ORIGYM

Level 2 Certificate In Fitness Instructing Online

MODULE 1:
THE SKELETON, JOINTS & EFFECTS OF EXERCISE

CONTENTS

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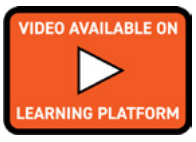


Anatomical Positional Terminology

MODULE 1:
THE SKELETON, JOINTS & EFFECTS OF EXERCISE

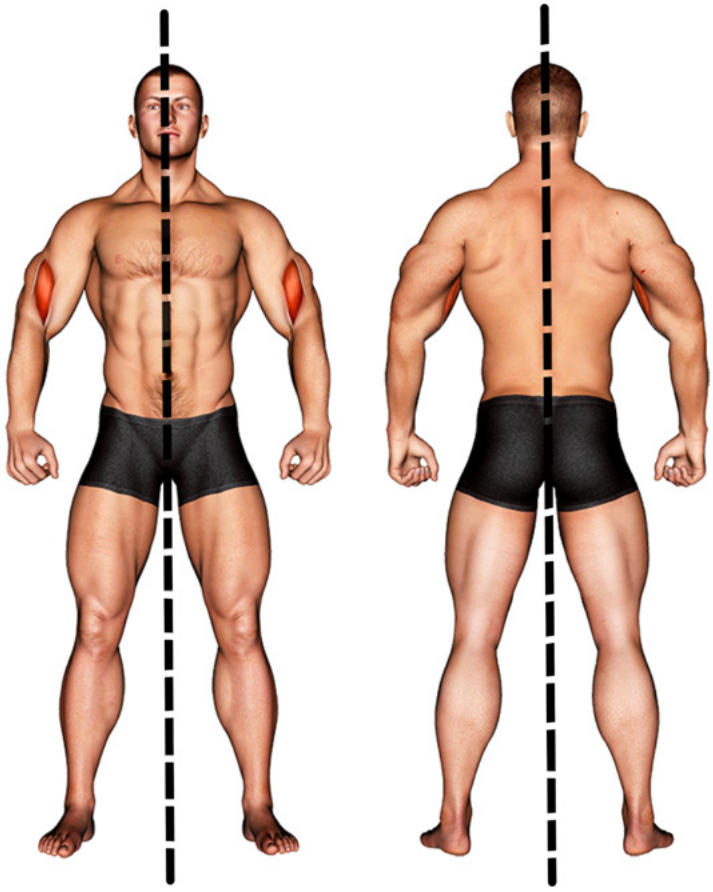
Introduction

Anatomical Terminology: Relative Position
https://youtu.be/1Y51oP3yA3A

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

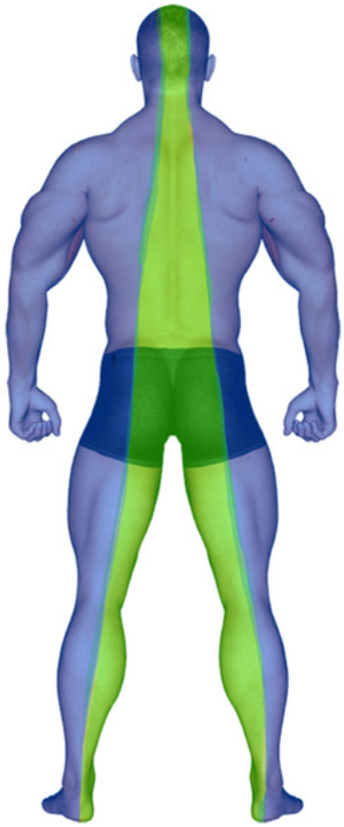
ANTERIOR
At or near the front of the body **(front view)**

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.

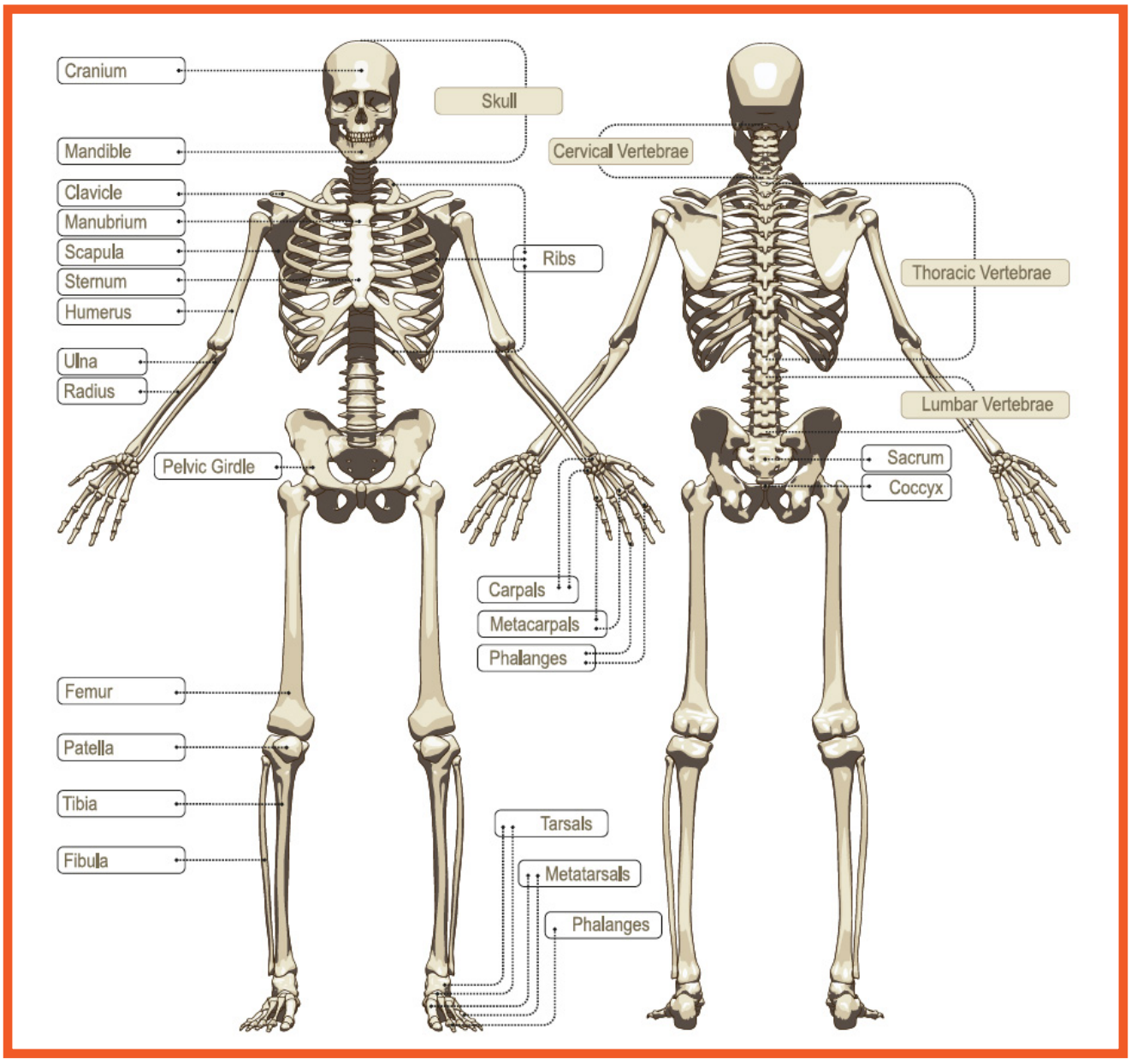
DEEP
Away from the surface of the body.

The Skeletal System

MODULE 1:
THE SKELETON, JOINTS & EFFECTS OF EXERCISE

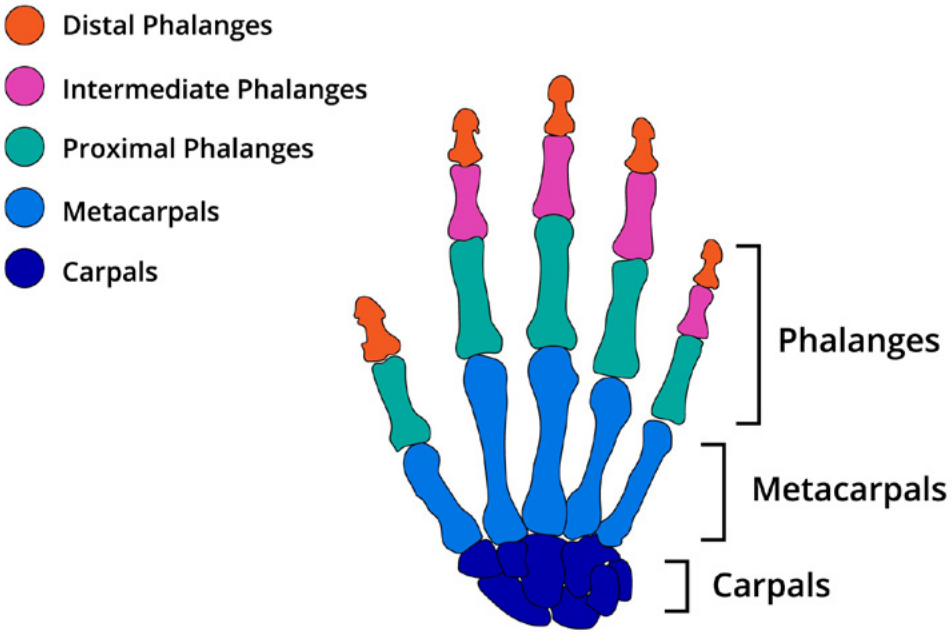
The Skeleton

Skeleton Diagram

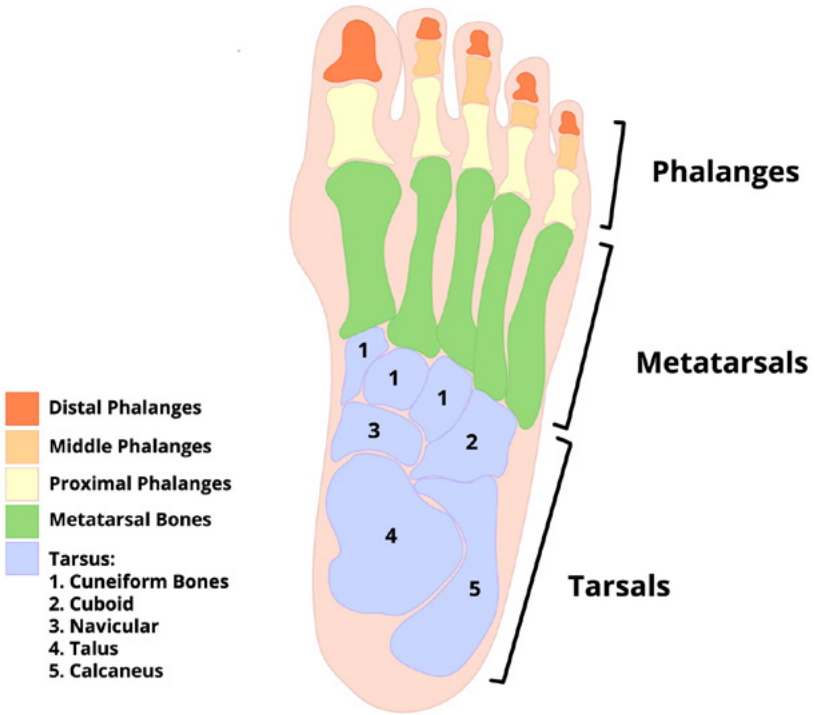


Skeleton Diagram: A Closer Look

The Hand



The Foot



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 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 Skeleton

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 AXIAL

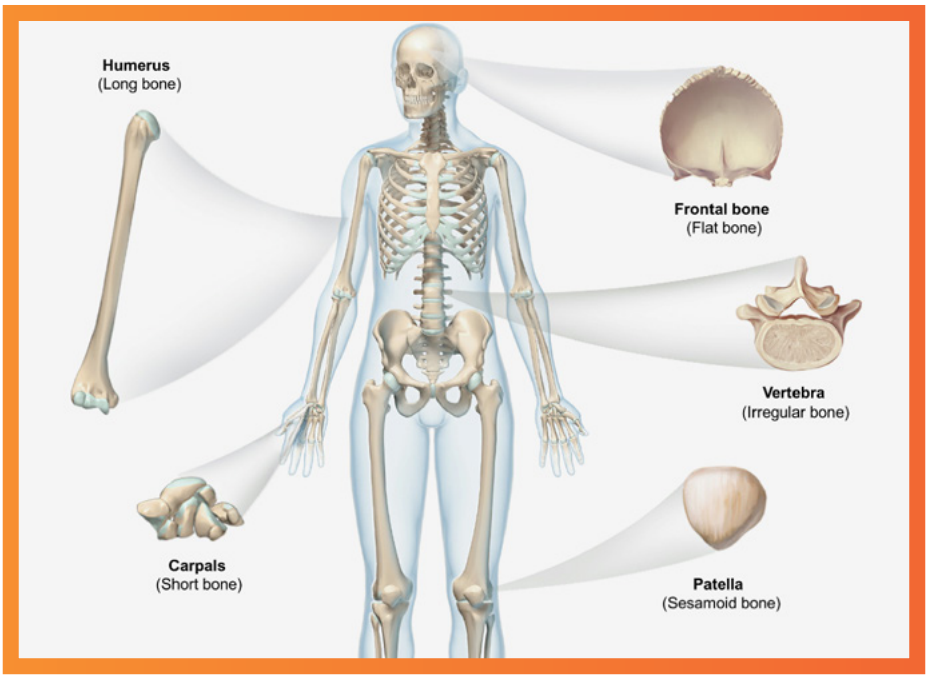
The APPENDICULAR Skeleton

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

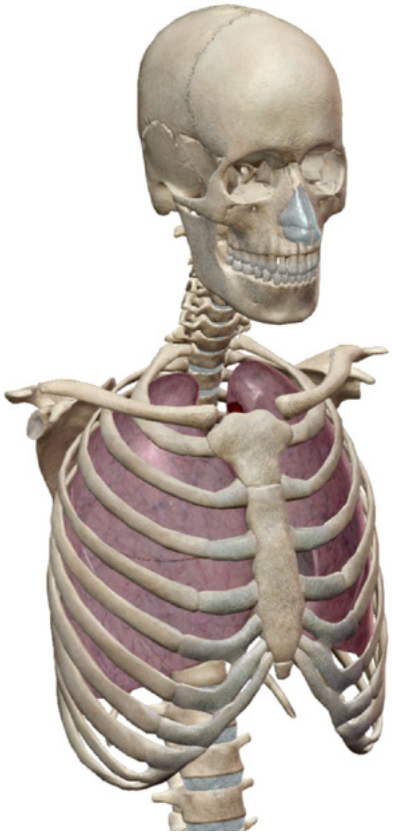
The Classification of Bones

- 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

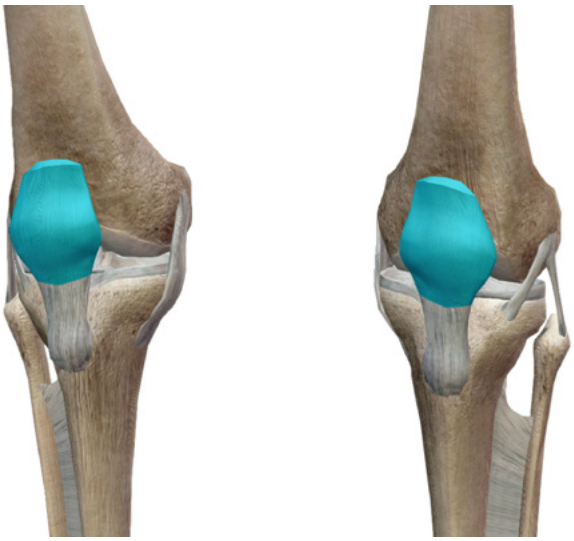
- Humerus
- Radius and Ulna
- Femur
- Tibia and Fibula
- Metacarpals and Metatarsals
- Phalanges

SHORT BONES

- Carpals
- Tarsals

IRREGULAR BONES

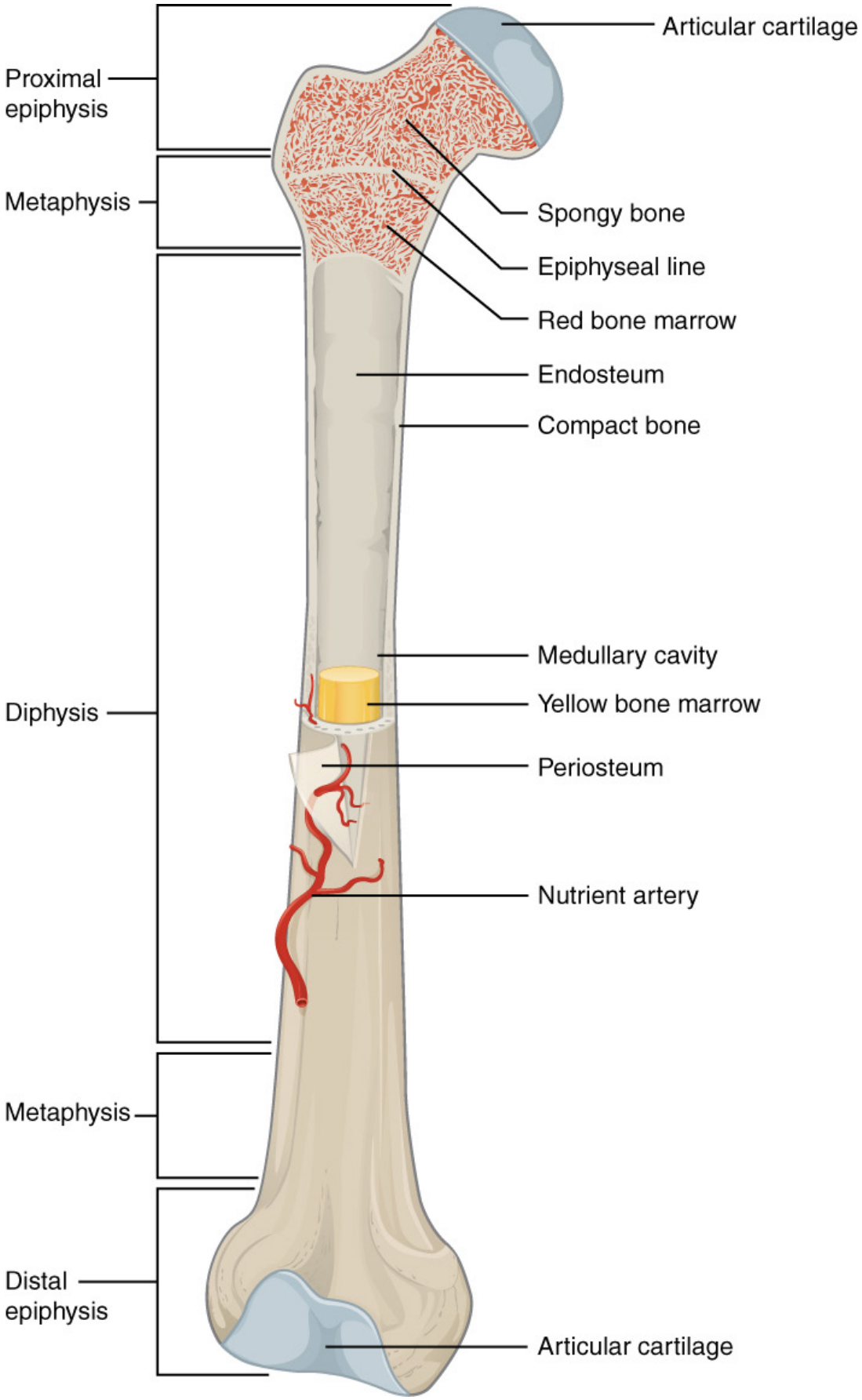
- Vertebrae
- Pelvic bones



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.

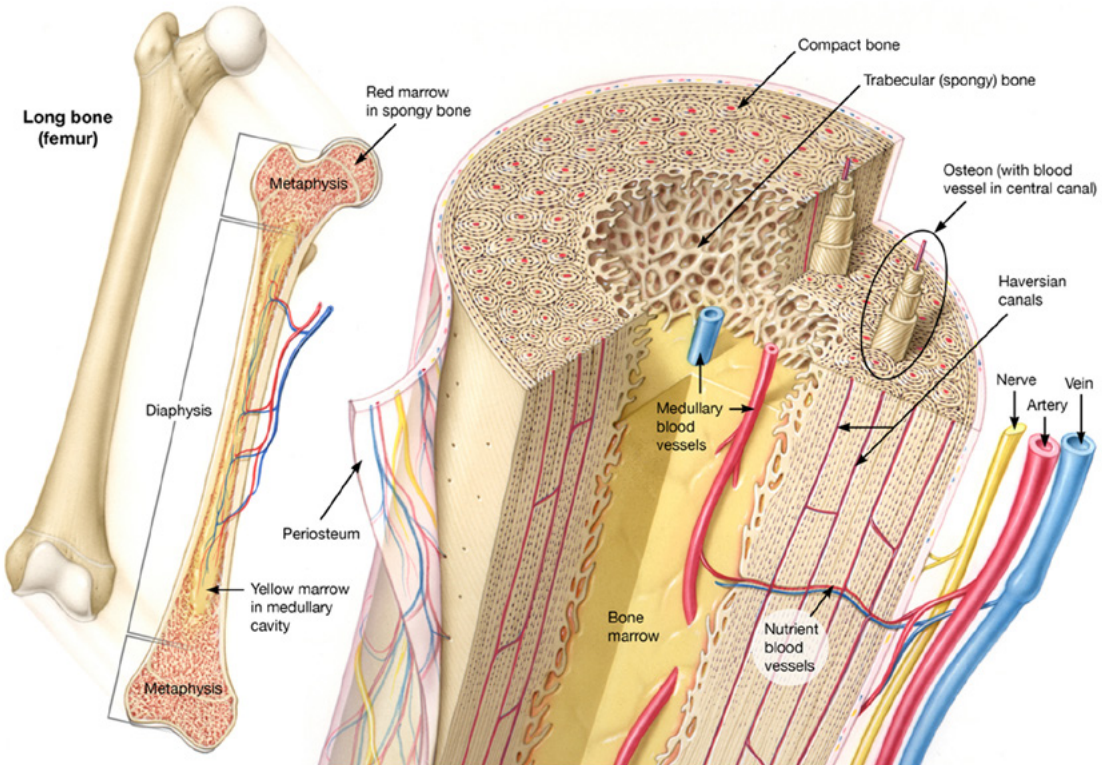
Articular (hyaline) cartilage: The ends of articulating bones are covered with articular or hyaline cartilage. It is a hard, white shiny tissue which, along with synovial fluid, helps reduce friction in freely moveable (synovial joints). The cartilage is necessary for smooth joint action.

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.

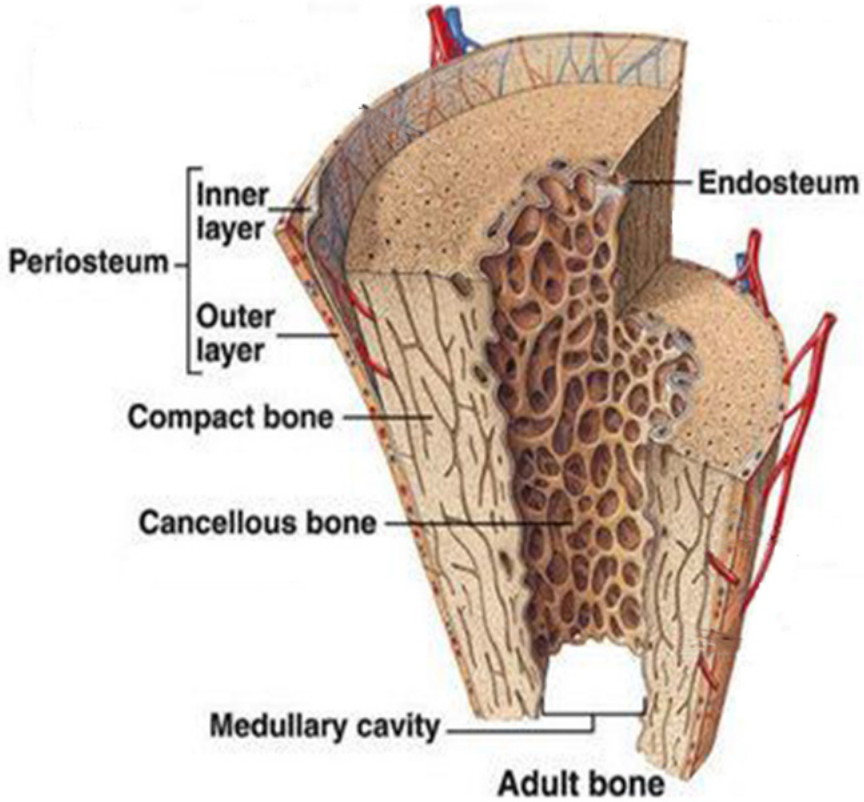


A CLOSER LOOK

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.

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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.

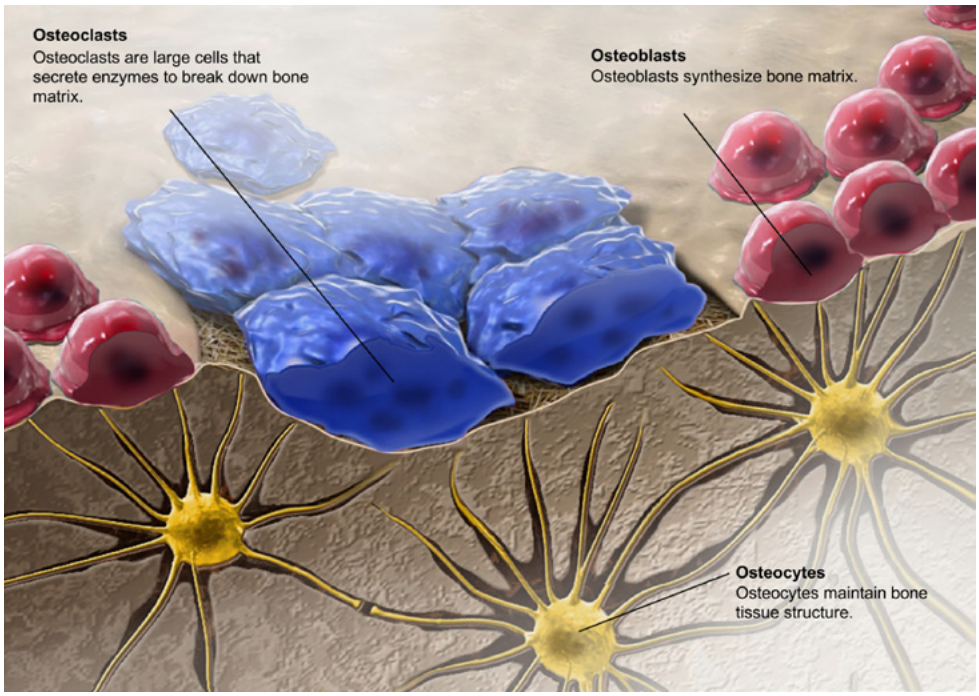
As above there are 3 main osteo-cells used in this process, they are;

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.



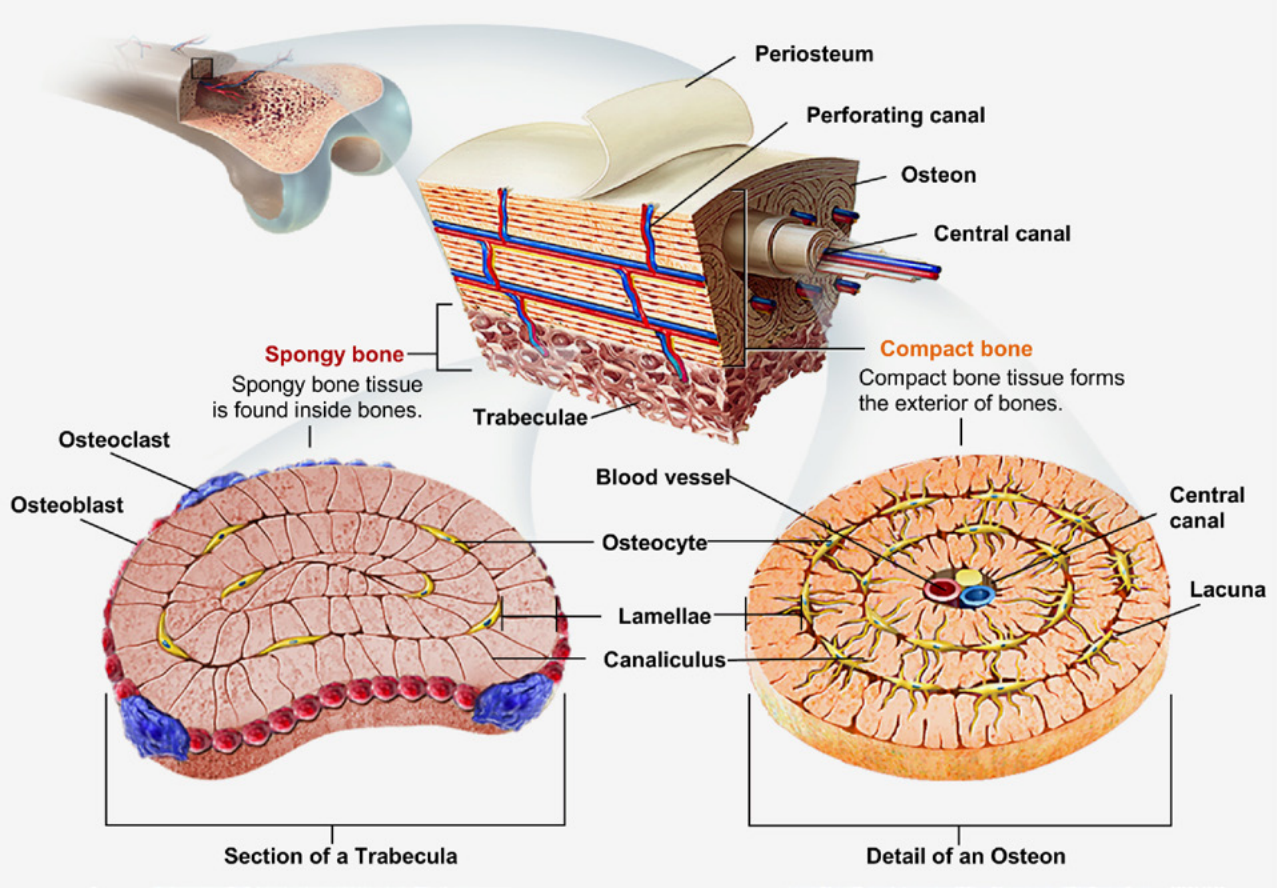
Any stress from physical activity, be it from impact or from tendons pulling on the bone itself, this will create 'microfractures' and begin the process of bone growth and repair.

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).

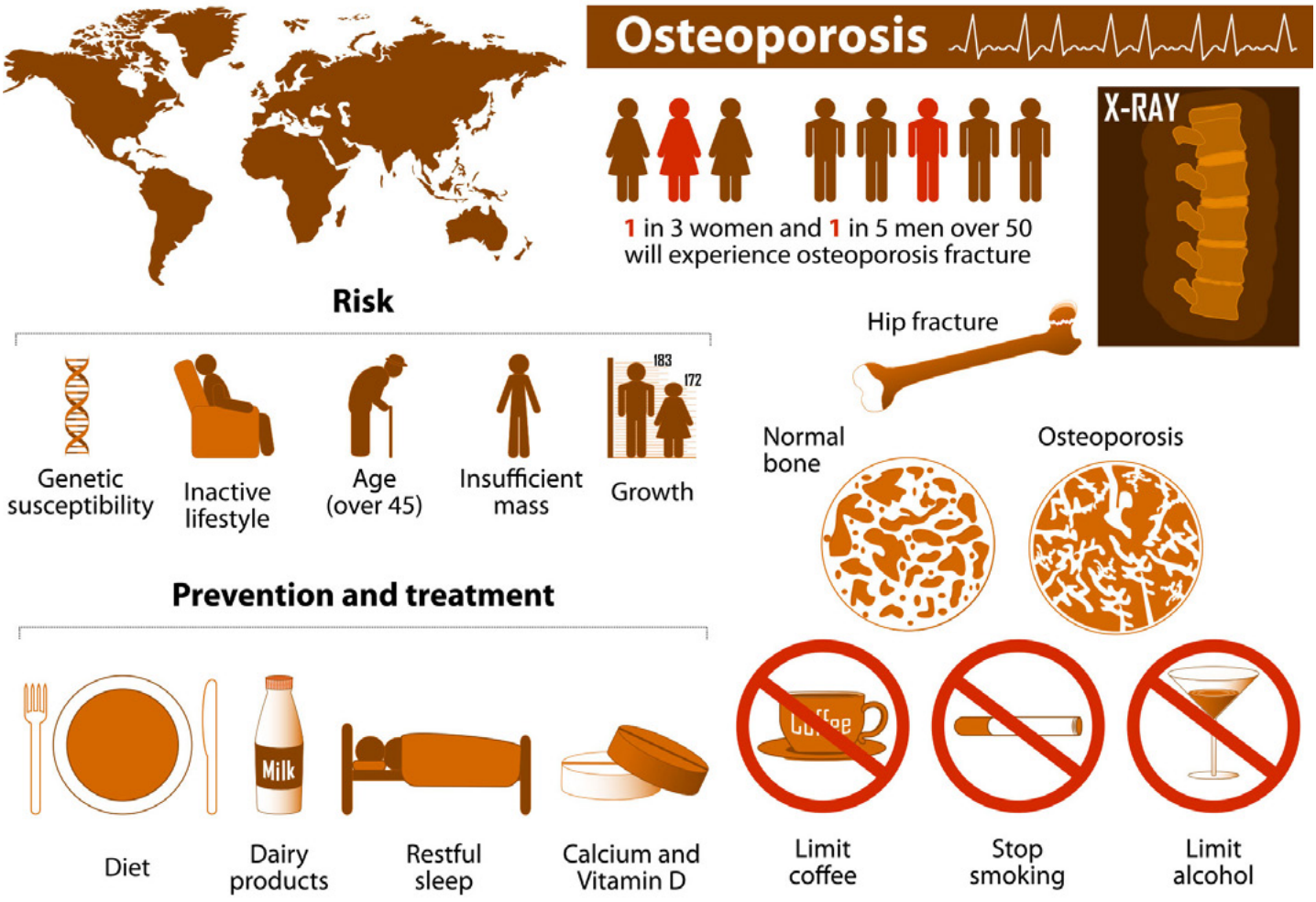
Additional aspects of bone growth are discussed below with respect to the structure of a long bone.

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.

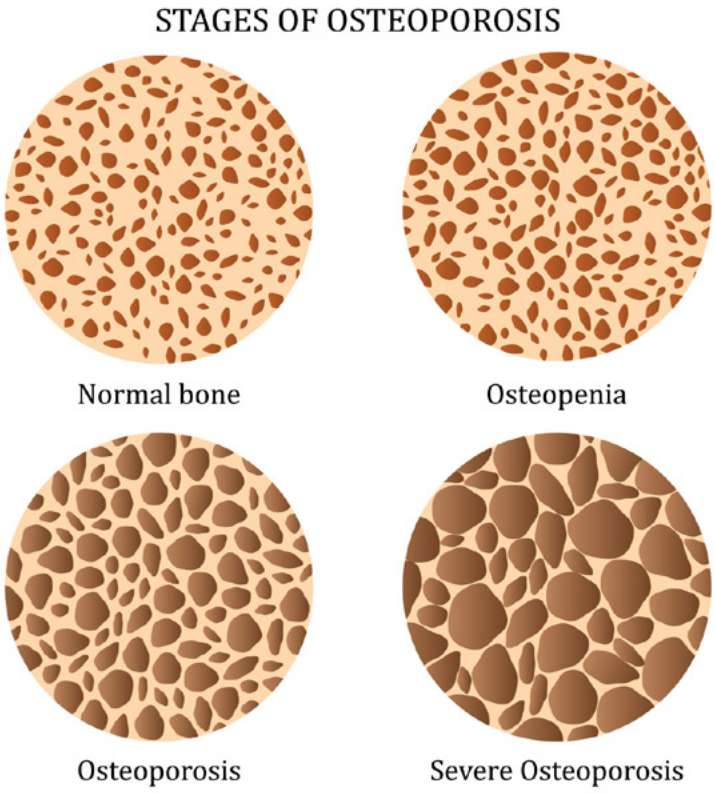
The condition may give rise from a number of causes; however one of the biggest is the drop in oestrogen levels associated with the menopause. This makes women significantly more likely to develop the condition than men. In men, a proportion of circulating testosterone is converted into oestrogen and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

Types of Joints

MODULE 1:
THE SKELETON, JOINTS & EFFECTS OF EXERCISE

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

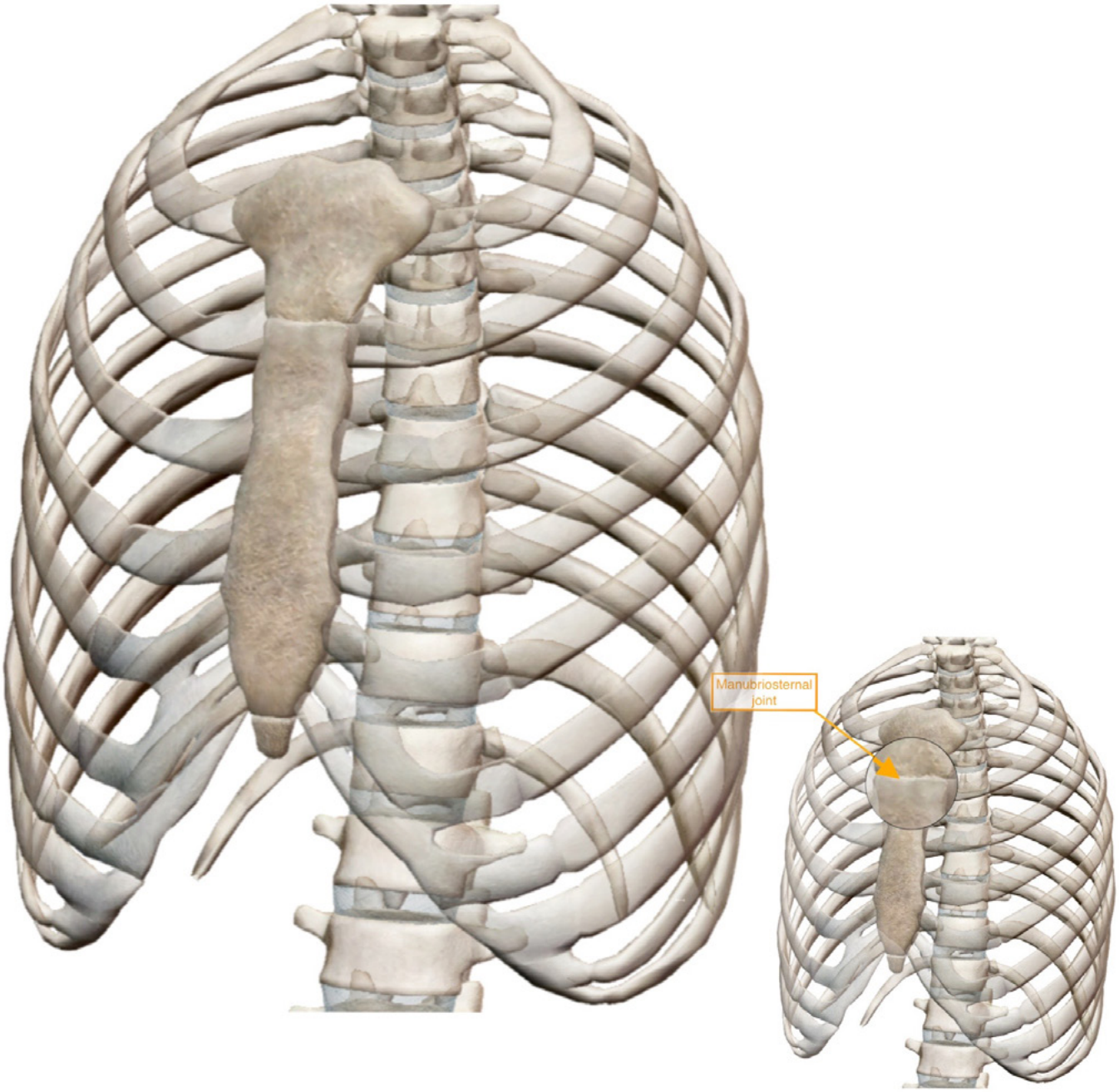
Fibrous joints are immovable and interlocking bones joined by fibrous tissue that is rich in collagen fibres.

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



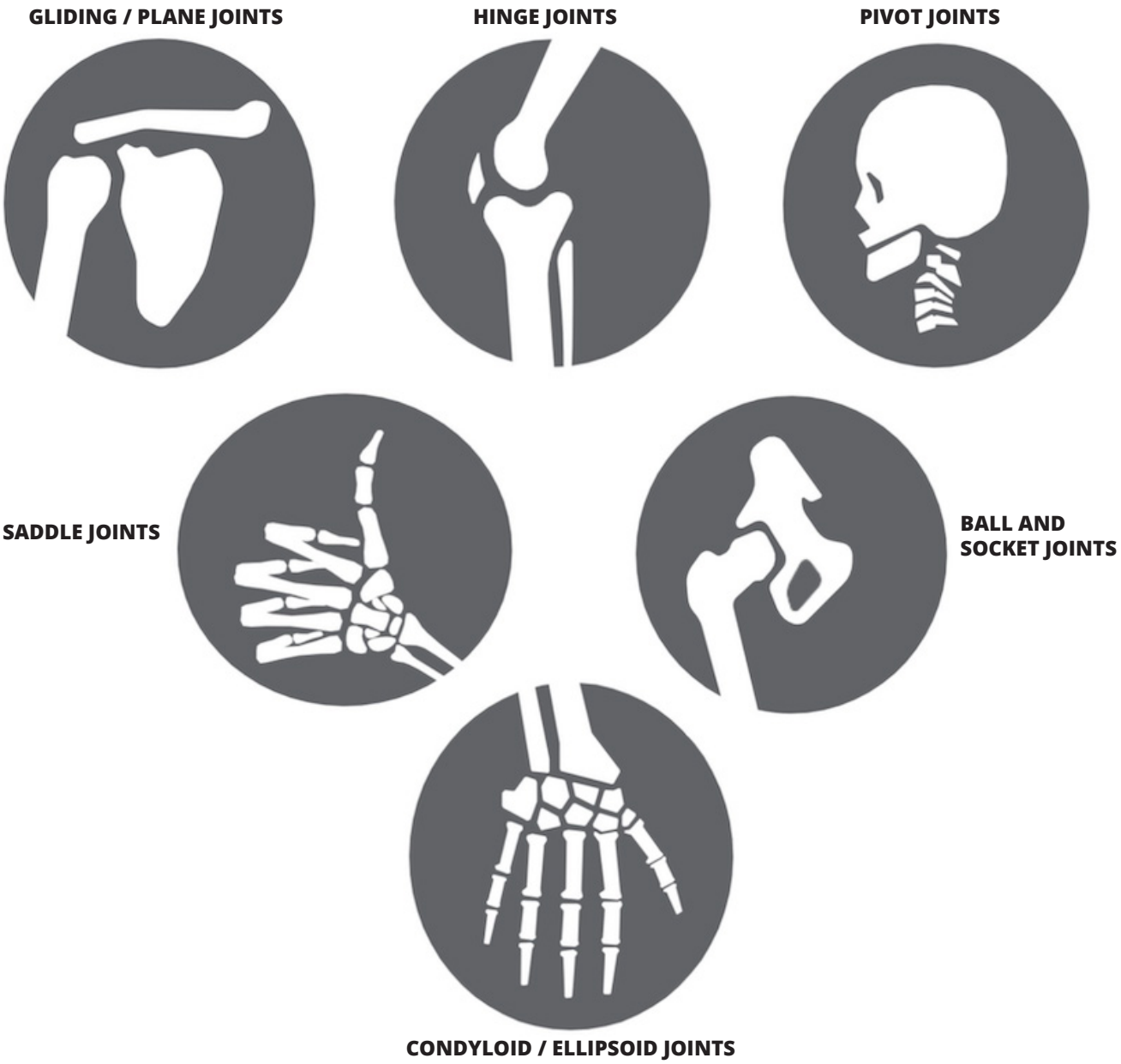
SYNOVIAL

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 Pateellofemoral (knee) joint.

Types of Synovial Joints

THERE ARE 6 TYPES OF SYNOVIAL JOINT:



Characteristics of Synovial Joints

All synovial joints have several common characteristics:

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

Synovial Joint Structure

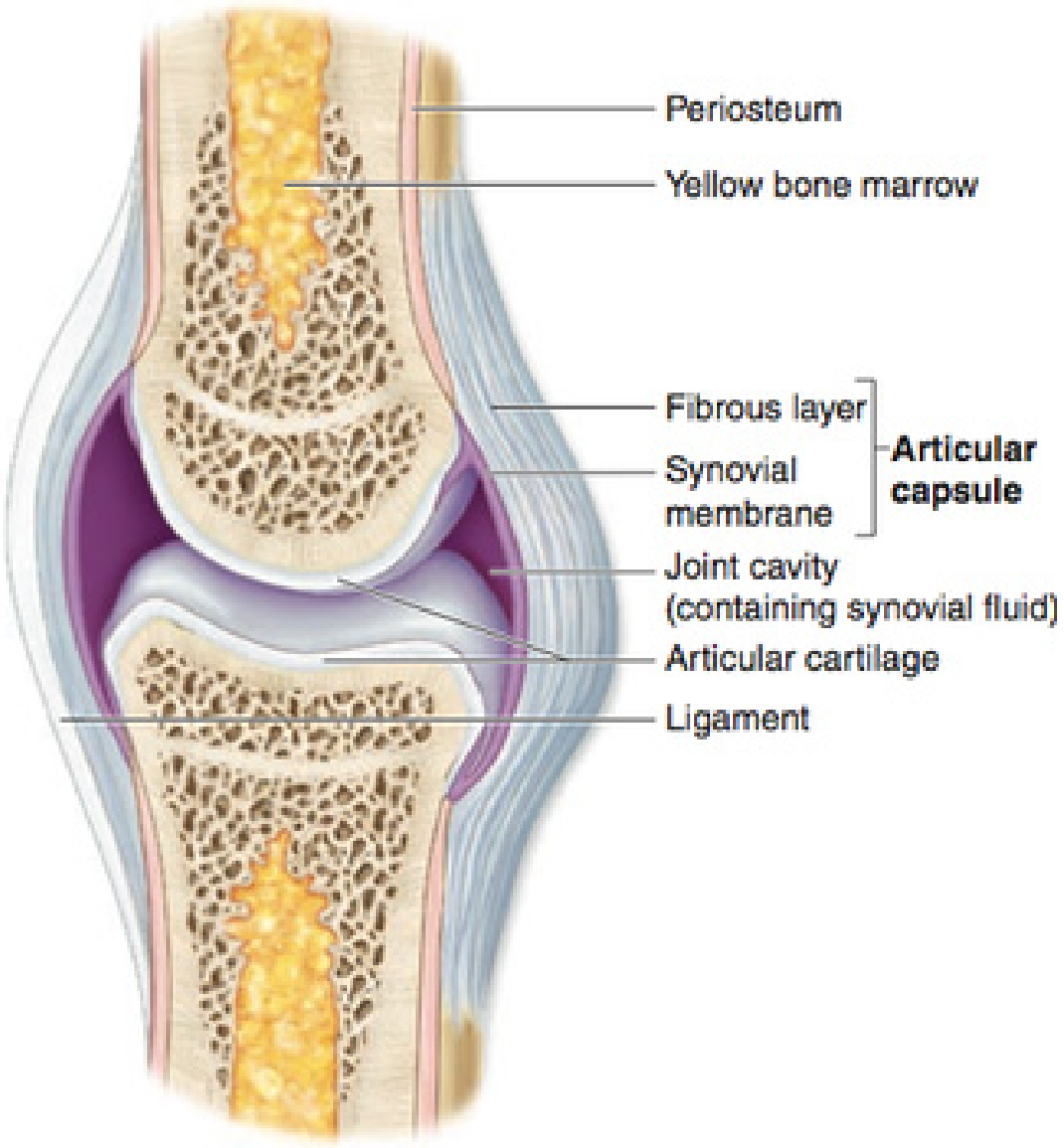
A synovial joint is the most common and most movable type of joint in a mammal's body. Synovial joints are freely movable articulations. In these joints, the bones that share common borders and their bony surfaces are covered with articular cartilage and connected by ligaments lined by synovial membrane. The joint may be divided; completely or incompletely, by an articular disk or meniscus. The outside of which is encased 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.

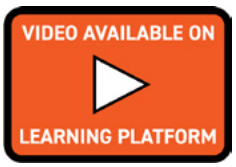
The bones of a synovial joint are covered by a layer of hyaline cartilage that lines the epiphysis of joint ends of bone with a smooth, slippery surface that does not bind them together. This articular (joint) cartilage **functions to absorb shock and reduce friction** during movement.



A Gliding/Plane Joint

Gliding or Plane Joint examples:

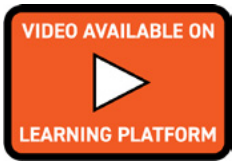
- Acromioclavicular Joints
- Carpal Joints
- Tarsal Joints
- Intervertebral Joints



A Hinge Joint

Hinge Joint examples:

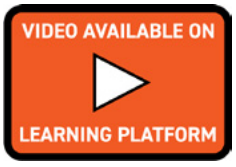
- Patellofemoral Joint (Knee - Patella and Femur).
- Tibiofemoral Joint (Knee - Tibia and Femur).



A Pivot Joint

Pivot Joint example:

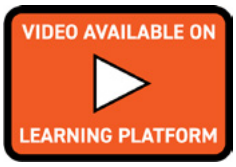
- Atlanto-Axial Joint (C1-C2) (Neck)



A Condyloid or Ellipsoid Joint

Condyloid or Ellipsoid Joint examples:

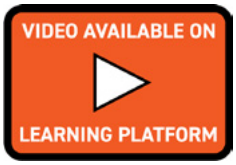
- Metacarpophalangeal Joint (Knuckles)
- Radiocarpal Joint (Forearm-wrist)



A Saddle Joint

Saddle Joint example:

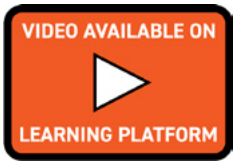
- Carpometacarpal Joint (Thumb)



A Ball and Socket Joint

Ball and Socket Joint examples:

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



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

Joint Actions

MODULE 1
INTRODUCTION TO THE HUMAN BODY AND THE SKELETAL SYSTEM

DOWNLOADABLE RESOURCE AVAILABLE

ON LEARNING PLATFORM

Joint Actions	Description
Flexion	Refers to movement where the angle between two bones decreases
Extension	Refers to movement where the angle between two bones increases
Horizontal Flexion	Refers to movement where the angle between two bones decreases and on the horizontal plane.
Horizontal Extension	Refers to movement where the angle between two bones increases and occurs on the horizontal plane.
Lateral Flexion	Refers to movement of the spine laterally away from the midline of the body. This can be seen when we bend to one side. Refers to movement of the spine laterally away from the midline of the body. Lateral extension refers to the increased angle at the spine. This can be seen when we bend to one side.
Abduction	Movement of a body segment away from the midline of the body.
Adduction	Movement of a body segment toward the midline of the body.
Circumduction	This is a movement where the joint is the pivot and the body segment moves in a combination of flexion, extension, adduction and abduction.
Protraction	This is forward movement of the scapula that results in 'hunching' of the shoulders.
Retraction	This is backward movement of the scapula as they pull together to 'square' the shoulders and push the chest out.
Elevation	Refers to the raising of the scapula to a more superior level (shrugging the shoulders).
Depression	Refers to the scapula moving to a more inferior position as they are pulled downwards.
Supination	Hand - movement so the palm of the hand faces upward or forward (anteriorly). Foot – combination of inversion, plantar flexion and adduction of the foot occurring at the same time.
Pronation	Hand – movement so the palm of the hand faces downward or backward (posteriorly). Foot – combination of eversion, dorsiflexion and abduction of the foot occurring at the same time.
Plantar Flexion	Moving the top of the foot away from the shin or 'pointing' the toes.
Dorsiflexion	Moving the top of the foot toward the shin or 'raising' the toes.
Eversion	The movement of the foot to bring the sole of the foot to face outward.
Inversion	The movement of the foot to bring the sole of the foot to face inward.
Rotation	Refers to a pivoting or 'twisting' movement. Rotation is broken down further into medial and lateral rotation.
Medial Rotation	The movement of a body segment where the front (anterior) of the segment rotates medially (inwards) towards the midline of the body.
Lateral Rotation	The movement of a body segment where the front (anterior) of the segment rotates laterally (outwards) away from the midline of the body.

Upper Body: Joint Actions

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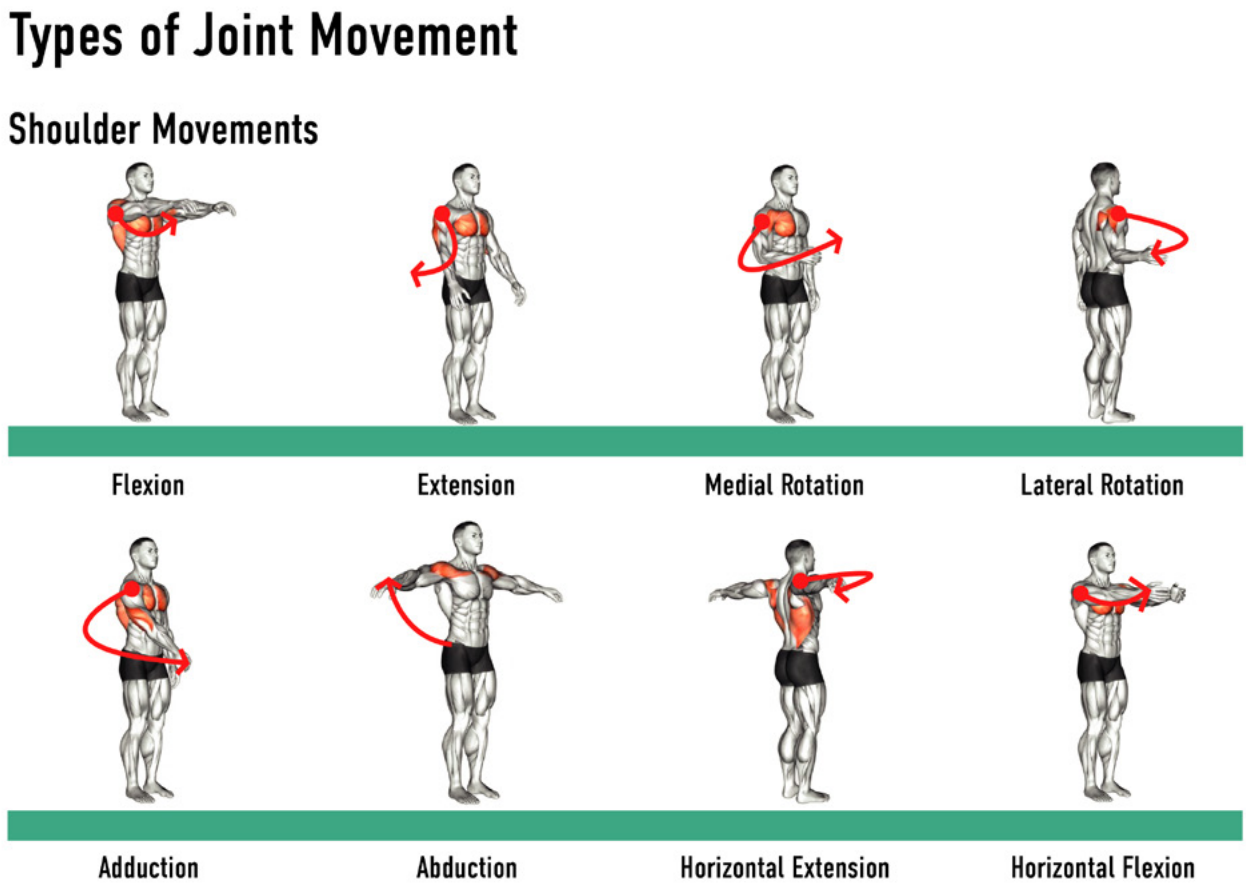
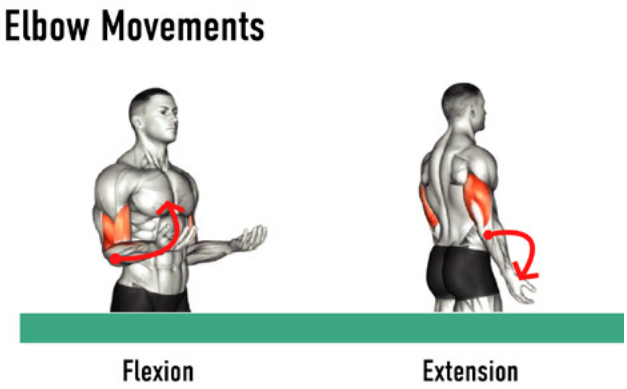
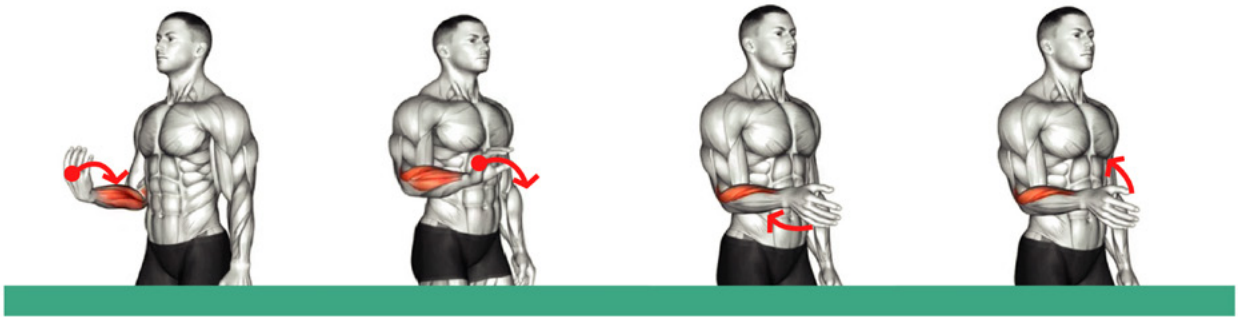
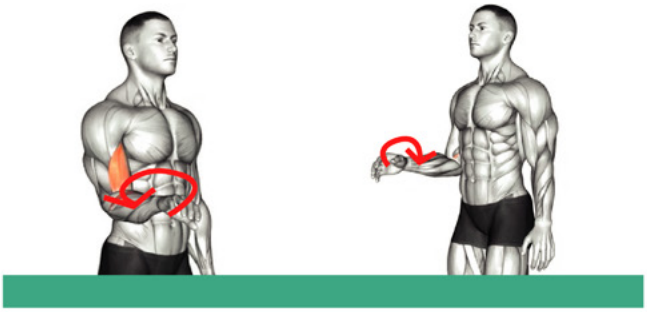




Wrist Movements



Forearm Movements



Lower Body: Joint Actions

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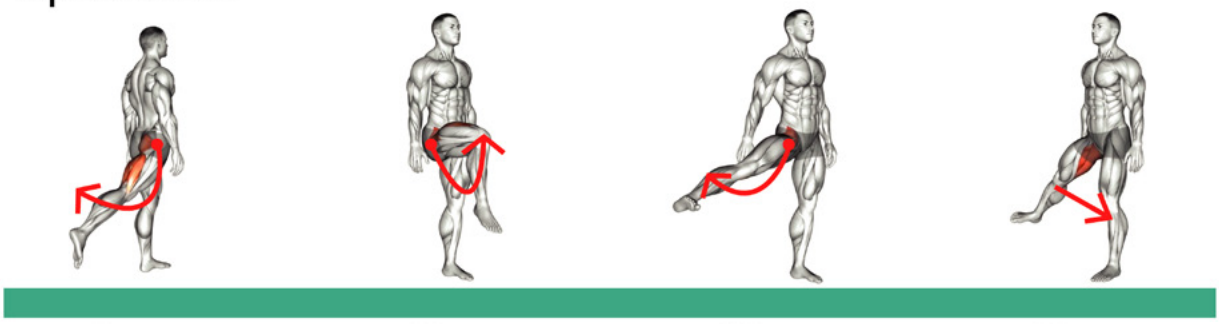
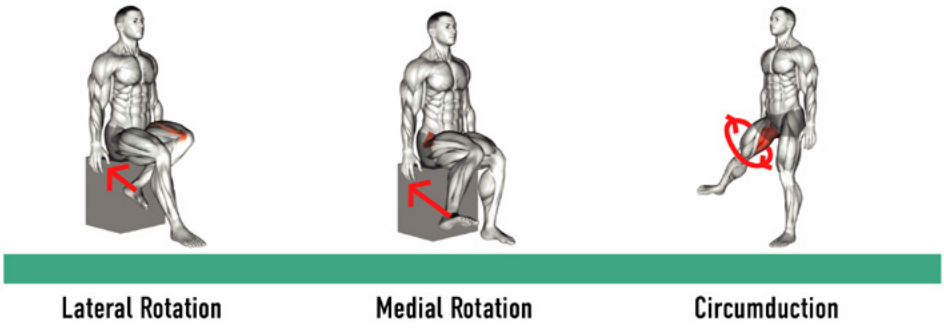
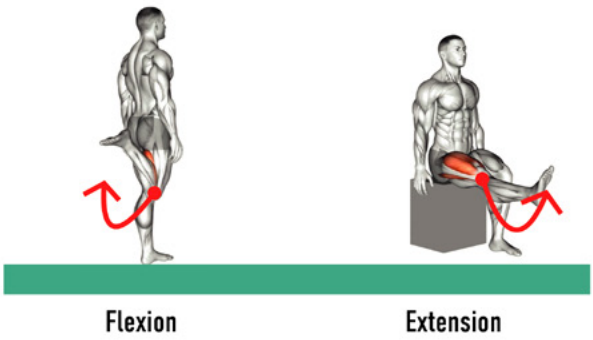
Hip Movements

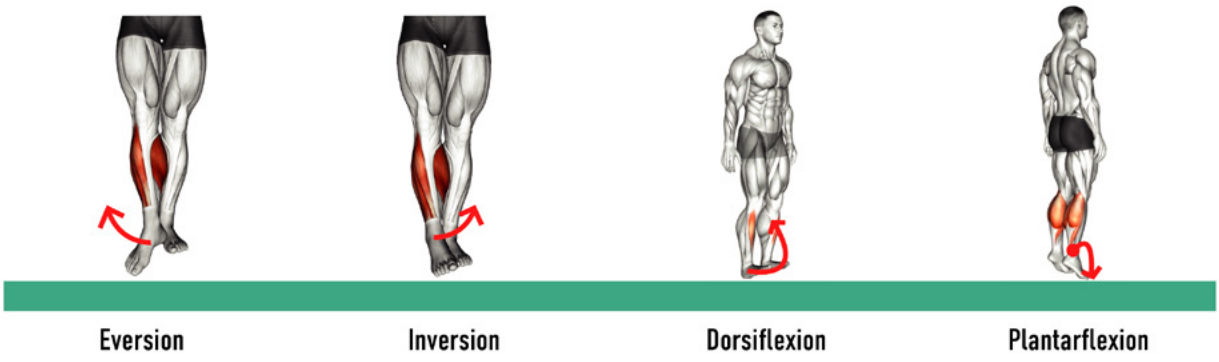




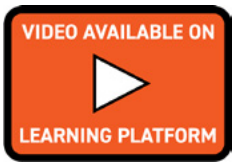
Knee Movements

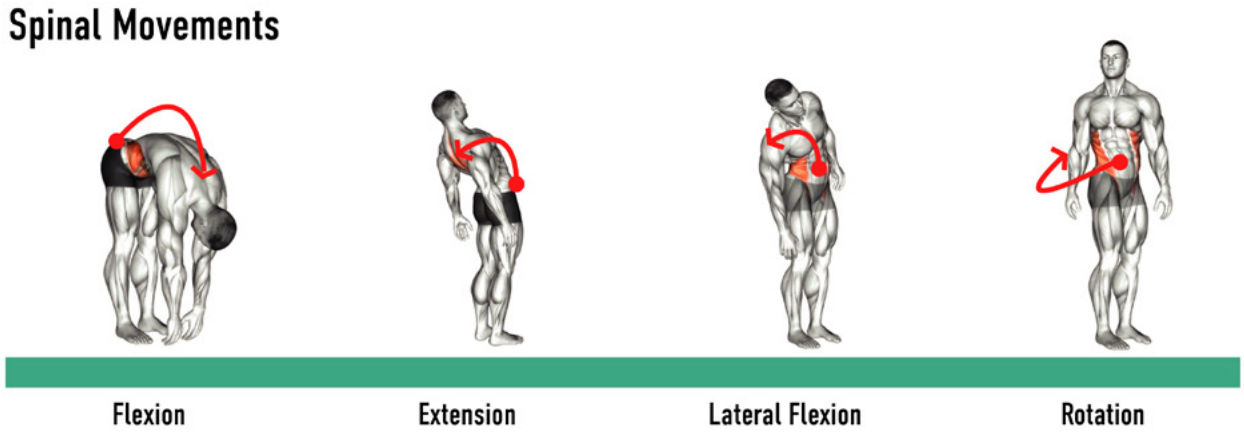


Ankle Movements



Spinal Movements

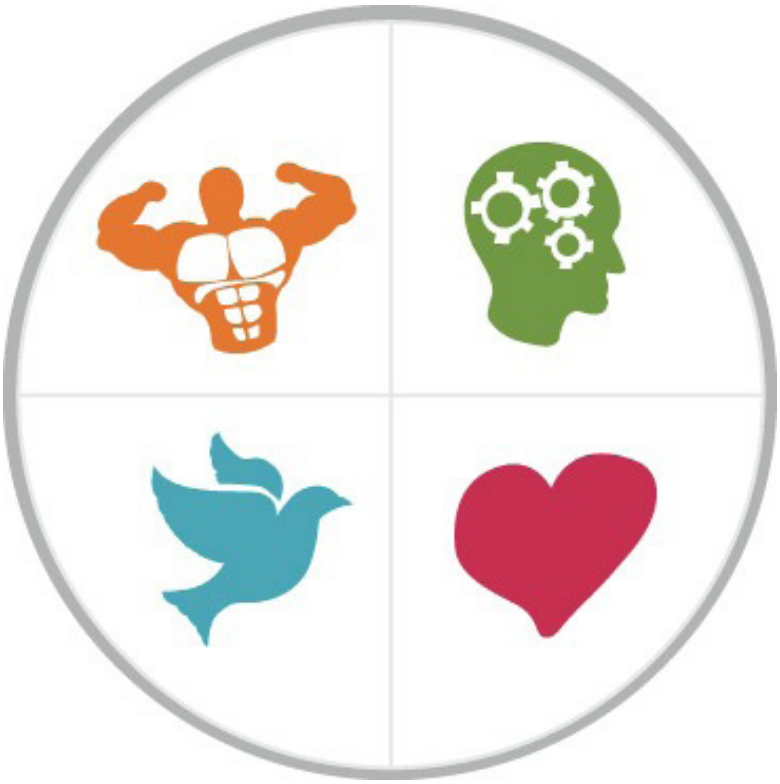




Types of Fitness

MODULE 1:
THE SKELETON, JOINTS & EFFECTS OF EXERCISE

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

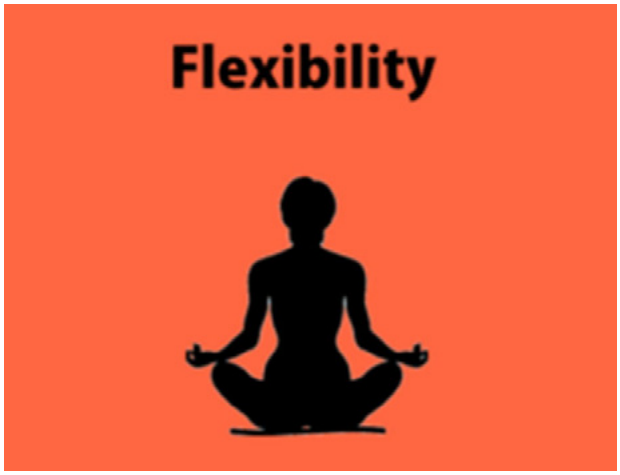
Pertaining to the ability of the lungs and heart to take in, transport and utilise oxygen, cardiovascular fitness can be improved by performing activities such as jogging and swimming at low to moderate intensities for extended periods of time. Cardiovascular fitness is inextricably linked to cardiovascular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

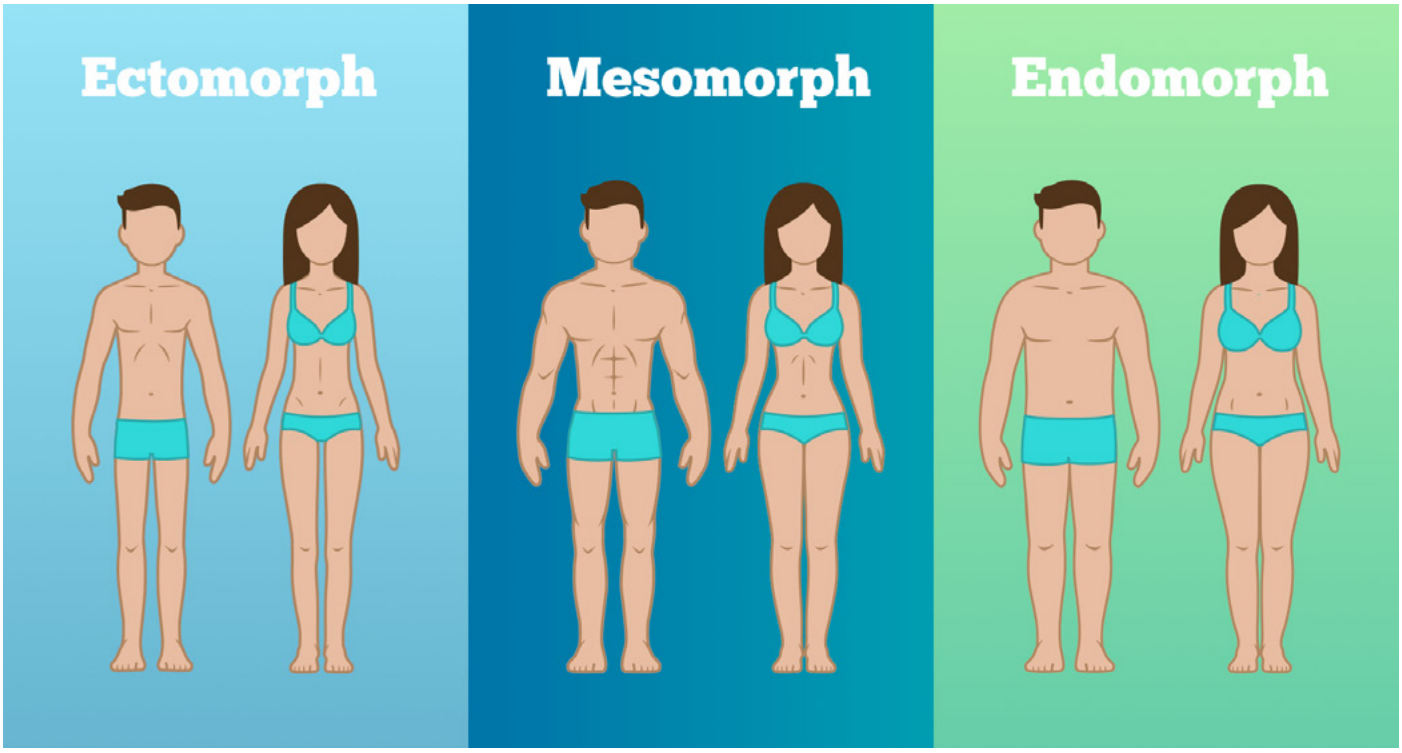
Gender

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.

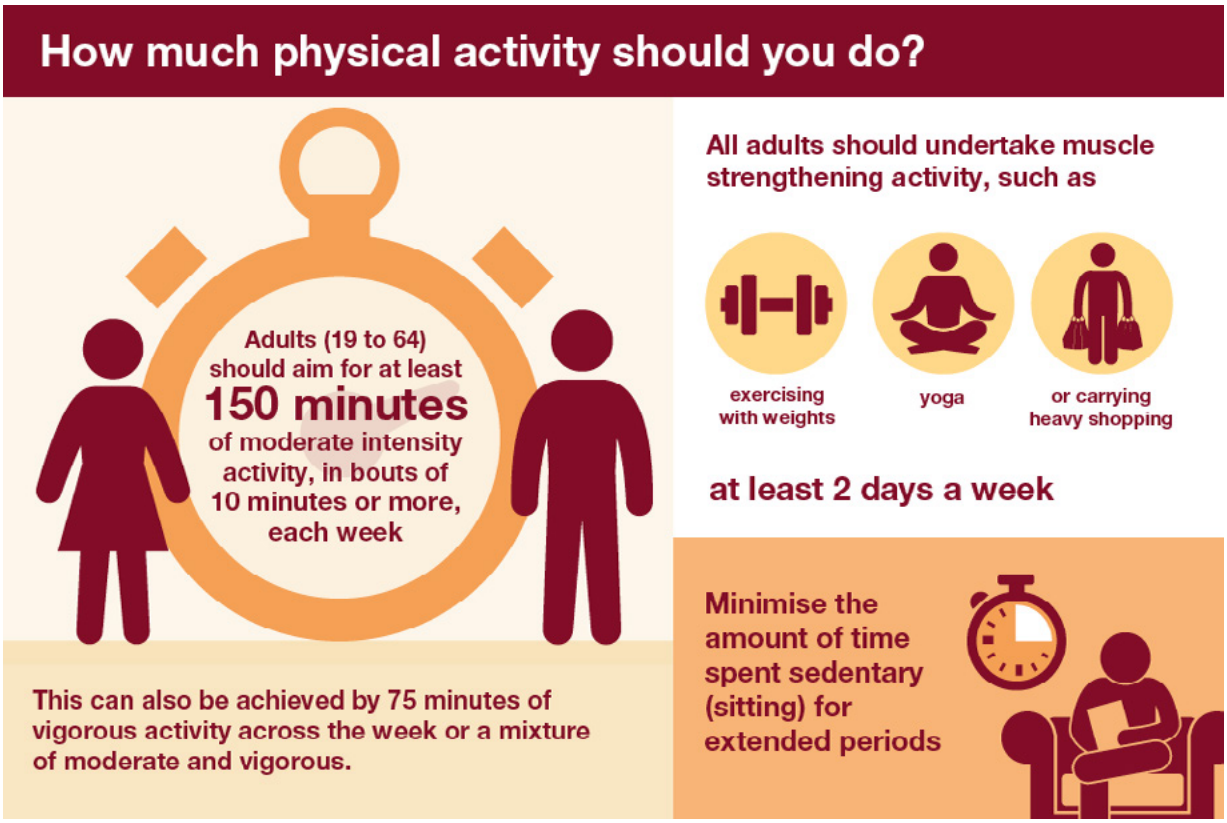
Stress

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:
THE SKELETON, JOINTS & EFFECTS OF EXERCISE

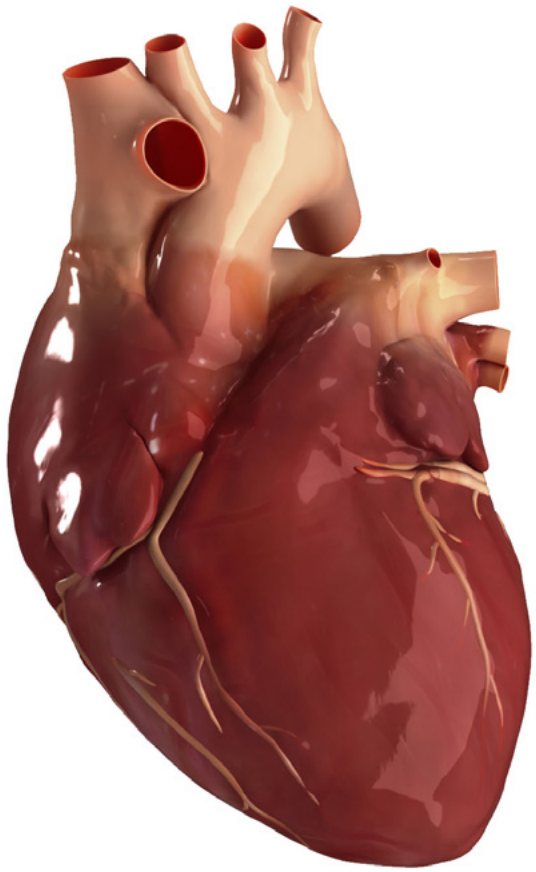
Exercise has a profound and powerful effect on the body. Effects are acute i.e. occur during exercise, and chronic i.e. happen in the days or weeks following a workout. The acute effects of exercise include increased heart and breathing rate, warmer muscles and increased synovial fluid production in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

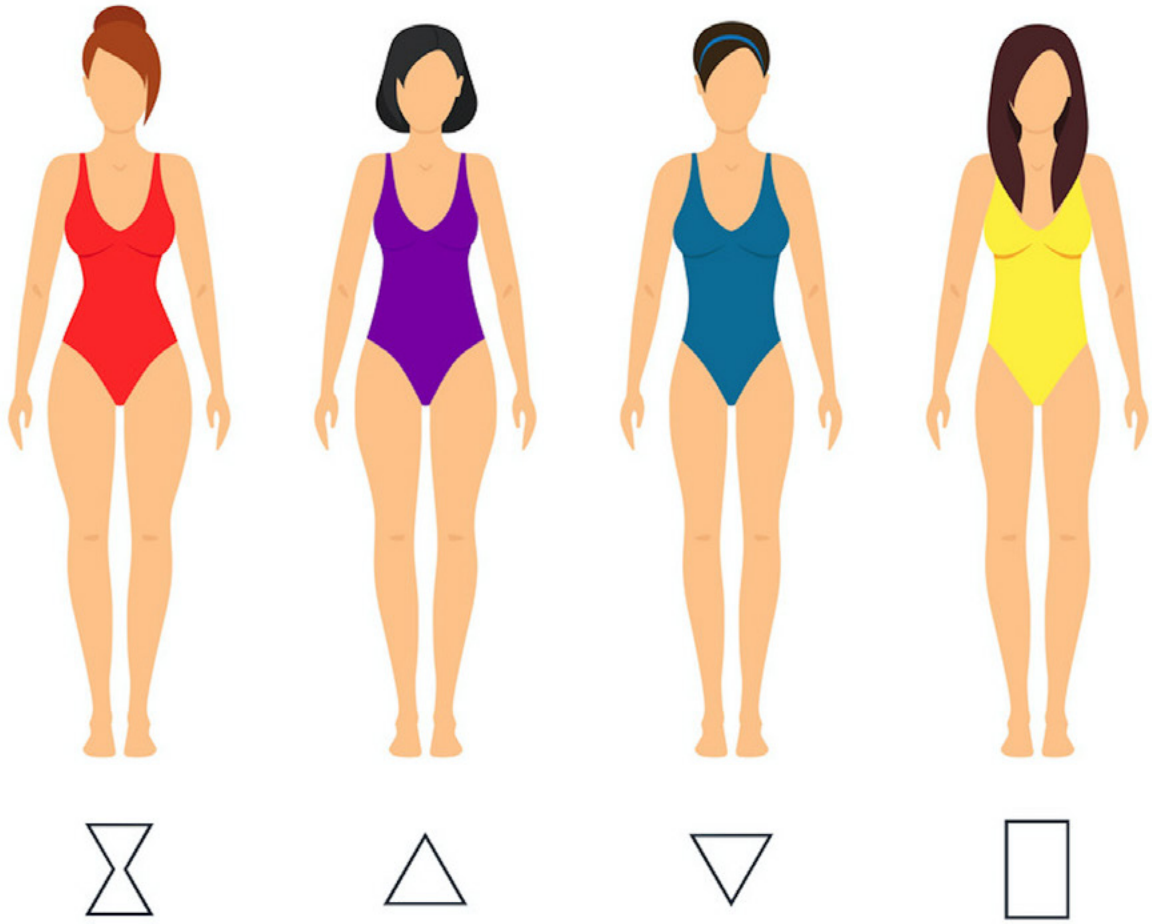
SHORT-TERM EFFECTS OF EXERCISE:

- 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

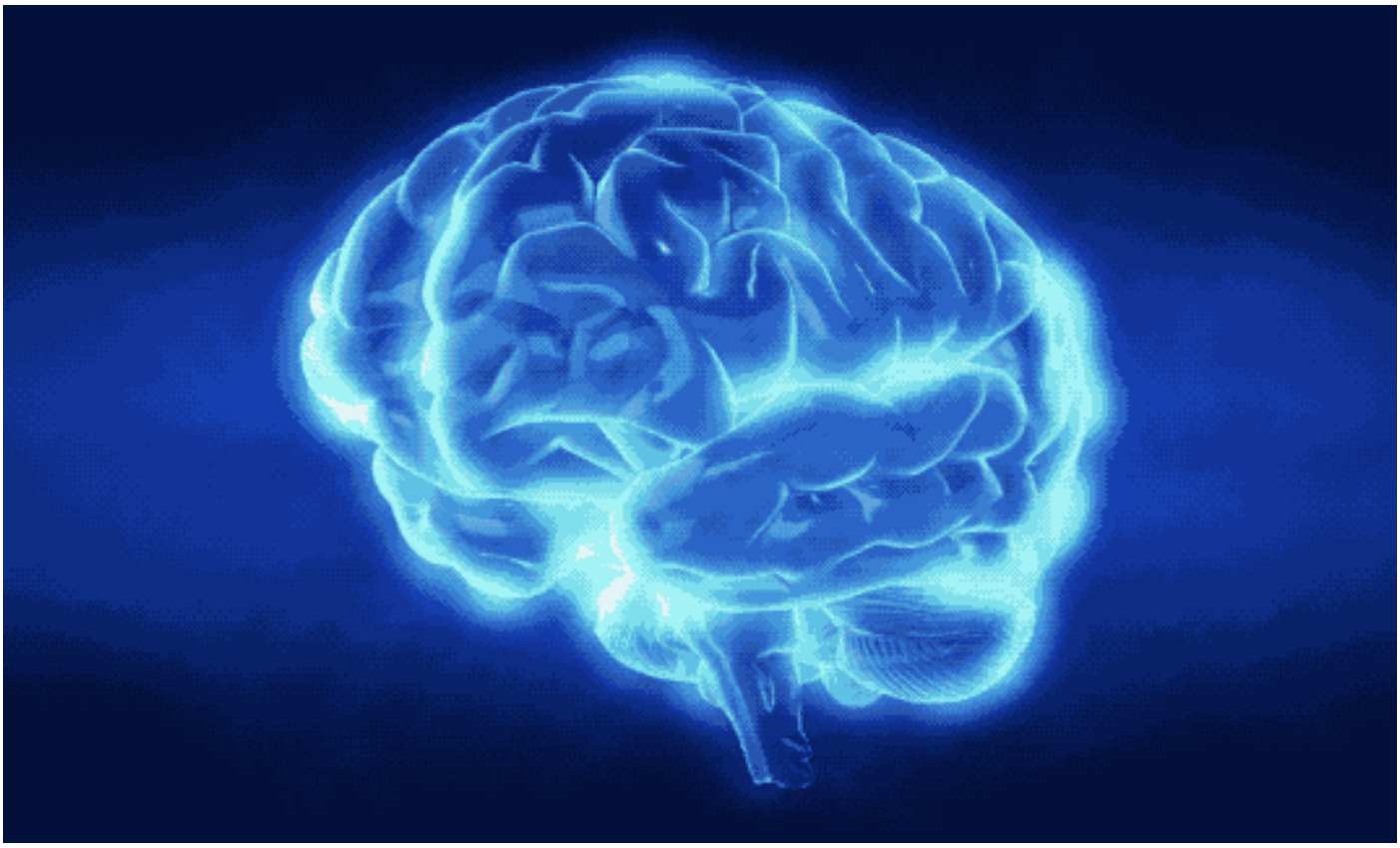


Metabolism is the sum of all chemical reactions in the body. Exercise, both aerobic and resistance training, can have an effect on our metabolic function in a positive or negative way. Exercise can help us to improve our insulin sensitivity, that is we become more efficient in regulating and utilising 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.

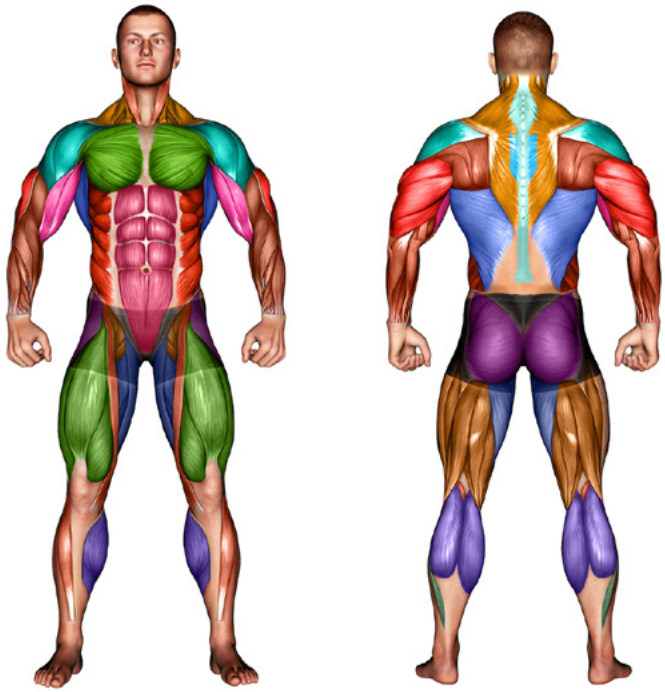
SHORT-TERM EFFECTS OF EXERCISE:

- 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:

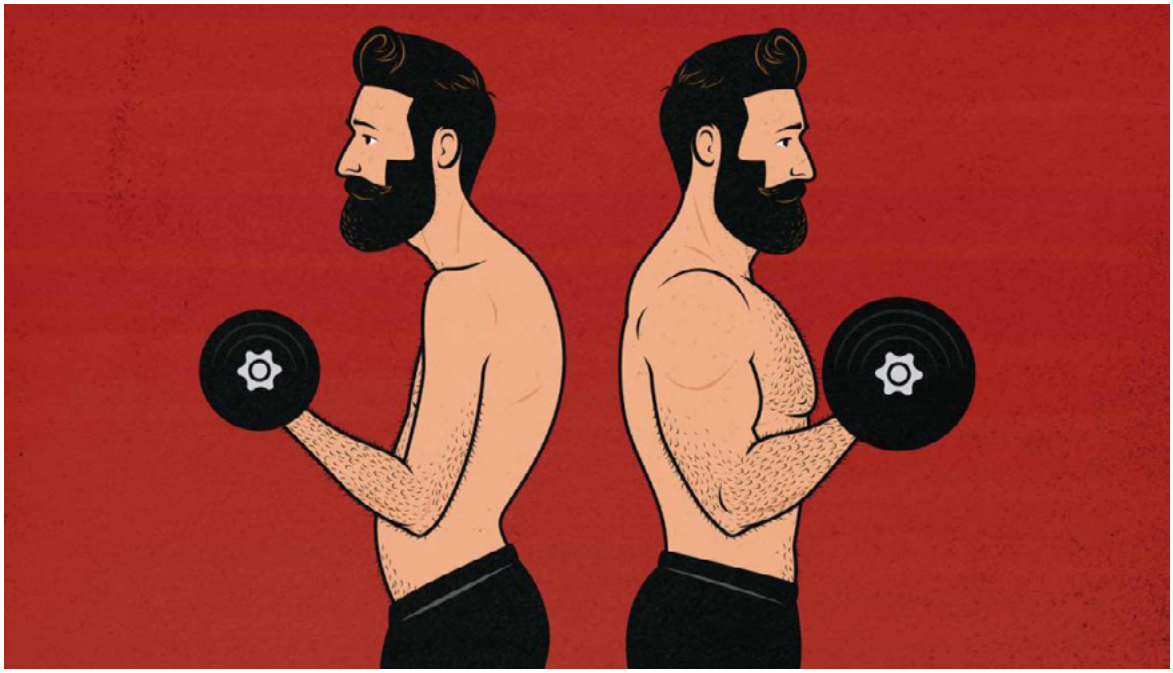
- Vasodilation
- Blood pumped preferentially to working muscles
- Possible DOMS – delayed onset muscle soreness
- Blood pooling

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.

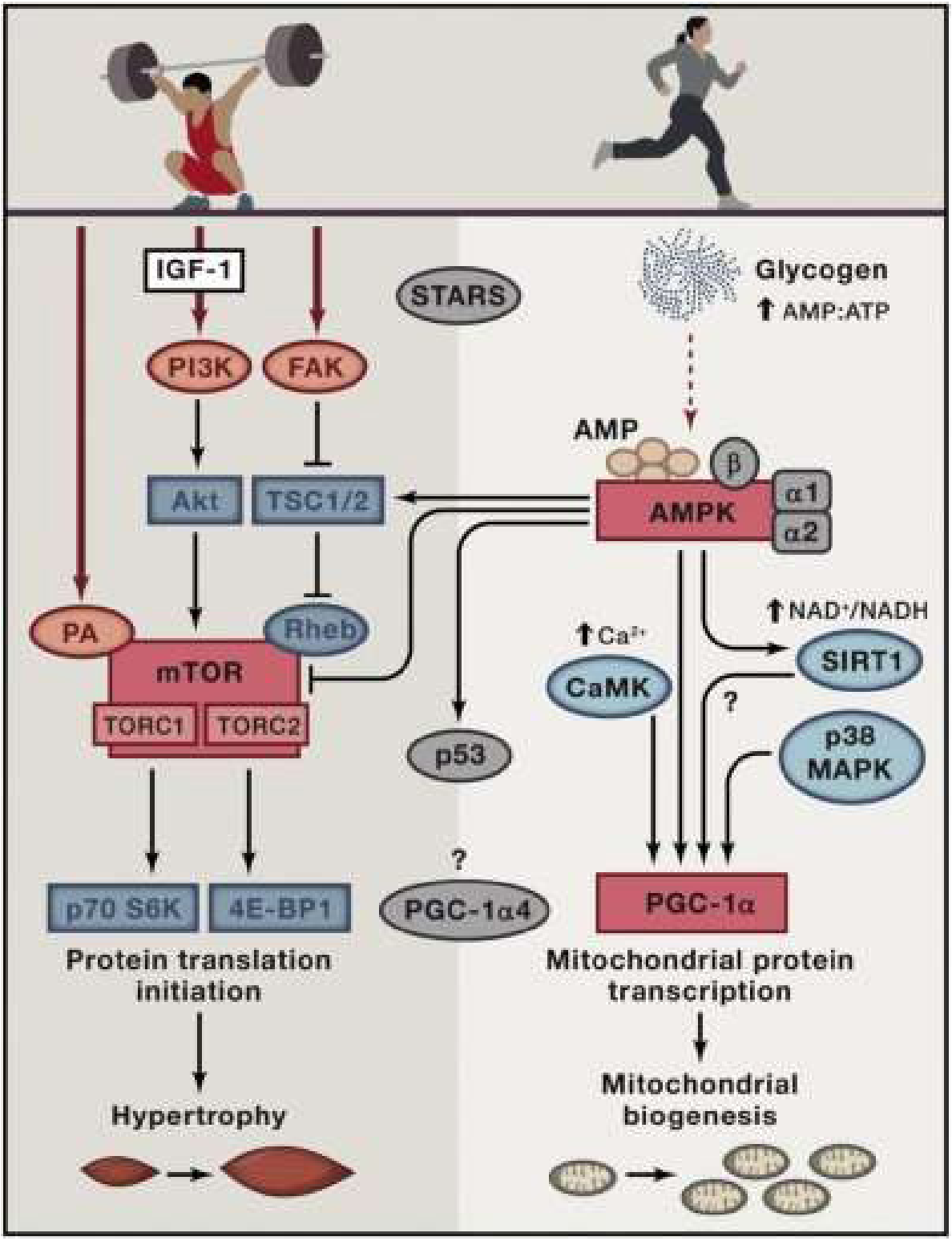
SHORT-TERM EFFECTS OF EXERCISE:

- 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.

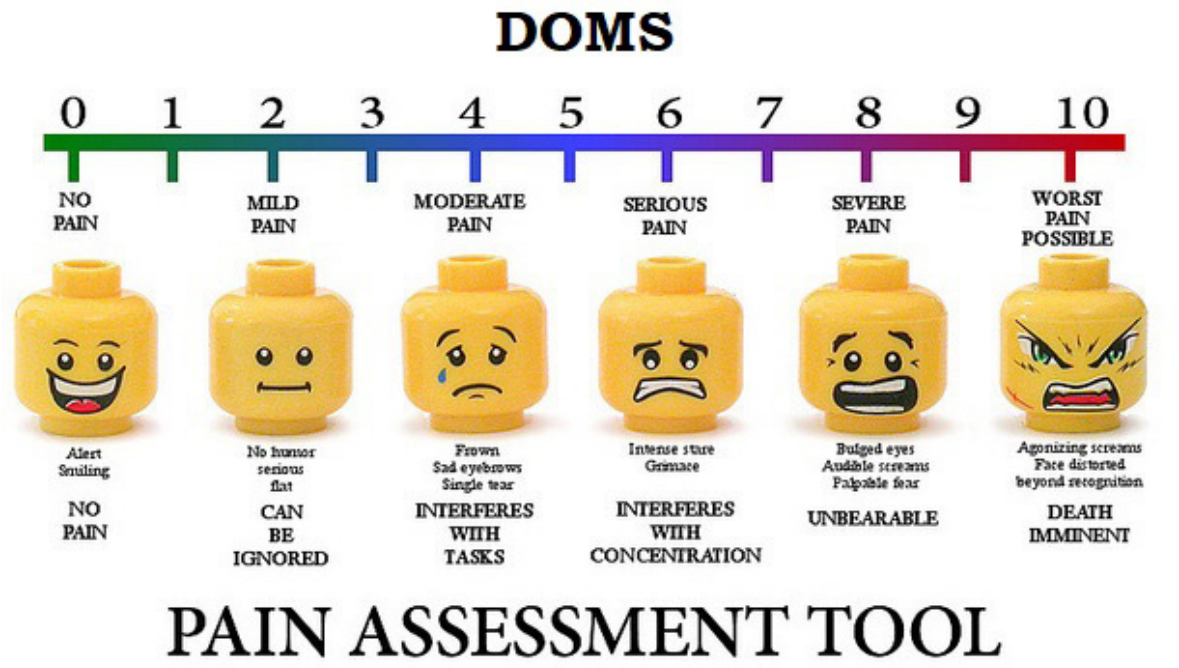
BLOOD POOLING

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.

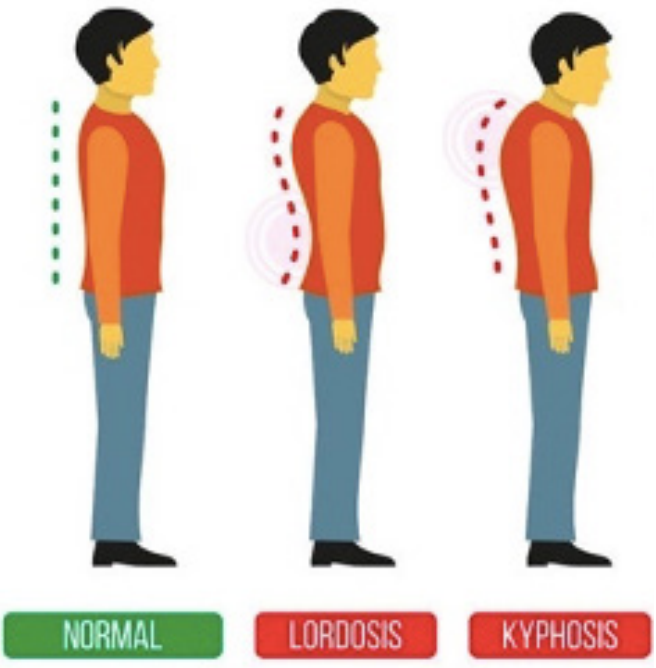


DELAYED ONSET MUSCLE SORENESS

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.

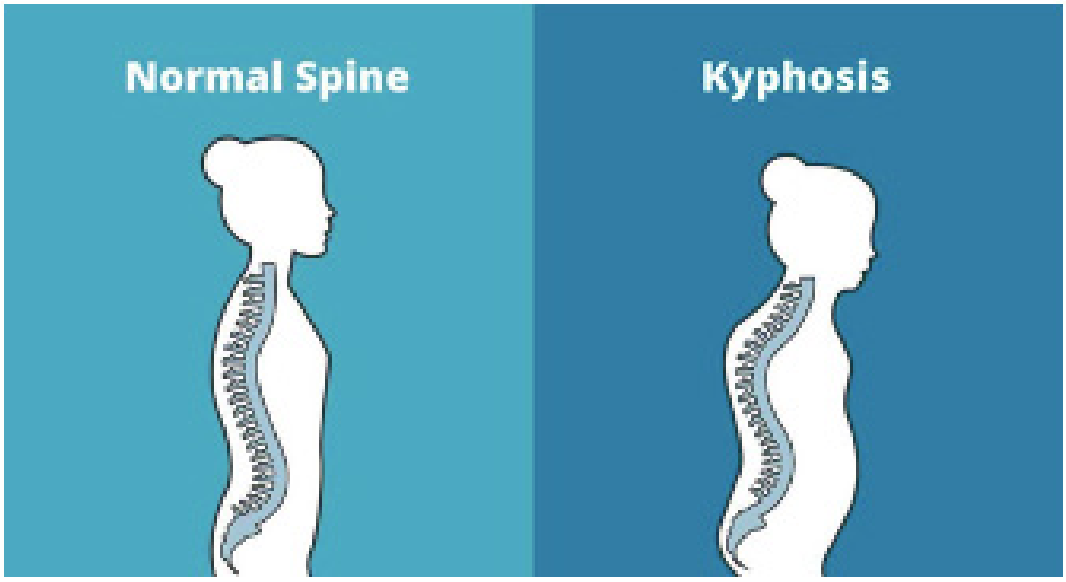
Good Exercise practice for healthy posture

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.



What is Kyphosis?

Presents as - An excessive curvature of the upper back (hunchback syndrome).

Main muscles affected - Pectorals (Shortened), Trapezius (Weakened), Rhomboids (Weakened)

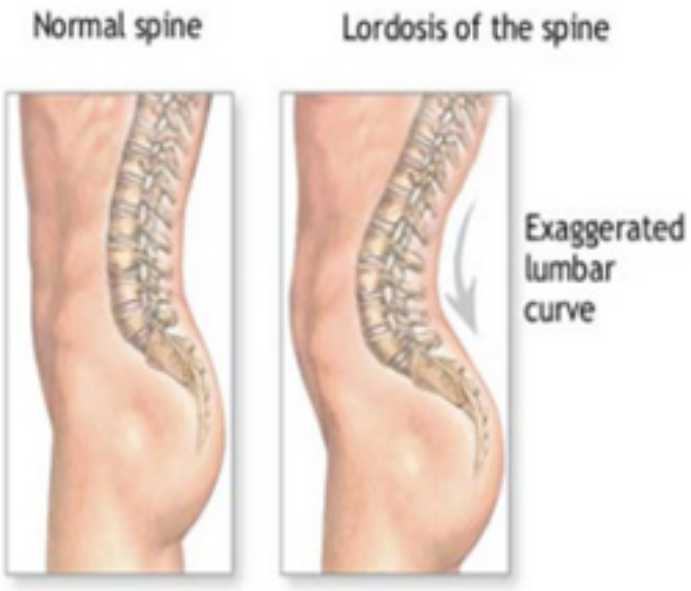
Causes - Sitting is arguably the most negative postural stress encourages a rounded upper back and protracted shoulders as well as a forward head position. Sitting using a computer keyboard is a prime example of another "posture buster" and a habitually rounded upper back deviation is commonly referred to as hyperkyphosis. This hyper kyphotic posture then becomes the norm – even in the standing position. Another cause is the overuse of chest exercises specifically pressing motions.

Effects - Restricted movement of the chest, Restricted breathing (severe cases).

Corrective Exercise practice for Kyphosis:

The below examples are exercises that exclusively use each practice, please be aware that this list is not exhaustive.

- Involve a full range of movement - Rear delt fly.
- Be compound, functional movement patterns - Bent over row.
- Are performed standing and/or unsupported - Face pulls.
- Utilise free weights and cables rather than machines - DB single arm row.



What is Lordosis?

Presents as - Excessive inward curve of the lumbar spine (saddleback).

Main muscles affected - Abdominals (Weakened), Hip flexors (Weakened), Erector spinae (Shortened)

Causes - When someone is overweight or obese with a greater amount of abdominal fat, there can be a shift in their centre of gravity. This shift can place an increase demand upon the posterior chain muscles to try and keep our abdomen upright, when the posterior chain eventually fatigues, we can see a gradual shift in the pelvic tilt taking their pelvis into a state of anterior tilt.

Weak core muscles – similar to obesity if the anterior core muscles are weak and the posterior core muscles are stronger than an imbalance can occur due to the core muscles being off balance.

Effects - Reduced range of motion in the legs. Reduced range of motion in the lumbar spine (lower back) and in some cases pain and discomfort can be felt in the hip flexors.

Corrective Exercise practice for Lordosis:

The below examples are exercises that exclusively use each practice, please be aware that this list is not exhaustive.

- Involve a full range of movement - Superman.
- Be compound, functional movement patterns - Deadbug.
- Are performed standing and/or unsupported - Barbell rotation.
- Utilise free weights and cables rather than machines - Cable wood chop.

Additional Consideration:

Lordosis is commonly seen during pregnancy, it is advised to keep a focus on the pelvic floor muscles to maintain good postural stability throughout pregnancy. When a client is postnatal, the planning of exercise should focus on the strengthening of abdominal muscles to combat the effects of pregnancy.