined as the ability to keep the centre of mass over the base of support e.g. standing on one leg or maintain a handstand. Balance is especially important for older people who are prone to suffering falls.

5. COORDINATION

The ability to move multiple limbs harmoniously and accurately is called coordination. While some people are definitely more coordinated than others, coordination can be practised and improved. All sports and many everyday activities require coordination.

6. PROPRIOCEPTION

The ability to sense where limbs are placed by feel alone is called proprioception. For example, maintaining neutral spine alignment despite not being able to see the position of your back.

7. AGILITY

Rapid changes of direction, being able to overcome obstacles and general athleticism all come under the banner of agility. Agility is the combination of all the preceding components.

Factors That Influence Health And Fitness

If you place two different people on the same exercise program, their results are very likely to be different. No two people respond exactly the same way to exercise. There are several factors that influence how people respond to exercise and the results they will experience.

Age

Potential for fitness tends to peak in the 20s and early 30s and decline thereafter although this decline can be offset by regular exercise. With age, muscles get weaker, joints become worn, hormone levels decline, reflexes slow and body fat levels increase. Older people are also less able to tolerate high volume/ high-intensity exercise and require more rest.

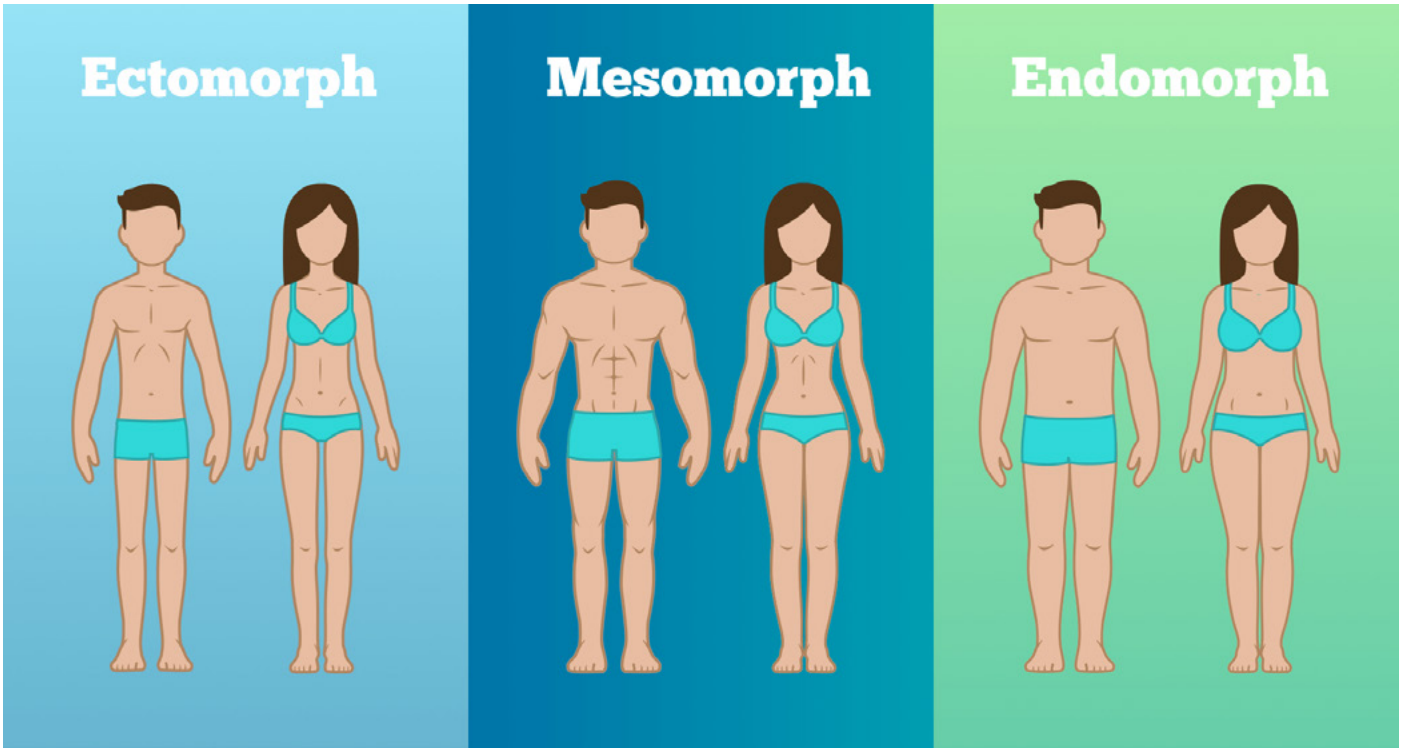
Gender

Men have more testosterone than women and as such have a greater potential for muscle mass and strength. Women, because of the hormone relaxin, tend to be naturally more flexible than men. However, both women can develop impressive levels of strength and men can be very flexible with the correct training.

Physique/ body type

The body type of an individual will have a profound effect on their ability to develop fitness. For example, a heavily built, naturally muscular person is better suited to rugby than long-distance running. The usual system for classifying body types is called somatotype, although it is important to note that most people are made up of a mixture of the three main somatotypes.

The 3 Somatotypes



ECTOMORPHS – naturally slim, lightly muscled, narrow in the shoulders and hips, ectomorphs usually find gaining weight very difficult and are well-suited to endurance sports such as running or cycling where their light bodies will be advantageous.

MESOMORPHS – with a tendency to be naturally lean and muscular, mesomorphs usually have wide shoulders and narrow waists and tend to be athletic and strong having a good strength to weight ratio.

ENDOMORPHS – with a propensity toward fat storage, endomorphs are usually "apple" or "pear" shaped but, despite high body fat levels, are usually also reasonably muscular. Heavy throwing events such as the hammer or shot-put as well as weightlifting are good activities for endomorphs.

Identifying a client's basic body type can be important when ensuring that proposed goals are viable. For example, an ectomorph needs to understand that they are not structurally well-suited to building large amounts of muscle while a mesomorph may need to reconsider thoughts of becoming an elite-class distance runner. However, it should also be noted that hard work and smart programming can still produce excellent results irrespective of the underlying somatotype.

Diet

For the body to adapt to exercise, it needs a broad range of nutrients including protein and carbohydrates, vitamins and minerals. A low-quality diet can adversely affect gains in fitness.

Activity level

A few hours of exercise per week will not be sufficient to develop a good level of fitness if, for the other 165-hours a week, the client is sedentary. Conversely, if the client is so active that they cannot effectively recover from the training sessions, they too will not experience noticeable improvements in fitness.

Physical disabilities

As demonstrated in the Paralympics, people with disabilities can be very fit and strong but, in cases of the body not functioning as it should, a physical disability may place limits on fitness and performance.

Drugs

Pharmaceutical and recreational drugs can adversely affect fitness. Instructors should ask clients if they are taking any prescription or recreational drugs prior to exercise so any potential contradictions should be investigated. If in doubt, the instructor should refer the client to a medical professional.

Illness and fatigue

Illness and tiredness can diminish physical performance as both interfere with not only exercise but the recovery from exercise. In some cases, too much exercise – a condition called overtraining – can cause both illness and fatigue.

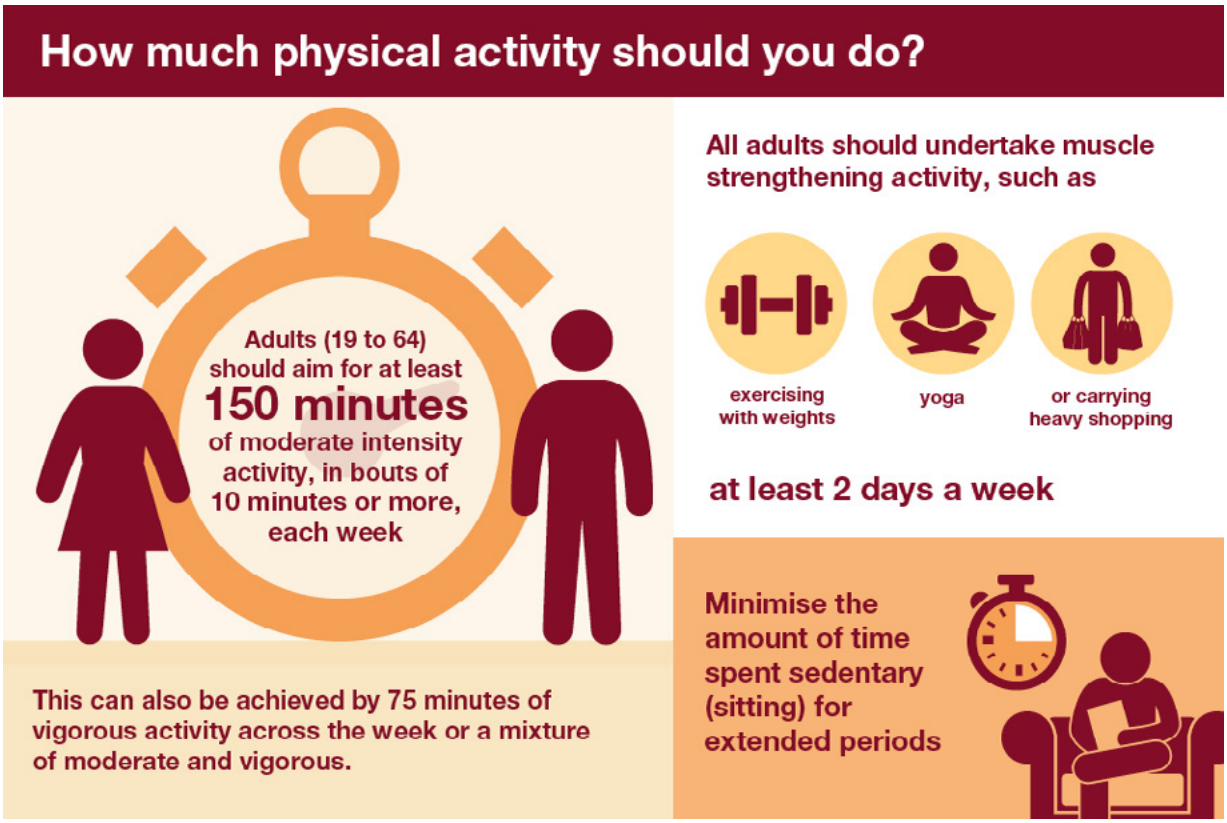
Stress

Stress increases the production of the catabolic (breaking down) hormone cortisol and can also cause an elevation of blood pressure, increase the prevalence of heart disease and trigger stress-eating. Stress, therefore, can have an adverse effect on fitness.

Environment

Water, food and air-borne-toxins can have an adverse effect on fitness and health. Fumes from traffic can significantly impair aerobic function as well as exercising at altitude. Weather can also affect exercise intensity and duration.

Health Benefits Of Physical Activity



Exercise has a profound and beneficial impact on not just fitness but health too. In fact, too little exercise has been shown again and again to be the cause of various medical conditions. Despite the message that exercise is "good for you", a large percentage of the population is still so inactive (hypokinetic) that their long term health is at risk.

Current guidelines for physical activity suggest that:

Significant health benefits can be gained by being **moderately active for 30-minutes most if not all days of the week.** There are additional health benefits to being active for longer or engaging in more vigorous activity.

Regular physical activity has been shown to:

- Reduce mortality rates in young and older adults
- Reduce the risk of death from cardiovascular disease, coronary heart disease and other conditions of the cardiorespiratory system
- Lower risk of developing certain cancers including colon cancer where the risk is halved
- Reduce impairment due to osteoarthritis
- Increase bone mass and so reduce the risk of osteoporosis
- Reduce the risk of falls in older adults
- Effectively prevent and treat obesity and weight gain
- Reduce the risk of developing and help manage the symptoms of type 2 diabetes
- Improve mental health and relieve depression and stress
- Increase general quality of life by enhancing physical and psychological well-being

Effects Of Exercise On The Body

MODULE 1:
INTRODUCTION TO LEVEL 3 PERSONAL TRAINING

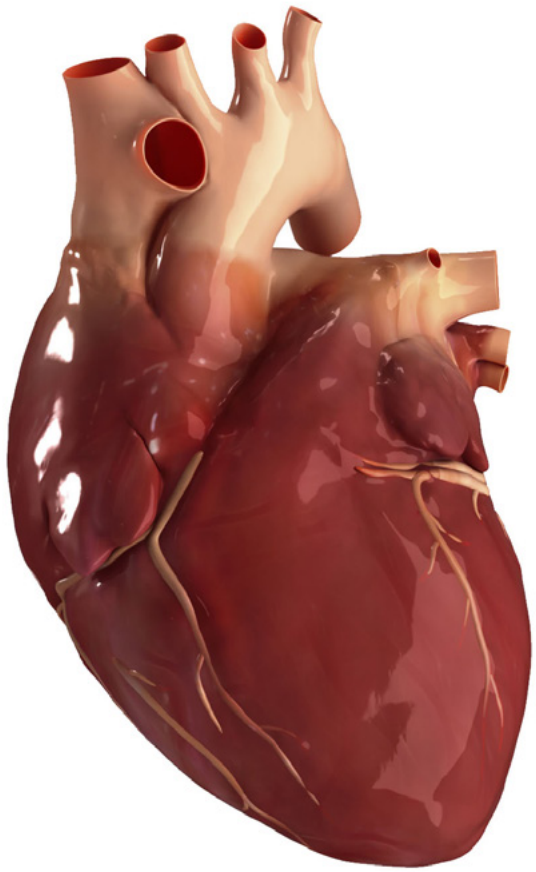
Exercise has a profound and powerful effect on the body. Effects are acute i.e. occur during exercise, and chronic i.e. happen in the days or weeks following a workout. The acute effects of exercise include increased heart and breathing rate, warmer muscles and increased synovial fluid production in the joints however most exercisers are more interested in the long term effects of exercise.

Exercise is a form of stress, albeit "good" stress. When exposed to stress or a stressor, the body responds or adapts to the stress, so that when exposed to similar stress in the future, it will be better able to cope. Exercise affects virtually every system of the body but, for fitness instructors, the most relevant are the cardiovascular and neuromuscular systems.

1. The Effect of Exercise on the Cardiovascular System

SHORT-TERM EFFECTS OF EXERCISE:

- Increased heart rate.
- Increased blood pressure.
- Increased stroke volume.
- Blood temperature rises.
- Blood vessels near the skin open (vasodilation).



LONG-TERM EFFECTS OF EXERCISE:

- Ventricular hypertrophy (heart size increases).
- Increased contraction strength.
- Increased stroke volume.
- Increased cardiac output.
- Decreased resting heart rate.
- Decreased risk of heart disease.
- Decreased risk of heart attack.

2. The Effect of Exercise on the Blood Vessels and Blood Chemistry

Regular aerobic exercise has been shown to reduce both systolic and diastolic blood pressure by as much as 10 mmHg in mild to moderate hypertensives. However, and with the exception of circuit weight training, exercising with weights shows no such benefit and may actually increase diastolic blood pressure.

- Improved blood lipid profile.
- Increased haemoglobin levels.
- Increased blood volume.
- Reduced systolic and diastolic blood pressure.

3. The Effect of Exercise on the Respiratory System

During exercise, the heart rate increases and so too does the rate and depth of breathing. The body does this to ensure the blood has a larger uptake of oxygen as well as to expel carbon dioxide more readily. During exercise and over time the body will adapt to this stimulus and both short term and long term effects will occur.

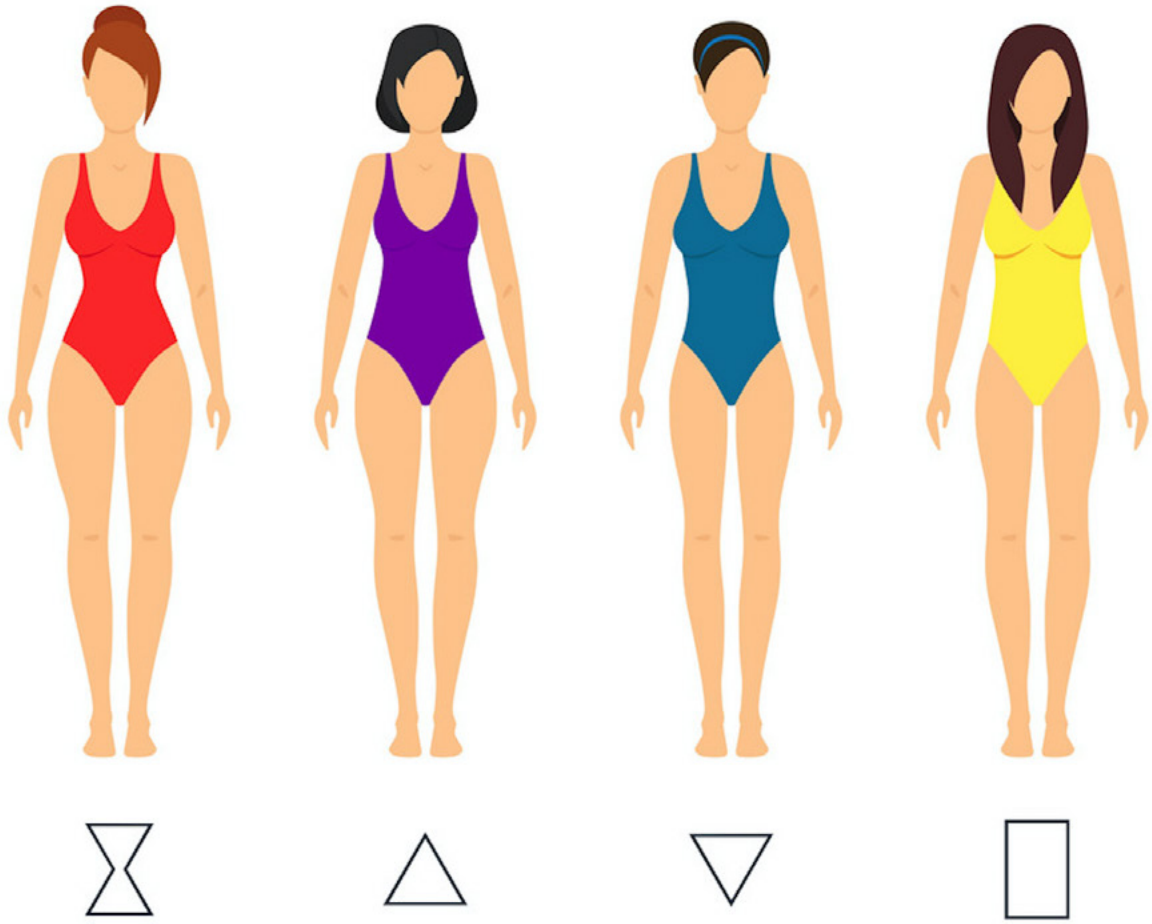
SHORT-TERM EFFECTS OF EXERCISE:

- Increasing breathing rate by about three times the normal rate.
- Increasing tidal volume by five times the normal rate.
- Increasing blood supply to and through the lungs.
- Increasing oxygen uptake.

LONG-TERM EFFECTS OF EXERCISE:

- Increased functional capacity during exercise
- More efficient diffusion of respiratory gasses.
- Increased vital capacity
- Improved integrity of respiratory muscles.

4. The Effect of Exercise on Metabolic Function

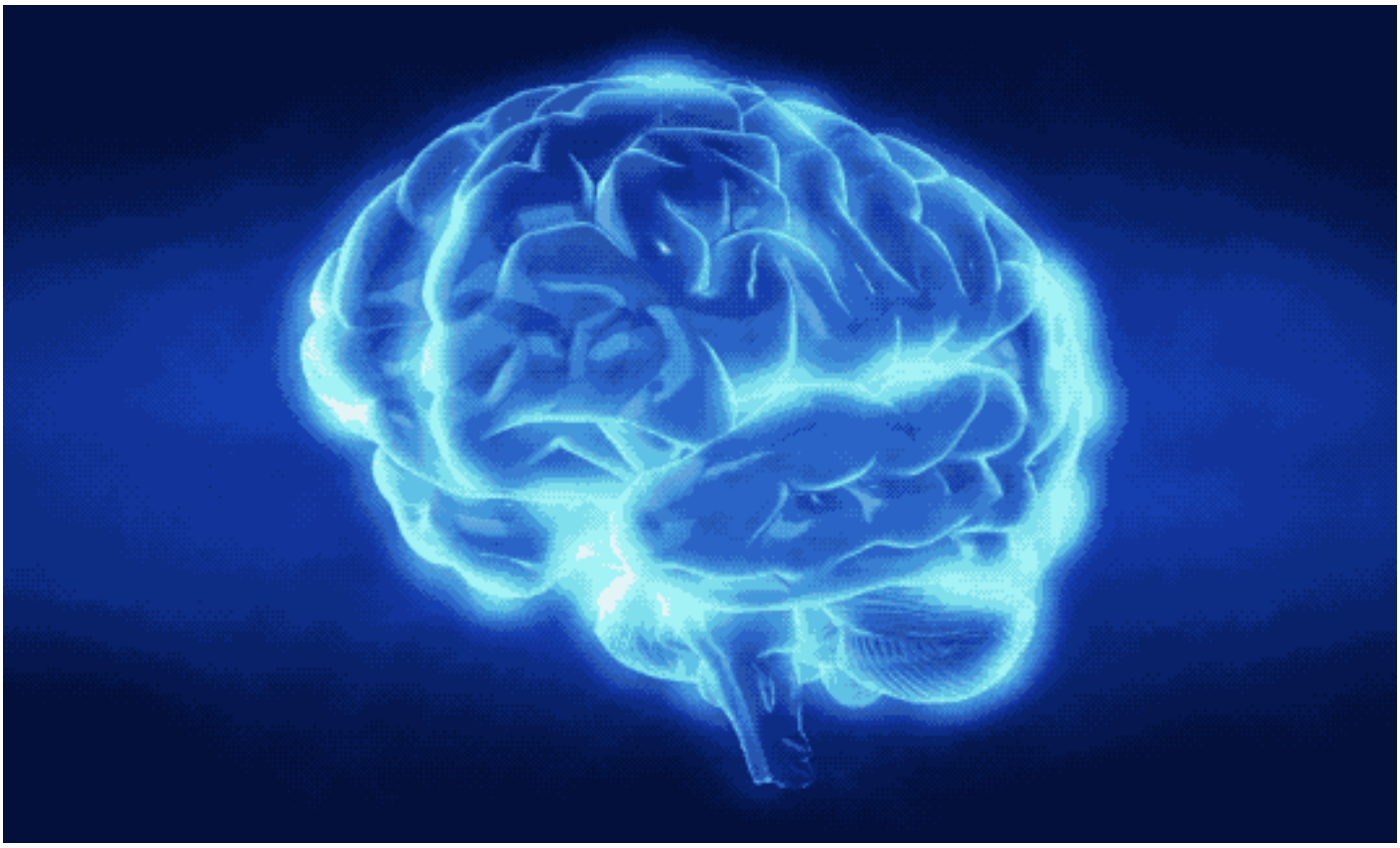


Metabolism is the sum of all chemical reactions in the body. Exercise, both aerobic and resistance training, can have an effect on our metabolic function in a positive or negative way. Exercise can help us to improve our insulin sensitivity, that is we become more efficient in regulating and utilising our blood glucose levels. High levels of sedentary behaviour and adiposity can have detrimental effects on our metabolism. Adiposity can lead to chronic levels of high blood glucose which can lead to type II diabetes or metabolic syndrome. There is currently novel research being conducted to investigate the association between adiposity distribution and metabolic function, e.g. exploring if central adiposity has a more damaging effect than lower/upper body adiposity.

LONG-TERM EFFECTS OF EXERCISE:

- **Decreased insulin resistance/improved insulin sensitivity.**
- **Reduced body fat.**
- **Increased maximal oxygen uptake – VO2 max.**
- **Increased metabolic rate after exercise.**

The Effect of Exercise on Psychological Changes



The physical benefits of exercise are often touted (e.g., increasing heart health), however we seldom here of the psychological benefits promoted by exercise. Engaging in a moderate amount of exercise will result in improved mood and emotional status. Exercise can promote psychological well-being as well as improve quality of life.

- **Improved self-image.**
- **Decreased depression and stress.**
- **Increased feelings of achievement.**
- **Distraction from daily routine.**

Effects of Aerobic Exercise on the Skeletal System

As the supporting structure of the body, the skeletal system also responds to aerobic exercise in the short and long term.

As a result of an increased range of movement, joints become more mobile and, as synovial fluid is a lubricant, the joint is protected from wear and tear. Synovial fluid also nourishes the articular surface of the joint which will help to keep the joints healthy. It should be noted that the above adaptations are more pronounced with weight-bearing exercise.

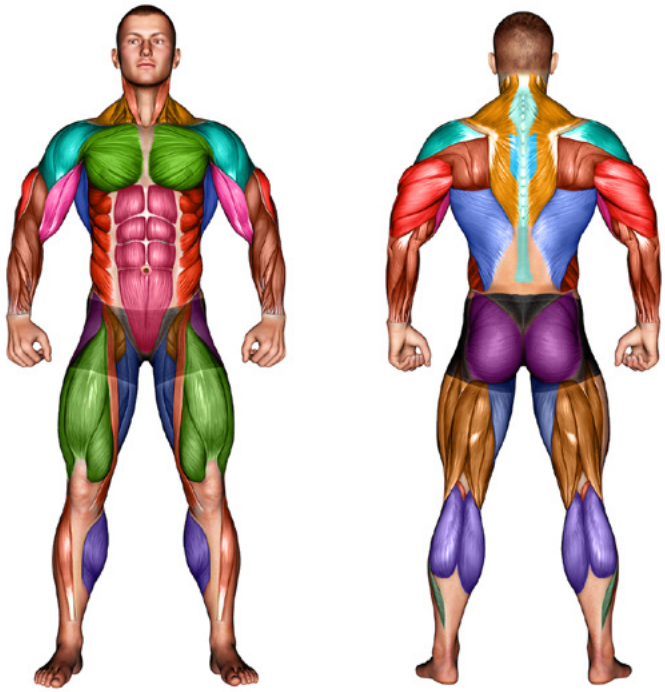
SHORT-TERM EFFECTS OF EXERCISE:

- Increased synovial fluid production.
- Increased range of movement of joints.

LONG-TERM EFFECTS OF EXERCISE:

- Stronger ligaments.
- Increased bone mass.
- Reduced loss of bone mass commonly associated with age.

Effects Of Aerobic Exercise On The Muscular System



SHORT-TERM EFFECTS OF EXERCISE:

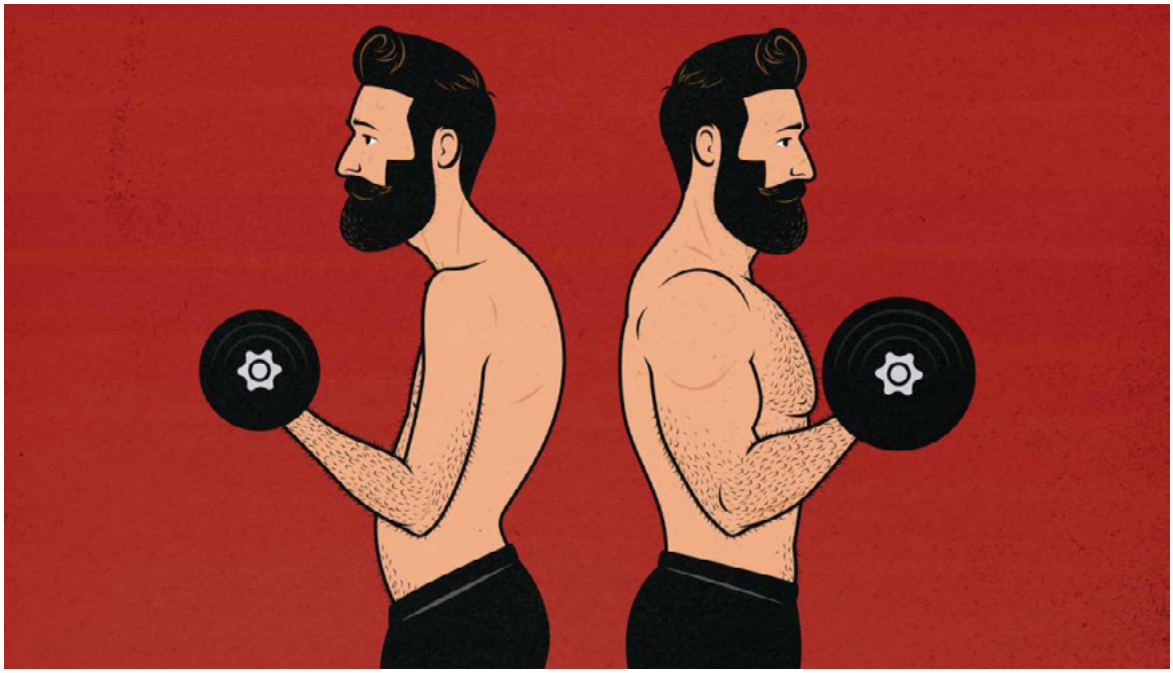
- Vasodilation
- Blood pumped preferentially to working muscles
- Possible DOMS – delayed onset muscle soreness
- Blood pooling

LONG-TERM EFFECTS OF EXERCISE:

- Improve muscular efficiency
- Increase capillarisation of the muscles
- Increase enzymatic function within muscle cells
- Increase glycogen and creatine phosphate stores
- Increase size and number of mitochondria

Most changes to the muscular system are associated with resistance training rather than cardiovascular training however, any repetitive activity such as running or cycling will cause adaptation.

Effects of Resistance Training on the Muscular System



While aerobic exercise has a beneficial role to play in muscular endurance and conditioning, overload is generally insufficient to trigger meaningful adaptations in terms of strength and/or power in any but the most deconditioned exerciser. If the goal is to improve the condition of the muscular system, resistance training is the best exercise option. Effects can be short term or long term and predominantly affect the type 2a and type 2b muscle fibres.

Note: some adaptations are also caused by aerobic exercise also.

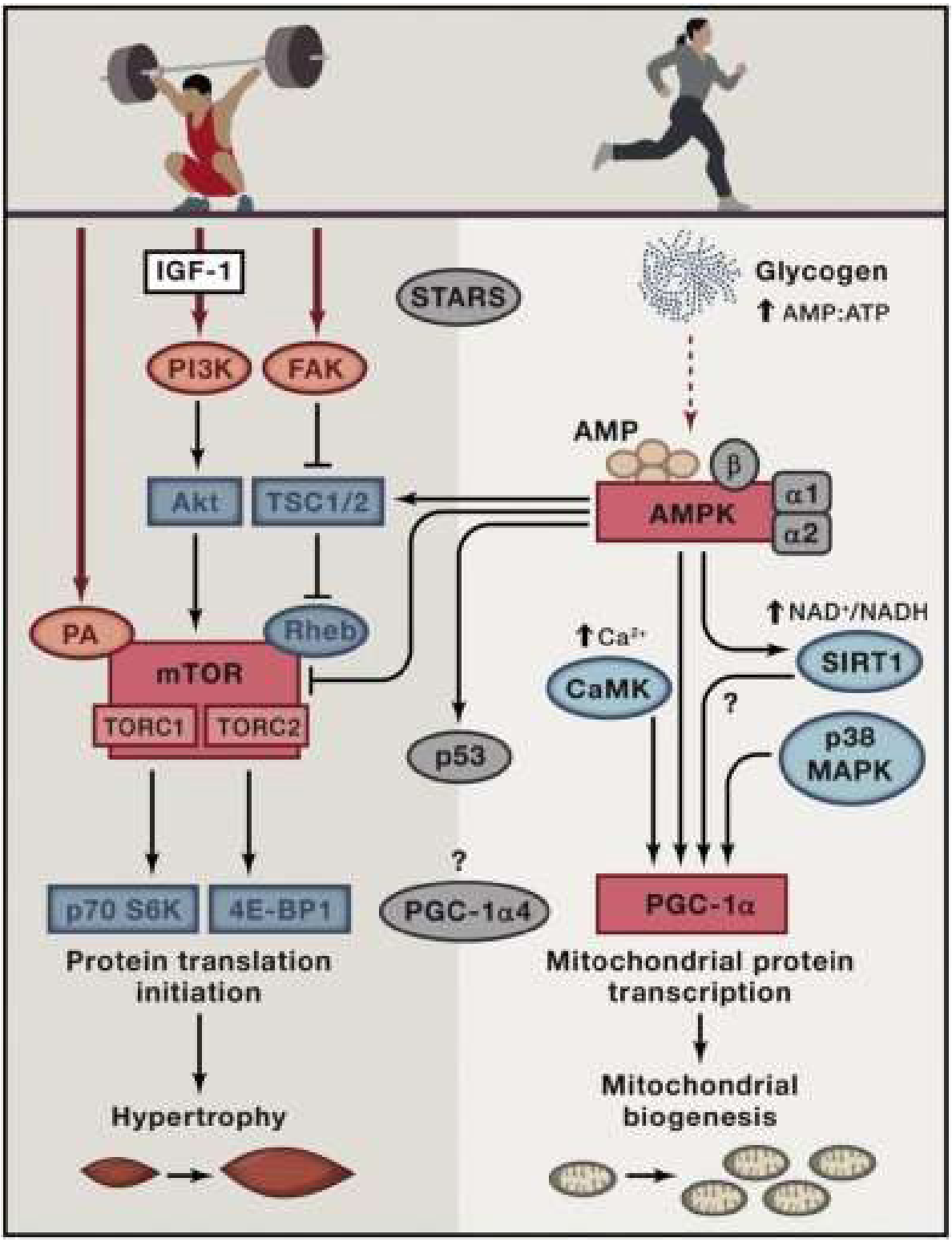
SHORT-TERM EFFECTS OF EXERCISE:

- Vasodilation.
- Blood pumped preferentially to working muscles.
- Possible Delayed Onset Muscle Soreness (DOMS).
- Blood pooling.

LONG-TERM EFFECTS OF EXERCISE:

- Decreased nervous inhibition leading to increased strength, power and speed.
- An increase in the cross-sectional size of a muscle.
- Increased glycolytic activity allowing for more work to be done under anaerobic conditions.
- Increased creatine phosphate and glycogen stores.
- Increased capillarisation.
- Increased tendon strength.

Effects of Aerobic Exercise and Resistance Training At A Cellular Level



The above diagram is for educational purposes and is above the level of this course.

The diagram offers a greater understanding of the differences between how aerobic exercise and resistance training effects the body at a cellular level.

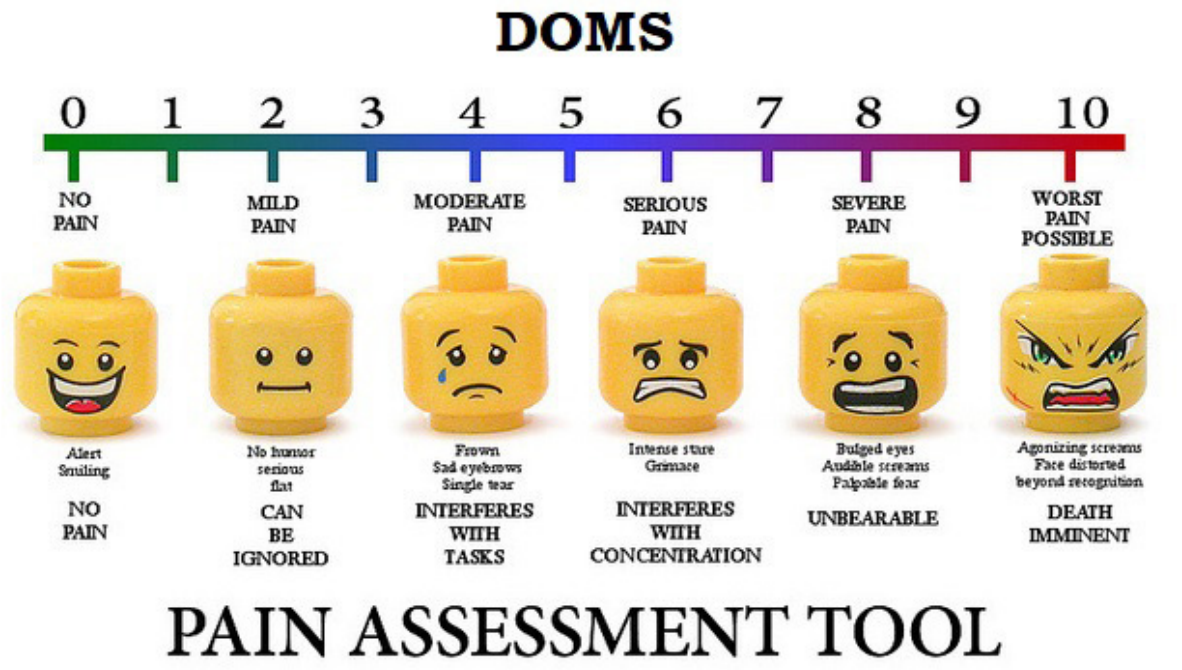
BLOOD POOLING

During rhythmical exercise which involves the legs, the calf muscles act as 'pumps', squeezing blood in the veins back towards the heart. This is necessary as there is no pressure applied to blood in the veins from the heart to keep it moving.

A sudden cessation in exercise means that this 'muscle pump' action stops abruptly and this can lead to the 'pooling' of blood in the legs as the heart will continue to beat at a faster than resting rate, forcing blood into the arteries for a few minutes after the exercise stops.

This pooling means that the blood and any waste products contained within it collect in the calf muscles. This can occasionally lead to pain and swelling in the lower limbs. More commonly, due to the accumulation of blood in the lower limbs, individuals experience symptoms such as dizziness and fainting and sometimes a drop in blood pressure.

To keep the blood being returned to the heart in the veins, at the same rate as the blood being pumped out of the heart into the arteries, it is important to do a cool down and ensure the person's heart rate is near resting levels before cessation of exercise.

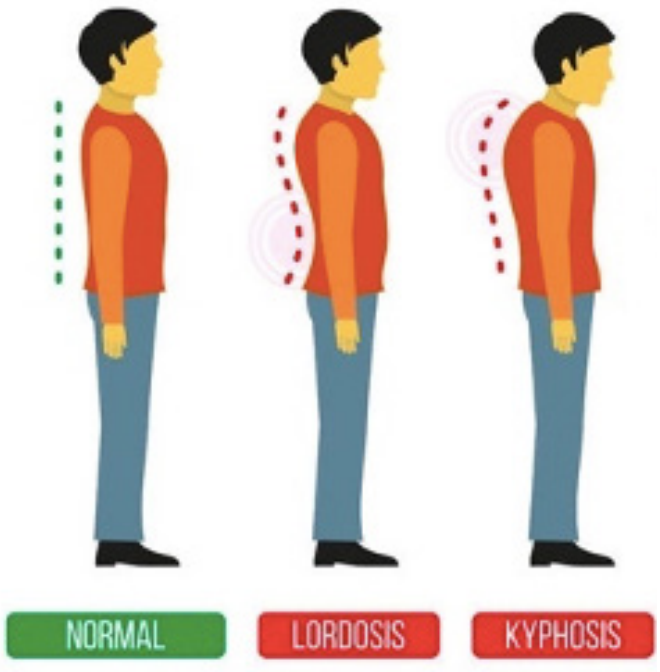


DELAYED ONSET MUSCLE SORENESS

Delayed onset muscle soreness (DOMS) is a phenomenon that typically occurs 12 to 72 hours after resistance training although it has been reported that this can continue to be experienced for up to nine days after training. DOMS is characterised as a dull, aching type pain experienced in muscles after unaccustomed or strenuous exercise, which may be accompanied by stiffness. It is tender when pressure is applied to affected muscles. The pain and sensitivity is caused by microtrauma to muscle fibres and the subsequent inflammatory response. DOMS is part of the normal repair process of muscle and is thought to be essential in order for hypertrophy to occur. Although any unaccustomed exercise can cause DOMS, certain types of exercise are strongly associated with it. Eccentric or negative contractions (the lowering phase of an exercise) and high impact exercises or jumping exercises such as plyometrics, which have intense eccentric loading phases cause the worst DOMS.

Posture

"The position in which someone holds their body when standing or sitting"



Long periods of inactivity or sitting down can have an adverse effect on posture; posture being the optimal alignment of a joint or joints. In addition, badly designed programs that place an emphasis on a limited number of muscles or activities that are very repetitive can also adversely affect posture.

Poor posture is caused by shortened muscles, poor flexibility, a lack of strength or weakened muscles responsible for maintaining good posture against gravity and bad habits such as slouching.

As sedentary jobs and subsequently poor posture are so common, instructors should endeavour to include stretches and strengthening exercises in their training programs which help to undo the damage of habitual sitting and slouching. This generally involves stretching the muscles on the front of the body and strengthening those on the back.

Good Exercise practice for healthy posture

Exercises that meet the following criteria will maintain proper posture:

- Involve a full range of movement
- Be compound, functional movement patterns
- Are performed standing and/or unsupported
- Utilise free weights and cables rather than machines

Therefore exercises that do not meet the criteria above will affect posture.

- Short-range of movements will not effectively work the muscle at its full potential causing weakness at certain parts of the movement.
- Isolation exercises performed to excess will promote muscular imbalance. Too much focus on pectorals and not the trapezius will cause a rounded upper back.
- Sitting down will cause the core to be underdeveloped as it is not supporting the body against gravity as the chair would be doing so.
- Fixed resistance machines are a fixed path, not allowing for the client's natural posture to be addressed, forcing them into a movement that they may not be ready for.

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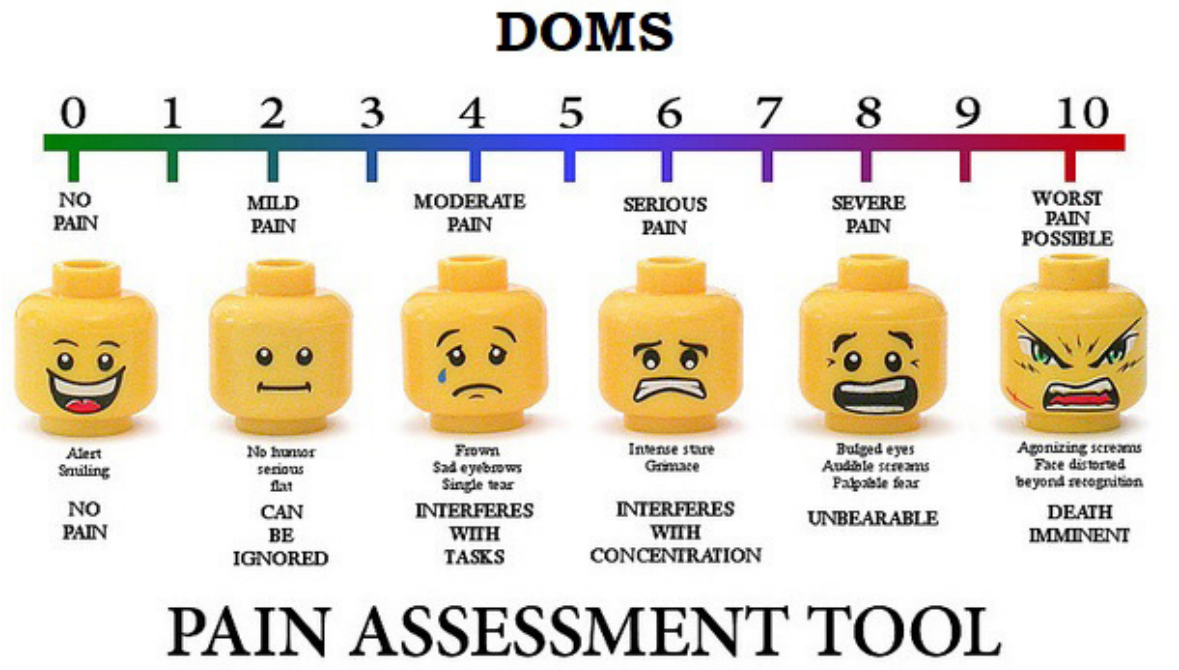

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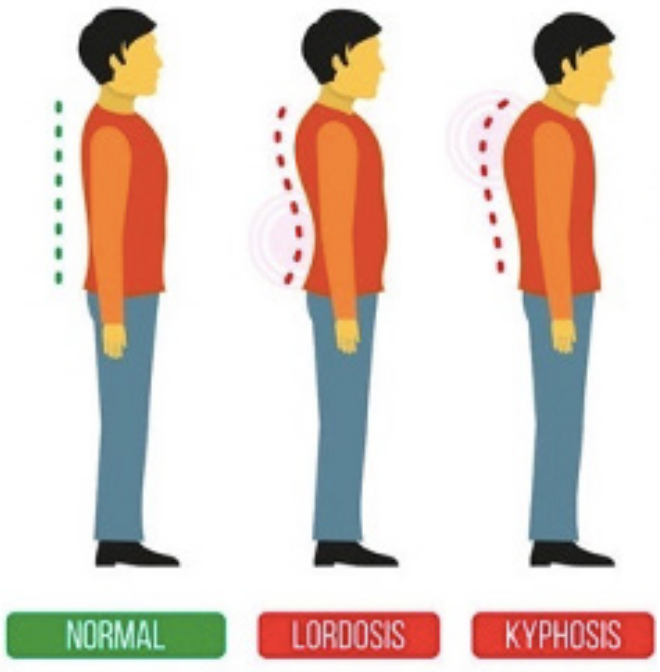

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Anatomical Positional Terminology

MODULE 1:
INTRODUCTION TO LEVEL 3 PERSONAL TRAINING

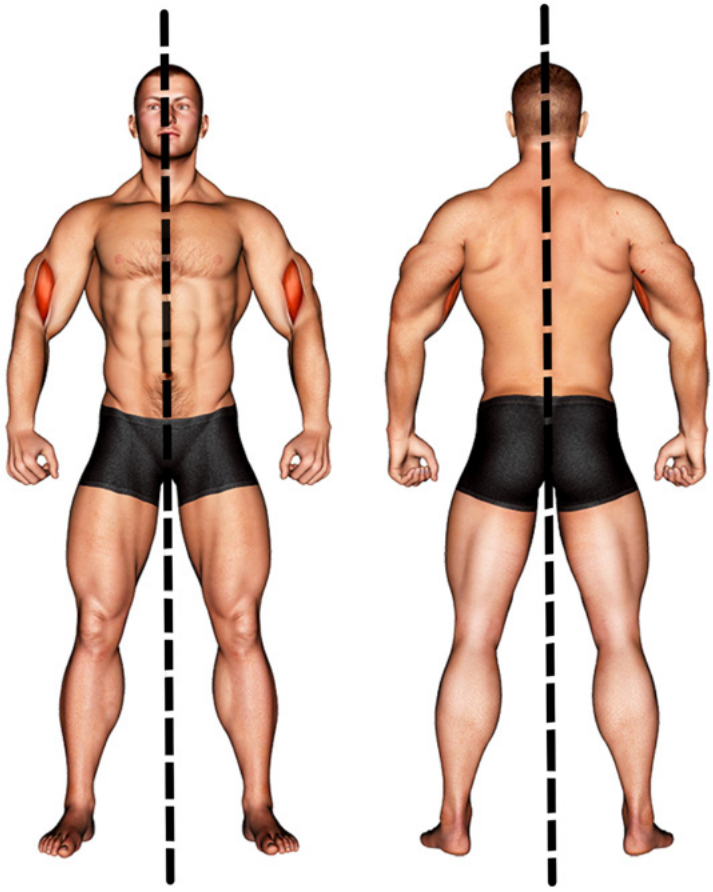
Introduction

Anatomical Terminology: Relative Position

VIDEO AVAILABLE ON
LEARNING PLATFORM

Where to Start: The Midline

THE MIDLINE OF THE BODY



The anatomical position is the reference point describing the relation of body parts to one another. When describing the structures of the body it is important to use terms which encourage precision. Using the anatomical position as a starting point, the following standardised terms are designed to avoid confusion and should be used at all times when discussing anatomical terms.

Relative Position: Anterior / Posterior

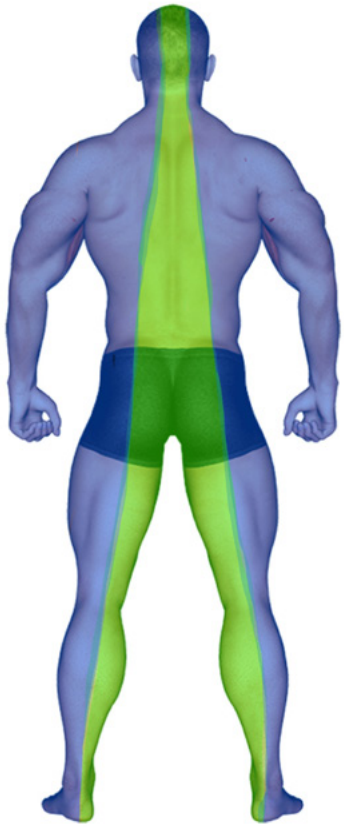
ANTERIOR
At or near the front of the body **(front view)**

POSTERIOR
At or near the back of the body **(back view)**

Relative Position: Medial / Lateral

MEDIAL
Nearer to the midline **(side view)**

LATERAL
Farther from the midline **(side view)**



Relative Position: Superior / Inferior

SUPERIOR
Toward the head/upper part of a structure **(bird's eye view, looking down).**

INFERIOR
Away from the head/lower part of a structure **(bottom view, looking up).**

Relative Position: Proximal / Distal

PROXIMAL
Nearer to the origination of a structure.

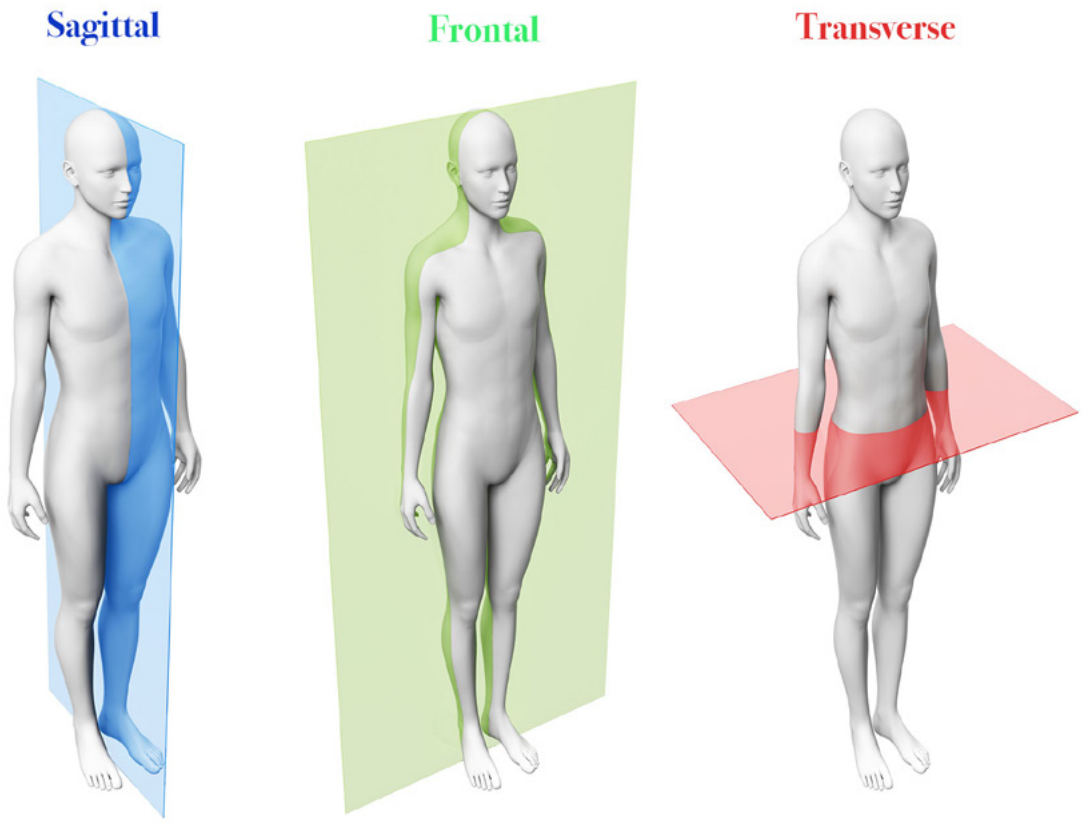
DISTAL
Farther from the origination of a structure.

Relative Position: Superficial / Deep

SUPERFICIAL
Close to the surface of the body.

DEEP
Away from the surface of the body.

Planes of Motion



Movements of the human body are often described in terms of the 'plane' in which they pass through.

There are three planes of the human body are:

- **Sagittal plane**
- **Frontal plane**
- **Transverse plane**

The Sagittal Plane

- **Passes through the body from front to back**
- **Dividing the body into left and right portions.**

The sagittal plane moves around:

- **The medio-lateral axis**

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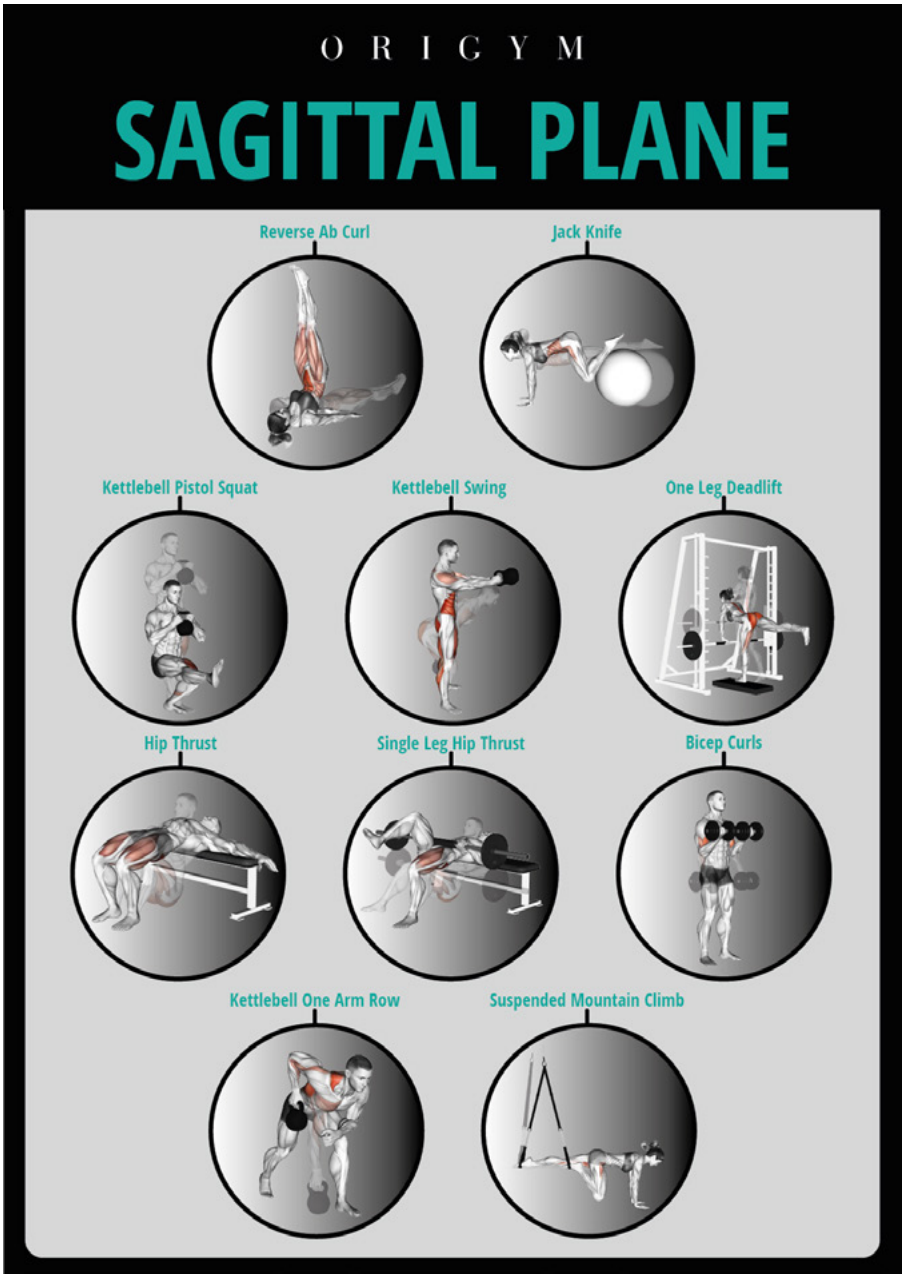
LEARNING PLATFORM

Exercise Examples



The Frontal Plane

- Passes through the body from **left to right**
- Dividing the body into **anterior** (front) and **posterior** (back) portions.

The frontal plane moves around:

- The **Anterior-Posterior axis**

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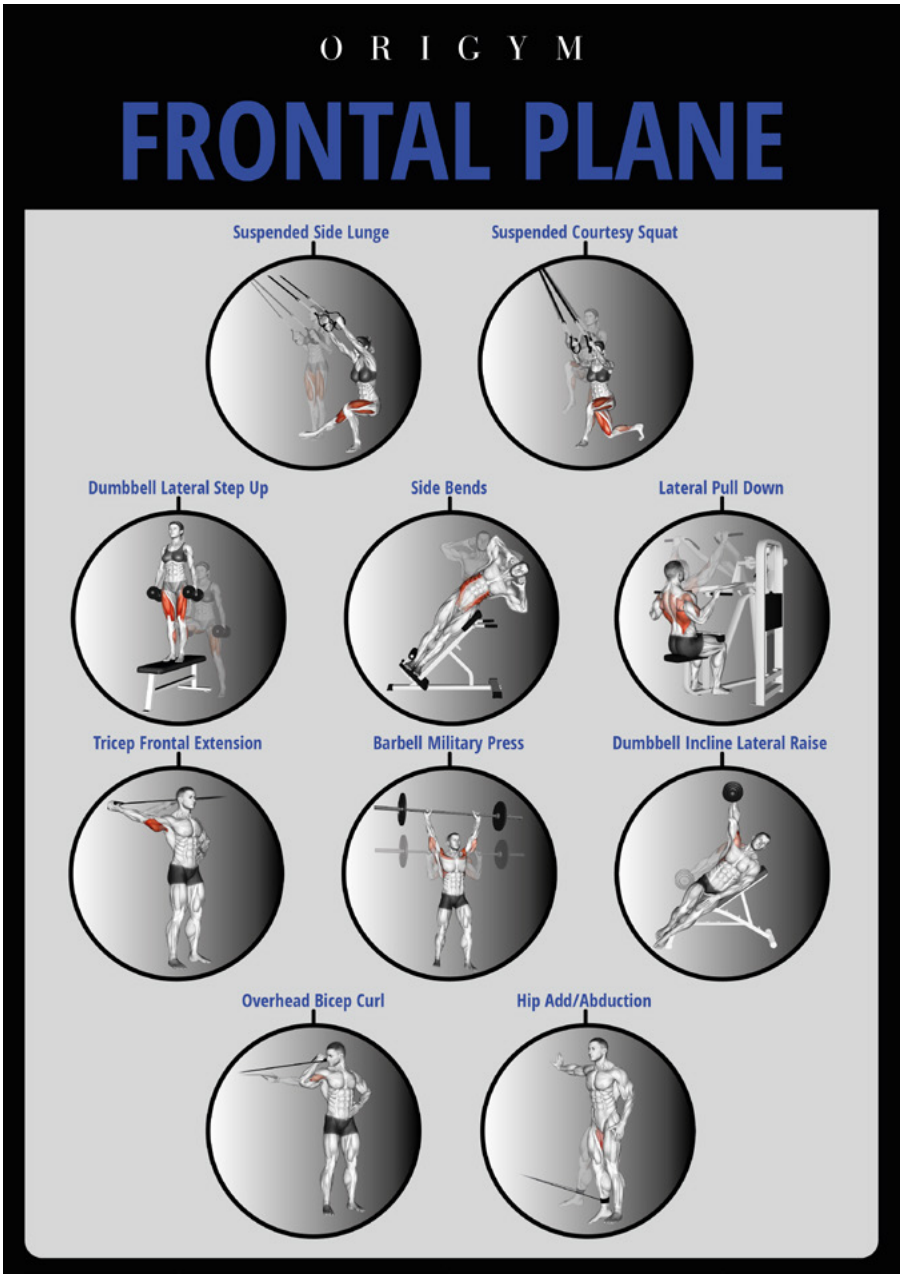
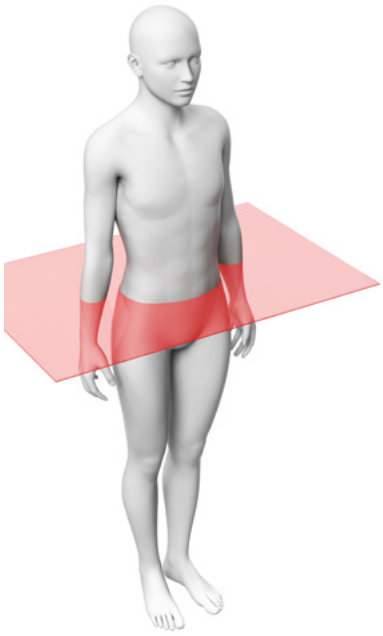
Exercise Examples



The Transverse Plane



- Passes through the body in a parallel line
- DIVIDING the body into top and bottom portions

The transverse plane moves around:

- The longitudinal axis

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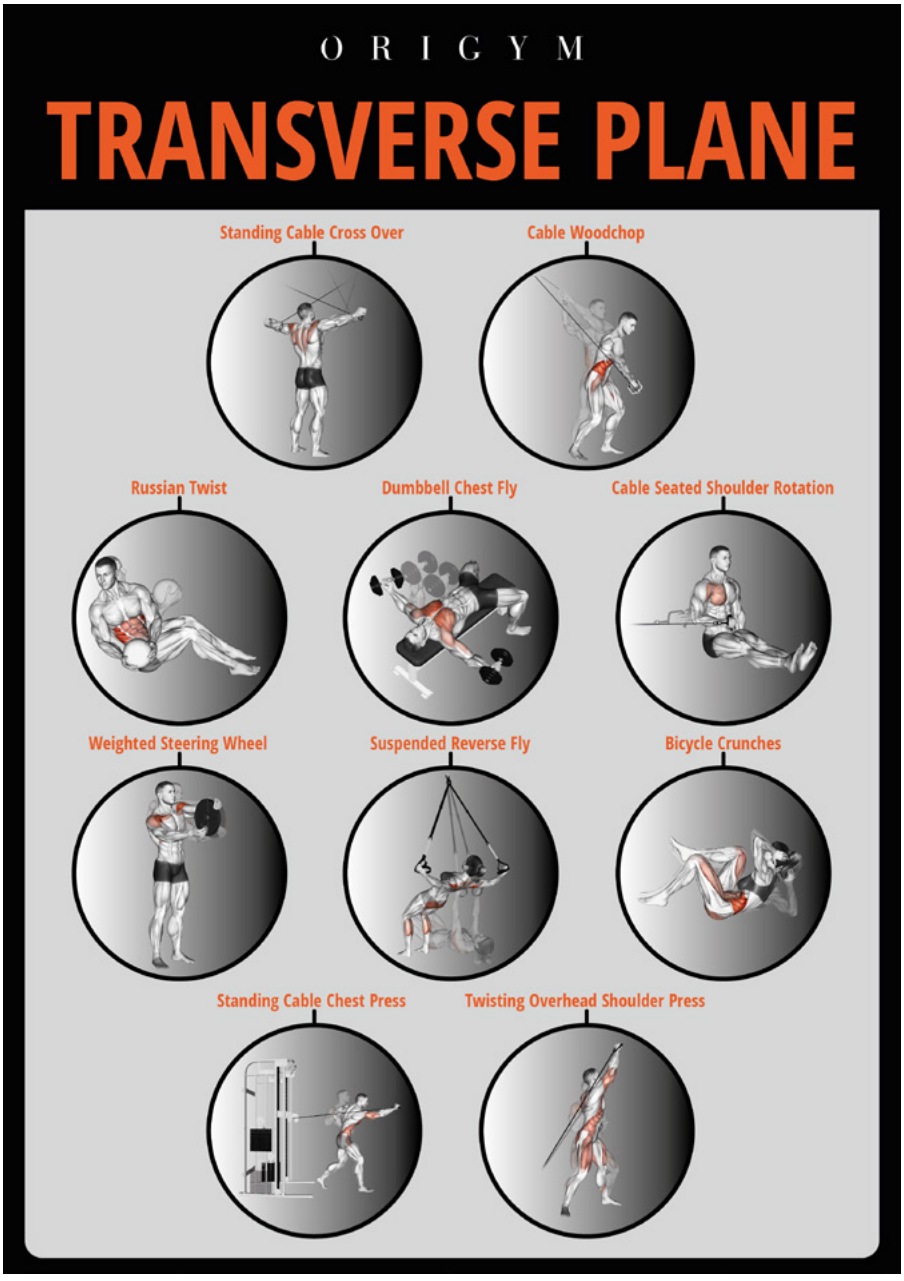
Exercise Examples



Multi-Planar Exercises

Downloadable Resources

DOWNLOADABLE RESOURCE AVAILABLE

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