Why do we sit?

Lesson overview

This Lecture will focus on the basic biology and physical properties of the body structures when in the sitting position, and the physics associated with these structures. What are bones, tendons and ligaments, what are muscles, joints and fascia and what are the relationships between them? What are these composed of and what do they do? What are their physical properties? What forces go through them and what happens when excess forces are applied through them? What is Tension, Stress, Torsion, Friction, Leverage and Creep?

Learning objectives

Find out what the effects on forces are on body structures

Keywords

Ergonomics, biomechanics, Tension, Stress, Strain, Friction, Torsion, Leverage, Creep

PRELOGUE

Why Do We Sit?

Whilst it might seem obvious, that we sit to perform sitting tasks, we also have to realise that sitting is somewhat a learnt position, and it is quite unnatural especially for our spine. We did not always need to sit, and when we started sitting we didn't always need something to sit in. Previously sitting on the floor as a method of resting was common place.

We sit to rest the standing and walking muscles, to rest our feet from the constant pressure of bearing weight, to decrease and lower the centre of balance, to increase the contact with the environment and finally to eat, work or …

Is Sitting Natural?

It is natural to rest, and sitting for short periods of time is ok, BUT sitting for long periods of time, is not well tolerated by the body. It is linked to obesity, increased blood pressure, high blood sugars excess body fat and high cholesterol levels.

General Health

Sitting per se has been linked to metabolic syndrome and higher incidence of mortality, but the negative effects of sitting have also been found to be nullified by regular moderate to intense exercise, especially so when the “sitting periods” are interrupted by breaks of movement, standing and walking.

Some philosophical thinking

For a second , think. Do we need to sit as much as we do?

- Can we watch TV whilst standing or walking on a treadmill?
- Can we work on a PC in standing on a standing desk?
- Can we walk whilst talking on the phone?
- Can we have walking meetings as opposed to sitting in a conference room?
- Can we change a normal chair that we ‘sink’ in, to an ‘unstable chair’?
- Can a treadmill, an unstable surface, a gymball, etc. replace a chair when at a desk?
- Can we take short breaks every 20 minutes to break the sitting marathons?

Is sitting part of our Social culture, that may be challenged up to a certain point?

Think hard ..

When we buy a car, we think of how long it will last, what are the common issues with this car, how much fuel it wastes, what is the range, what is the expected use, and how is does all this fit in with the lifestyle of the owner and the family.

But do we ever have a good look at the seating position, and the functions of the seat and the posture we sit in?

When we take on a new job or work experience do we try to figure out how long we are sitting for, and how we are sitting? How long can the body take such a position, for how long am I going to sit over a certain period of time? Can I disperse the sitting period throughout the day?

If you never thought about this you should be asking yourself, how long can my body sustain this kind of lifestyle?

Body structures..

- What are the various structures that we find in the body?
- What function do they have?
- What physical properties do they have ?
- How can the substance properties be affected by forces?

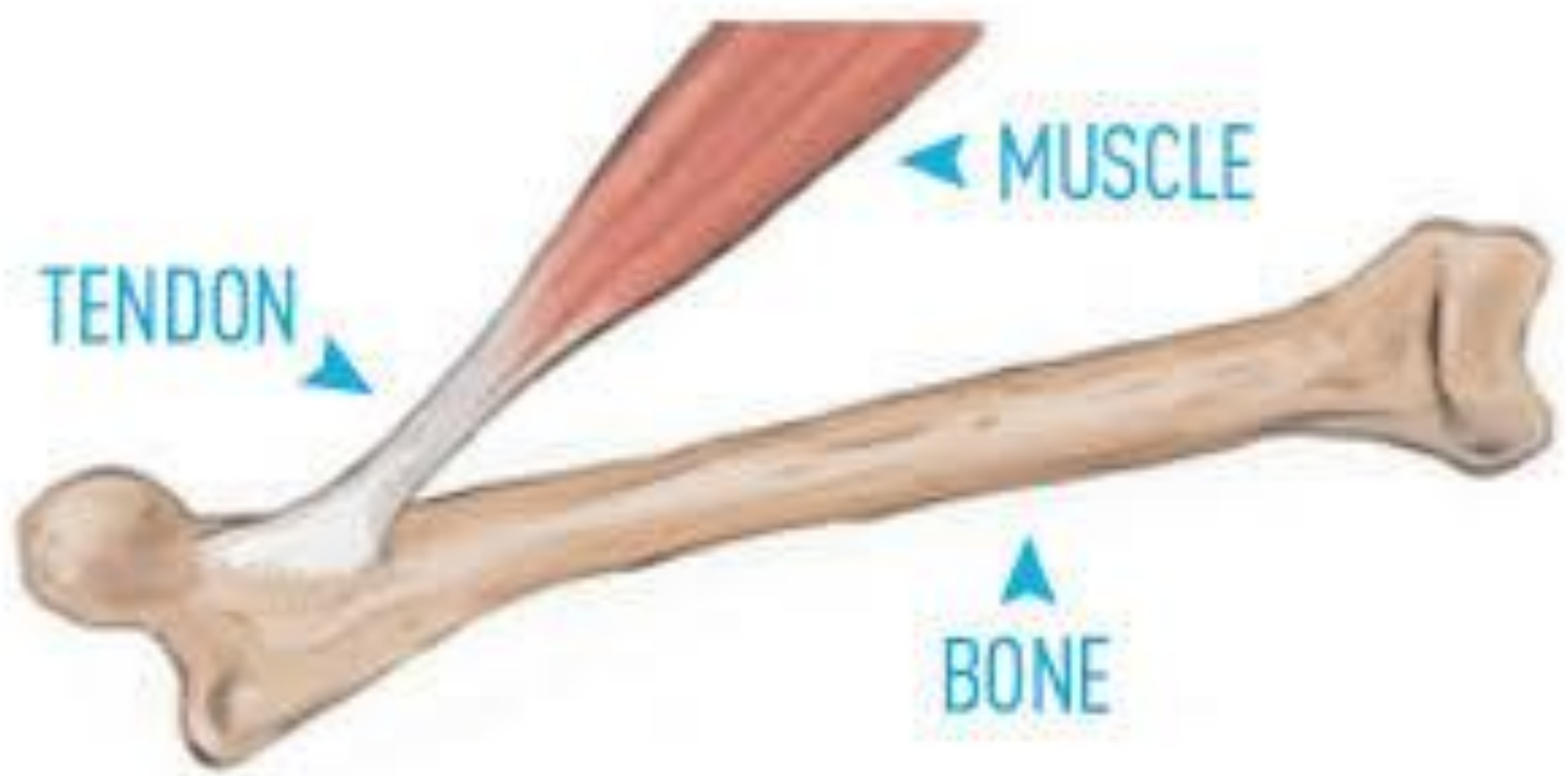
Bones

Bones are hard calcified tissue that has the function to strut and support weight of the body and limbs. It’s a very strong and lightweight living material, made up of a matrix with minerals .

Long bones are hollow to reduce weight and but support weight equally well. They also serve as attachments against which tendons pull and ligaments join.

Vertebrae are solid and smaller, but their shape is ideal to bear weight through them yet allow a lot of movement

Tendons



Tendon is a cord of strong, flexible tissue, similar to a rope. Tendons connect your muscles to your bones and allow us move our limbs.

Tendons are found all the way from head to toe, and their purpose is to transfer the total movement the muscle fibers' contraction to the bone, across a joint, causing movement. The Achilles tendon, which connects your calf muscle to your heel bone, is the largest thickest and toughest tendon in your body.

The thin lines you see at the back of your hand, travelling from your knuckles and converge on your wrist are also tendons

Muscles

Muscles are made up of little units called muscle fibers that contract together to produce a force that pulls on tendons at each end, getting each end closer. Usually the end with least resistance moves. Muscles are surrounded by protective sheats

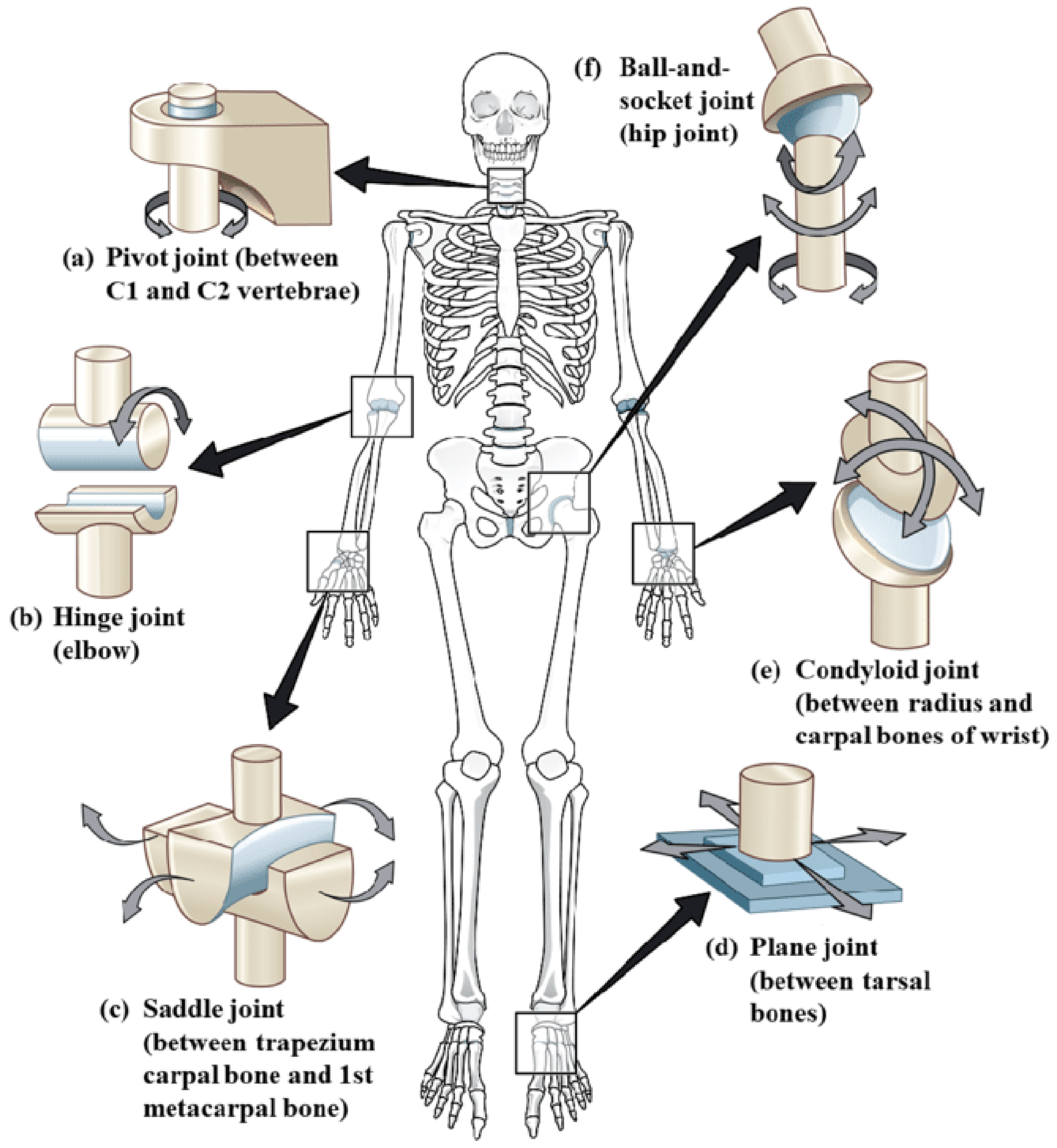
It is important to note that for a muscle to produce movement, the opposite muscle that does the opposite movement has to be relaxed.

There are muscles which are good for explosive bursts of force like jumping or running, and others which are good for more delicate jobs like threading a needle.

Joints

A joint is **the part of the body where two or more bones meet to allow movement**. Generally speaking, the greater the range of movement, the higher the risk of injury because the strength of the joint is reduced. The six types of freely movable joint include

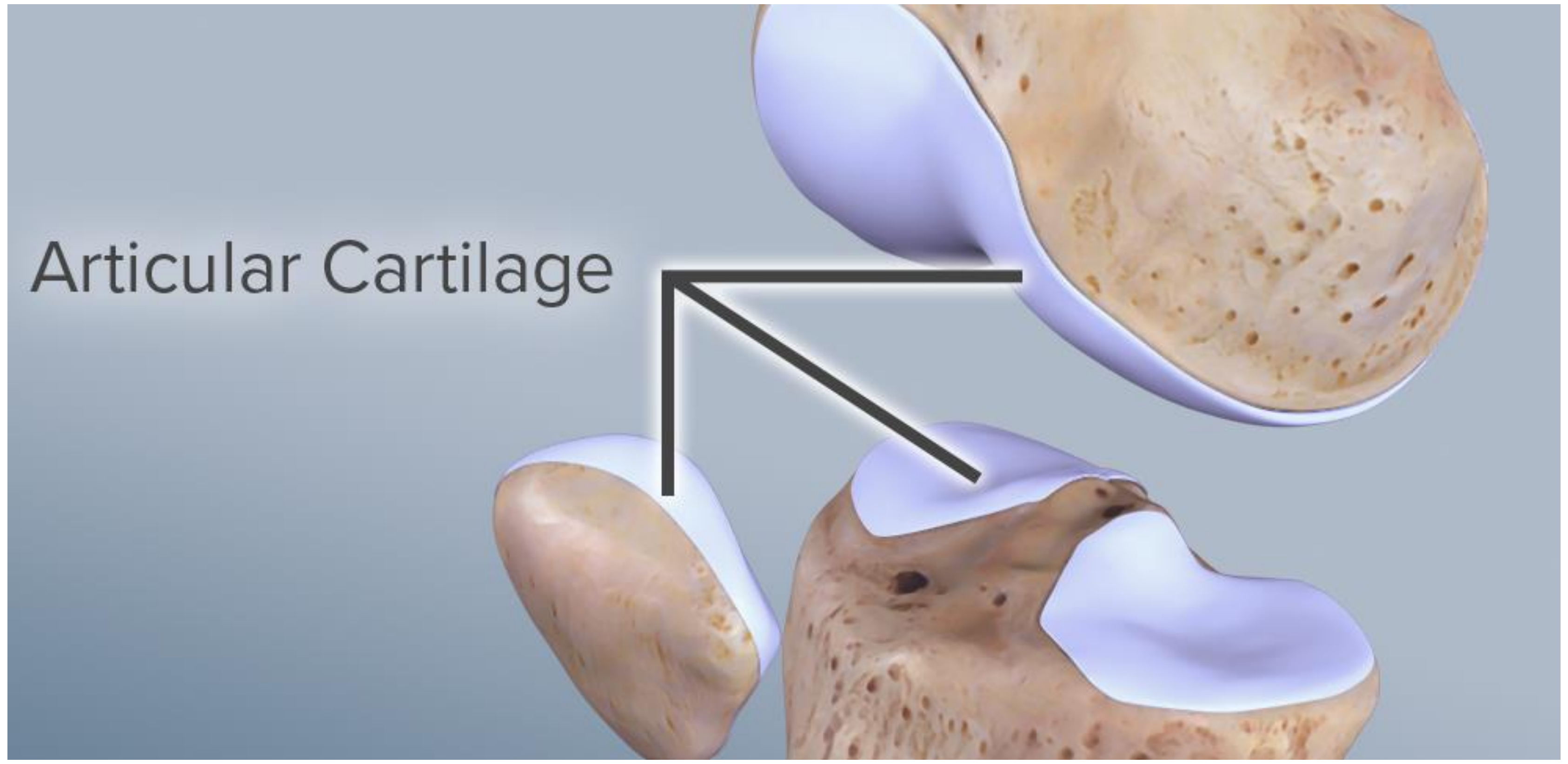
- ball and socket (ex. HIP),
- saddle (ex. THUMB),
- hinge (ex. KNEE),
- condyloid (ex. WRIST),
- pivot (ex. 1st and 2nd vertebrae of neck)
- gliding (ex. PATELLA)

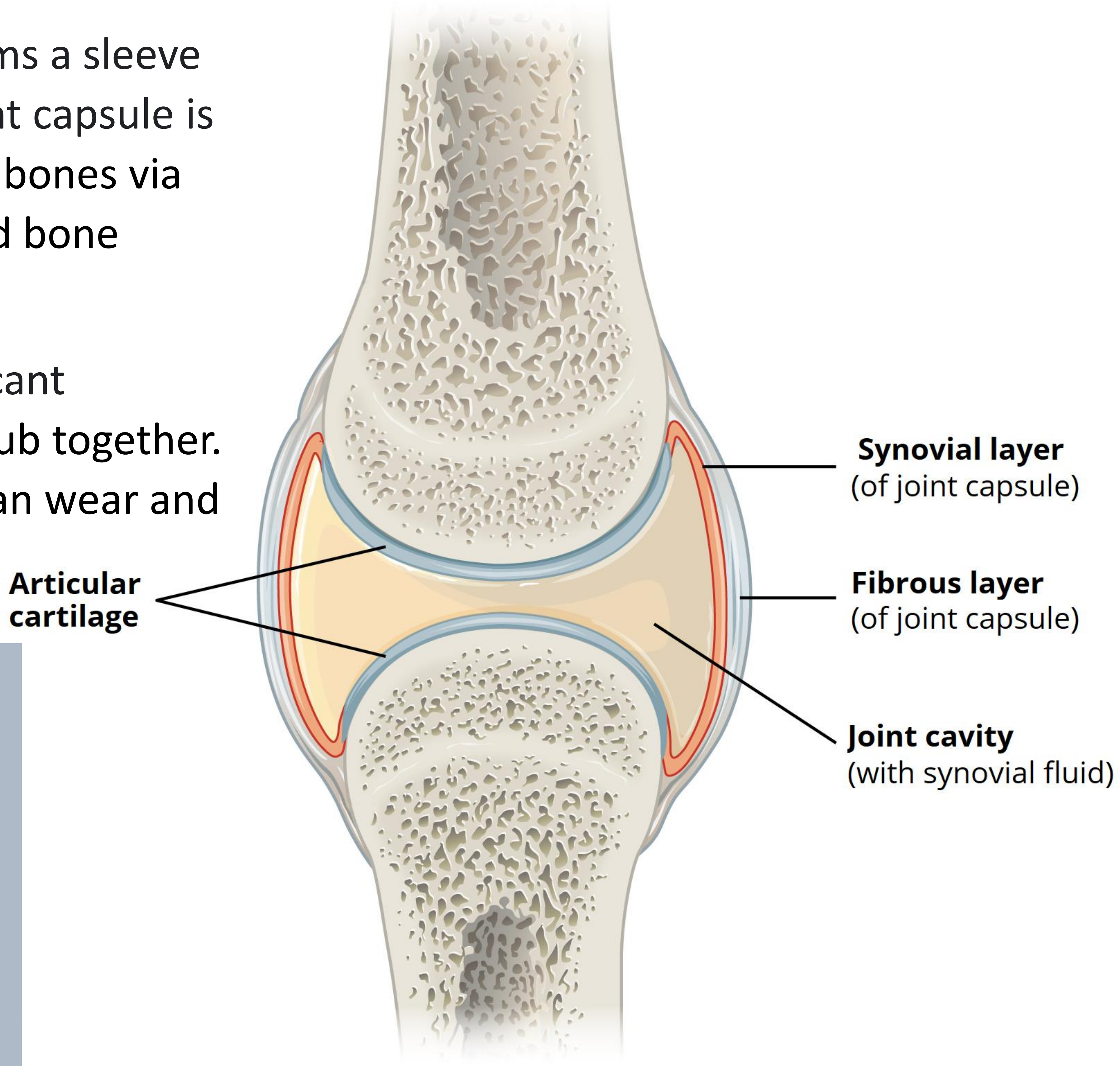


Joint Capsule & Lubrication

The Joint capsule resembles a sac-like structure that forms a sleeve around the synovial joint and encloses its cavity. The joint capsule is a dense fibrous connective tissue that is attached to the bones via specialized attachment zones at the end of each involved bone

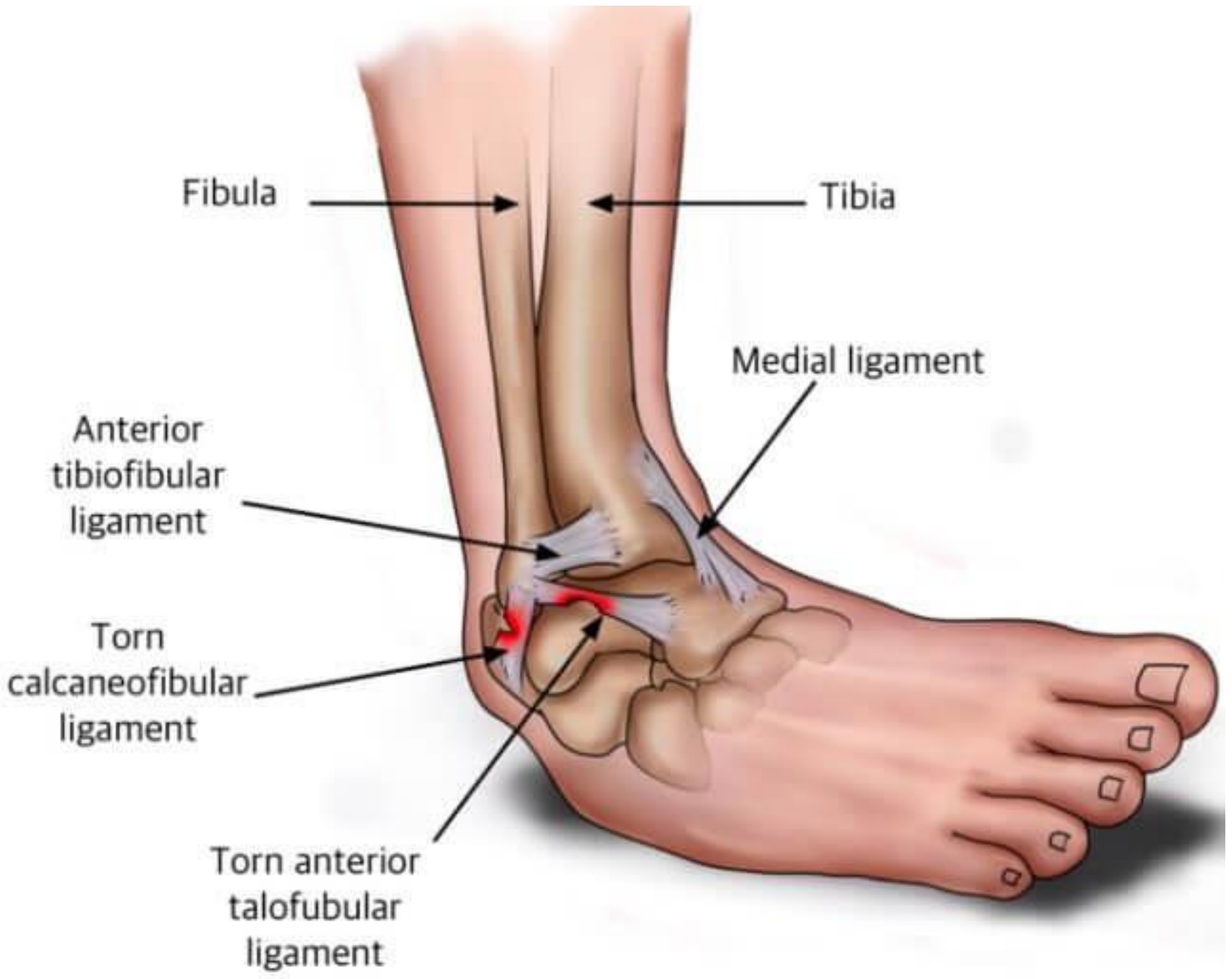
Smooth tissue called cartilage and synovium and a lubricant called synovial fluid cushion the joints so bones do not rub together. But increasing age, injury or carrying too much weight can wear and tear your cartilage.





Ligaments

Ligament is different from a Tendon yet similar. Similarly they are bands of strong connective tissue but they attach on both sides to structures just to hold them together. Most ligaments across a joint hold two bones together. They do not contract and not very elastic. They are prone to injury because they do not have a contractile or lengthening mechanism

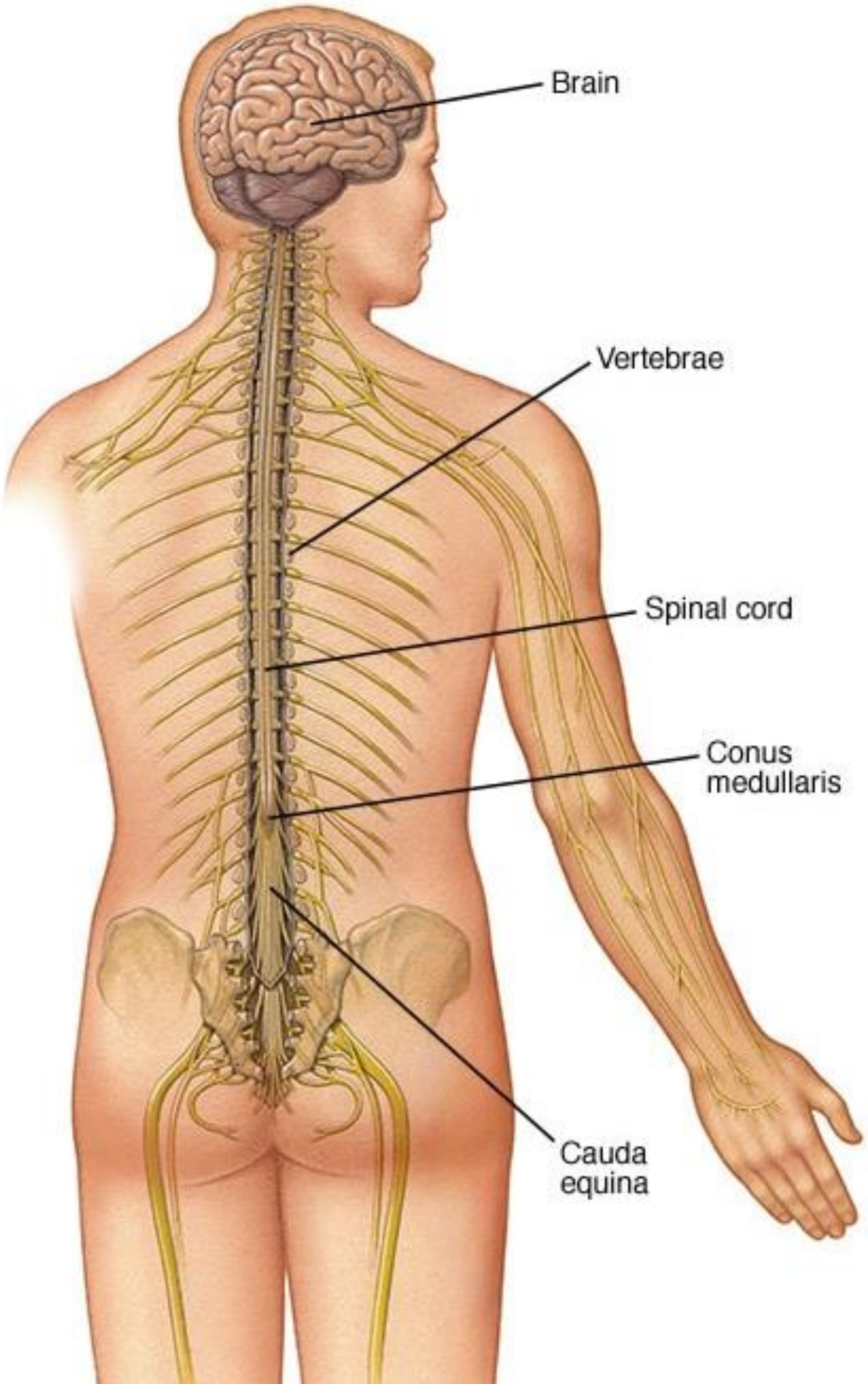


Nerves

Nerves are cord-like structures that have the role to provide a pathway to conduct electrical impulses from the brain to the rest of the body and back. It essentially relays information from one part of the body to another, requiring direct connection to the spinal cord and brain.

It is similar to the wiring system in a house where to switch on a light bulb there has to be a round connection to the power supply.

Injury to any of the nerves will cause severe pain, lack of movement, loss of sensation, weakness or loss of function, or a combination of the above



Injury

These structures are all susceptible to injury.

Injuries can take many forms :

- Sudden large external forces or impact that can break a bone, tear a tendon or ligament or rupture a muscle, or cause significant damage to a whole limb etc. (trauma)
- Repetitive low force over a period of time that causes inflammation and repetitive strain injuries to joints, tendons and muscles etc. (Carpal tunnel syndrome)
- Misuse of structures, apparatus or leverage (damaging footwear, wrong posture)
- Movement beyond the available range of motion (strain, sprain)
- Natural "wear and tear"

The first option is usually a result of accidental injury, which can rarely be controlled.

Our interest is mainly to reduce the possibility of the rest

External Forces..

- What are the various external forces acting on the body?
- What Positive and negative function do they have?
- How can they be biased in our favour?
- How forces interact with eachother?

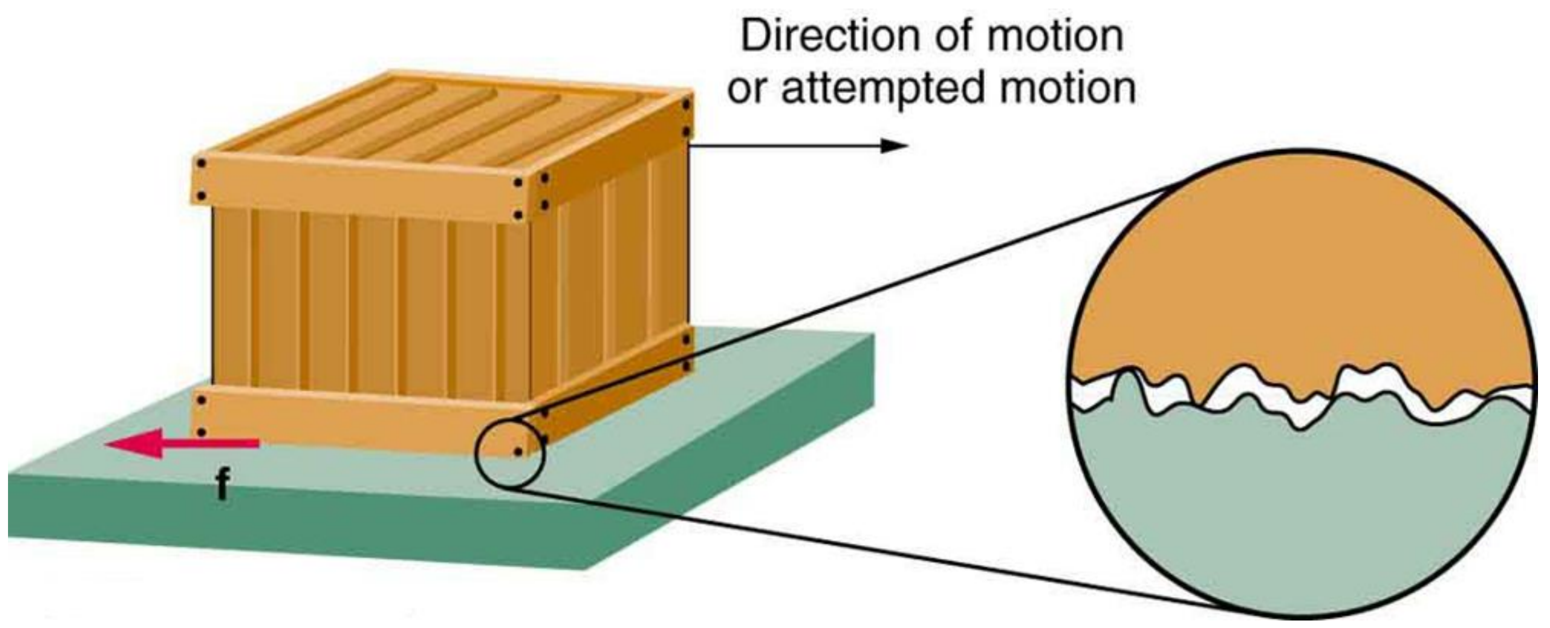
Friction

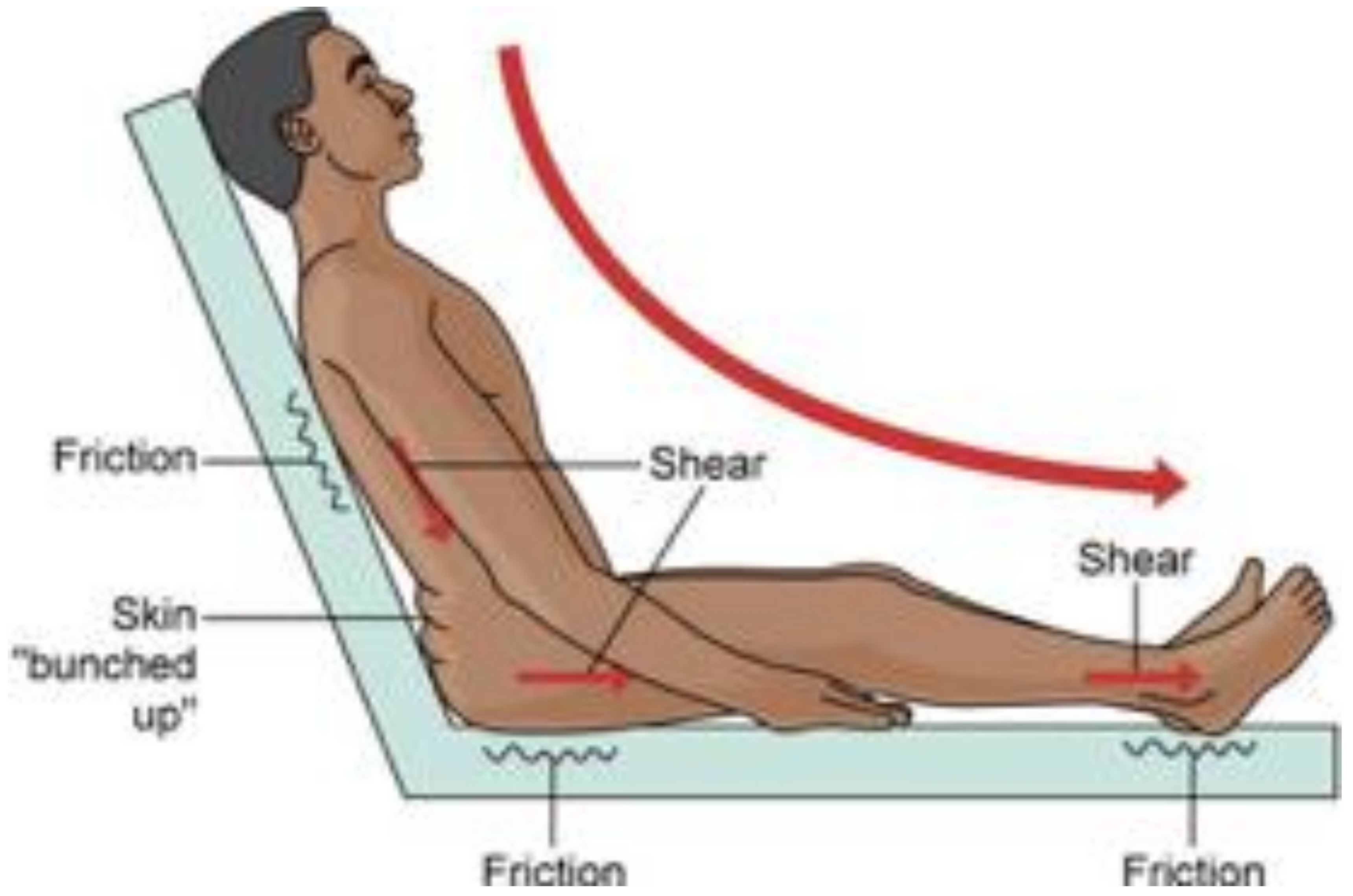
Friction is a force that opposes relative motion between two systems in contact

In the body friction is present in all moving joints, but also in the skin, tendonsheats, and in muscles themselves

The body uses various methods to decrease friction in joints, including synovial fluid, which serves as a lubricant to decrease the friction coefficient between bone surfaces in synovial joints.

Bone surfaces in synovial joints are also covered with a layer of articular cartilage which acts with the synovial fluid to reduce friction and provides something other than the bone surface to wear away over time.





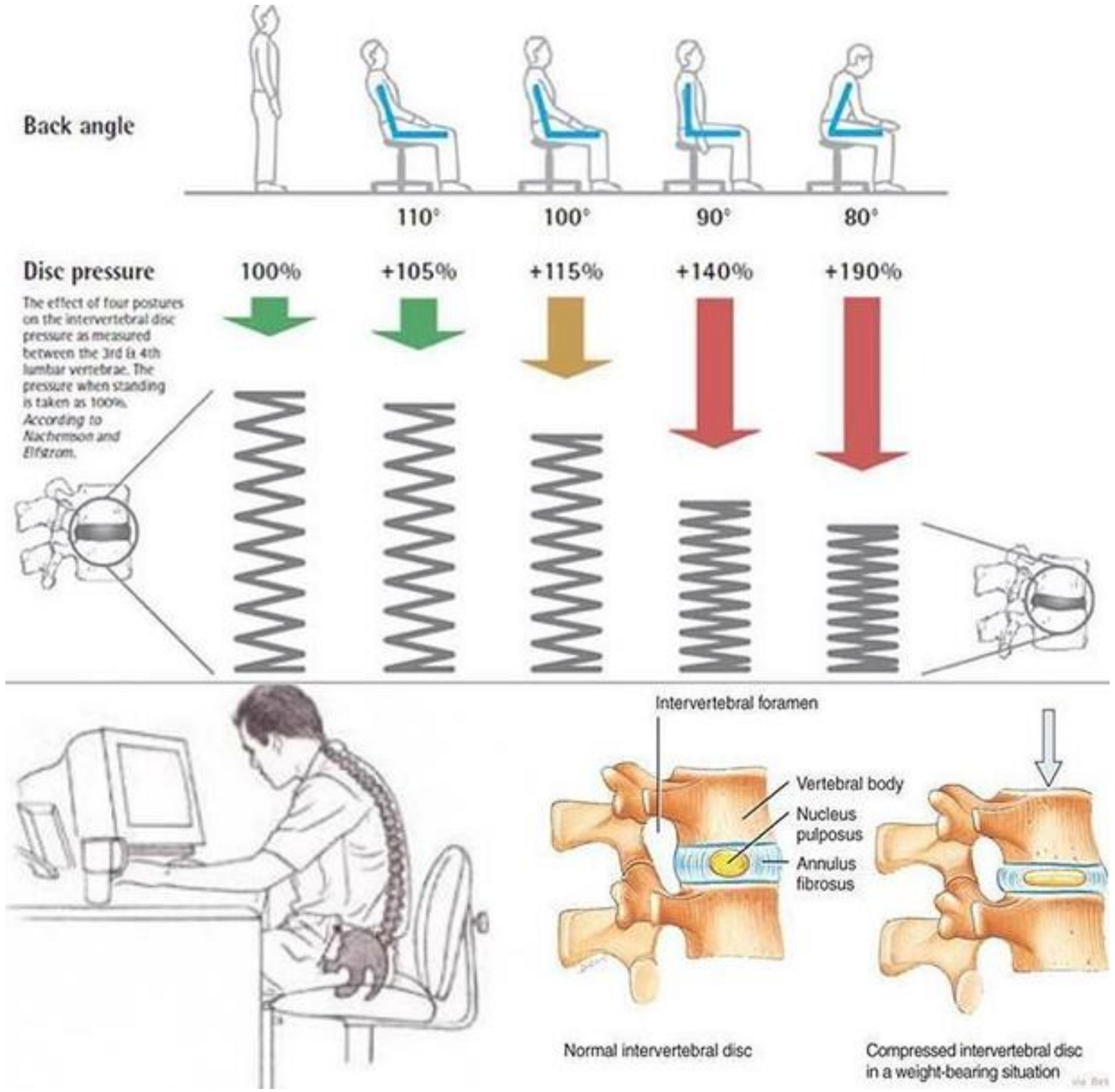
Gravity

Gravity is a force that pulls everything down towards the centre of the earth

keeps good health of bones and muscles, which would wither away and lose strength if this force, and associated stresses gravity has on the body had to be suddenly taken off.

The effect of gravity on the human skull which is heavier than one thinks, means that muscles at the back of the neck have to work hard to keep it upright especially so if it is looking forwards and downwards.

The same effect of gravity on our head and our thorax, means that our vertebral bodies, discs and pelvic structures we sit on all experience the effects of gravity and pressure



Pressure

Pressure as discussed above is the result of the forces acting on the area of contact.

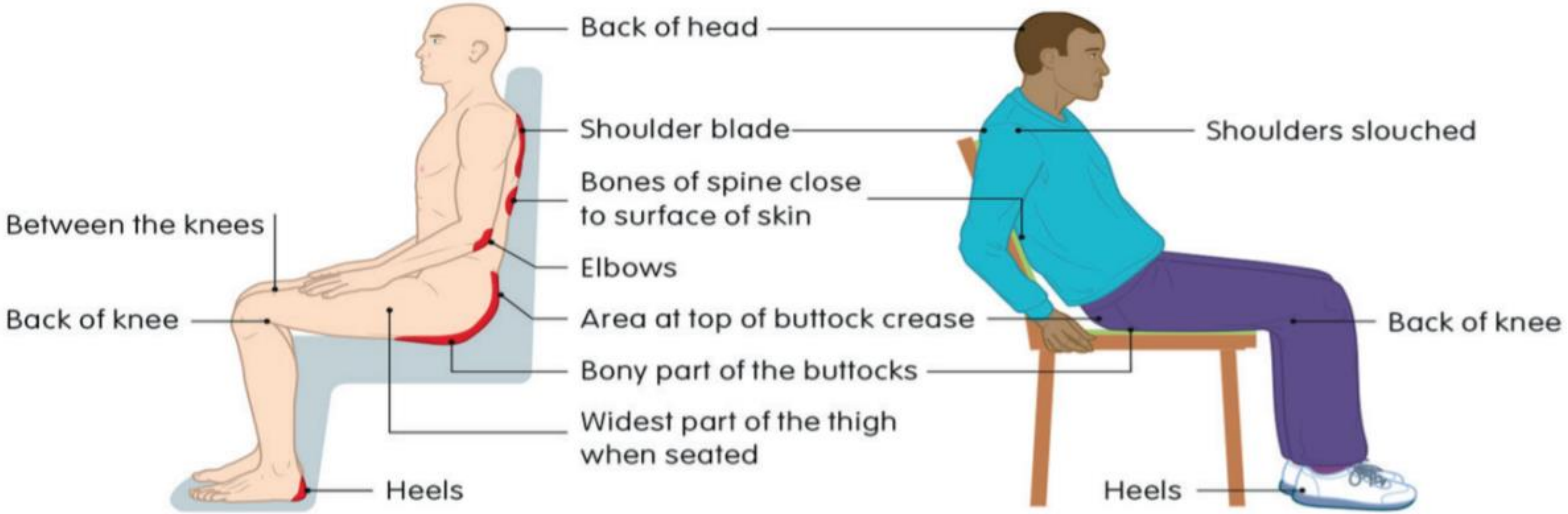
As described poor posture puts pressure on the intervertebral discs, causing disc bulging and nerve irritation.

The larger the area of contact on the pelvis , the more dissipated the pressure is. It is therefore important to have adjustable height chairs to be able to find the right level at which the area of contact minimizes the pressure

Shear

Shearing forces are unaligned forces pushing one part of a body in one direction, and another part the body in the opposite direction. A shearing force will produce a fracture parallel to the direction of the applied force, or deformation of layers in for example layers of skin and muscles.

It is therefore a force that can cause separation of the skin layers, and as a result diminishes circulation that would otherwise pass unhindered through vessels (arteries and veins) in the pelvic area and legs. It is also a main contributor to pressure sores, and ulceration if prolonged.



Creep

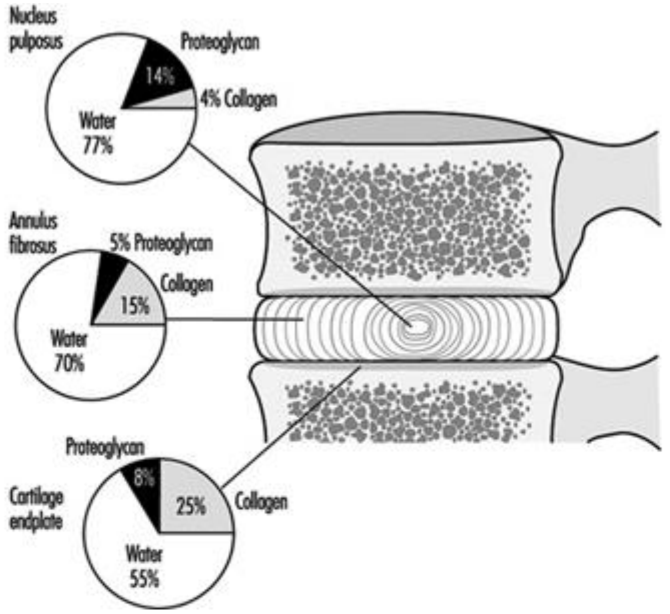
Creep is the deformation of a structure under load, over a period of time.

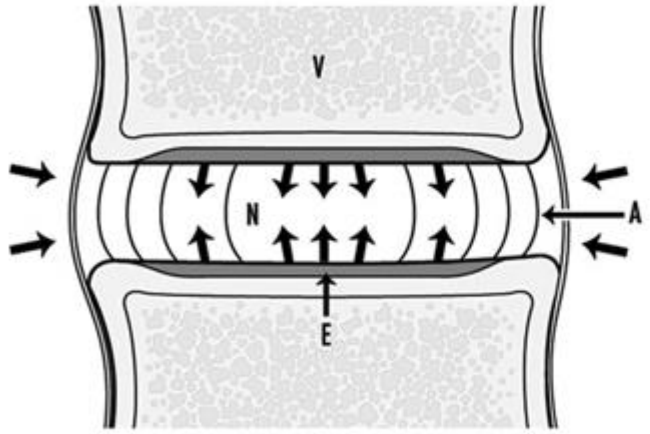
The viscoelastic property of human tissue means that small loads over a short period of time do not change the structure

When creep sets in there is permanent deformity of the vertebrae, vertebral discs, muscles, tendons and ligaments leading to clinically observable changes in shape.

The inherent porosity of the intervertebral discs allows water and nutrients to enter and exit. When creep sets in, the opposite occurs.

There is effusion of water, stiffness increases, elasticity decreases, and further creep sets in which can easily cause deformation and ruptures.



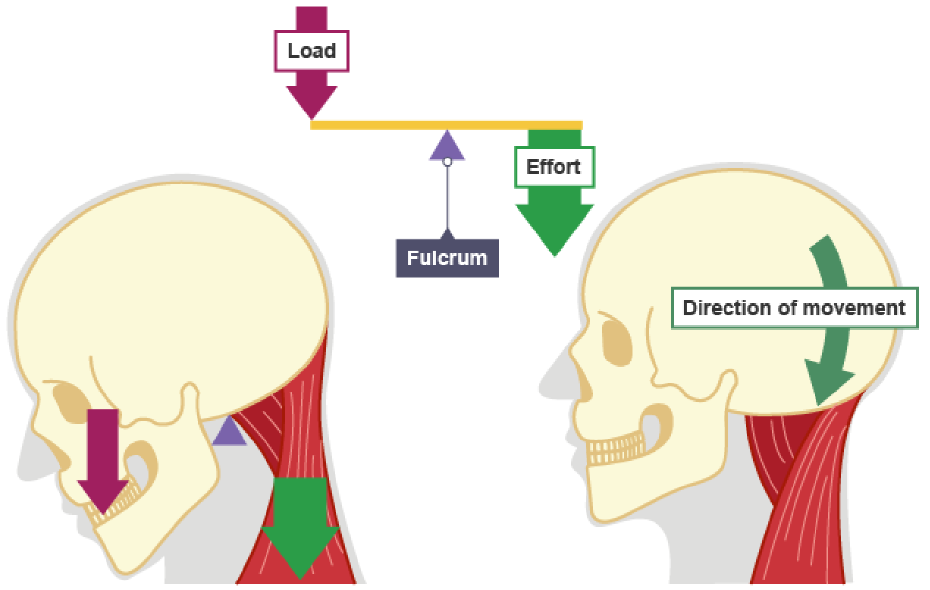


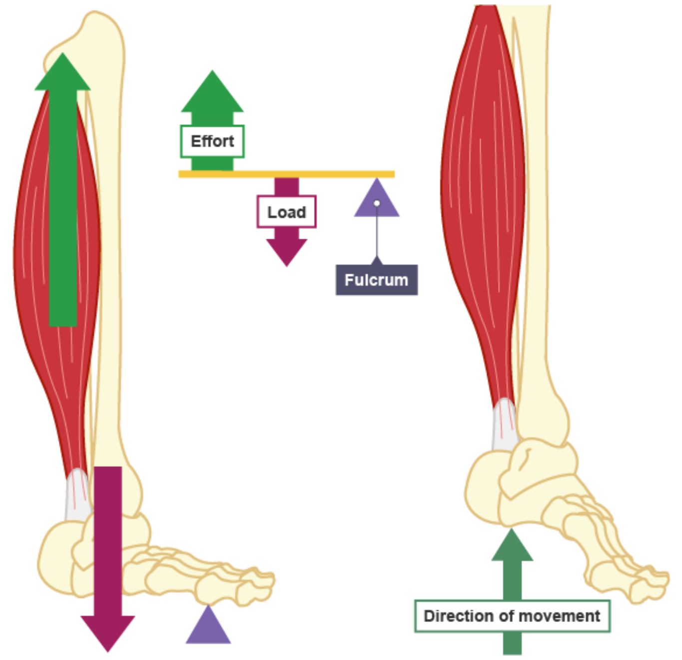
Leverage

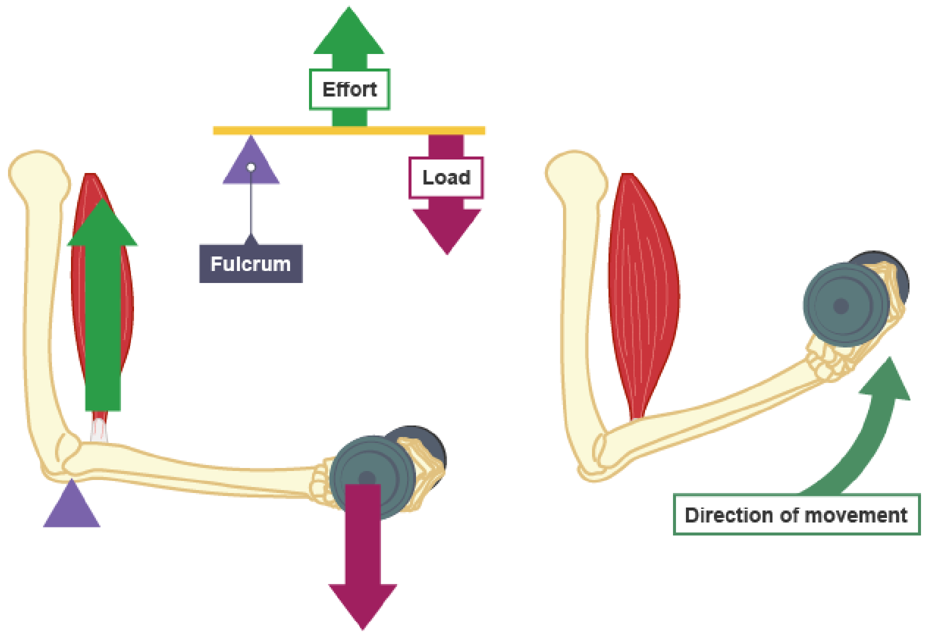
Levers in our body are formed from bones, joints and muscles. A lever consists of: a rigid structure (bone) a force acting upon it (muscle) to produce a turning movement (angular motion) a fulcrum which is a fixed point (joint)

Levers and leverage is what allows us to do less work over a larger distance of a lever arm, to essentially produce more force over a shorter distance.

In the same way muscles act on bones around joints to maximise function. Sometimes the function is strength, other times it is ease of repetition.





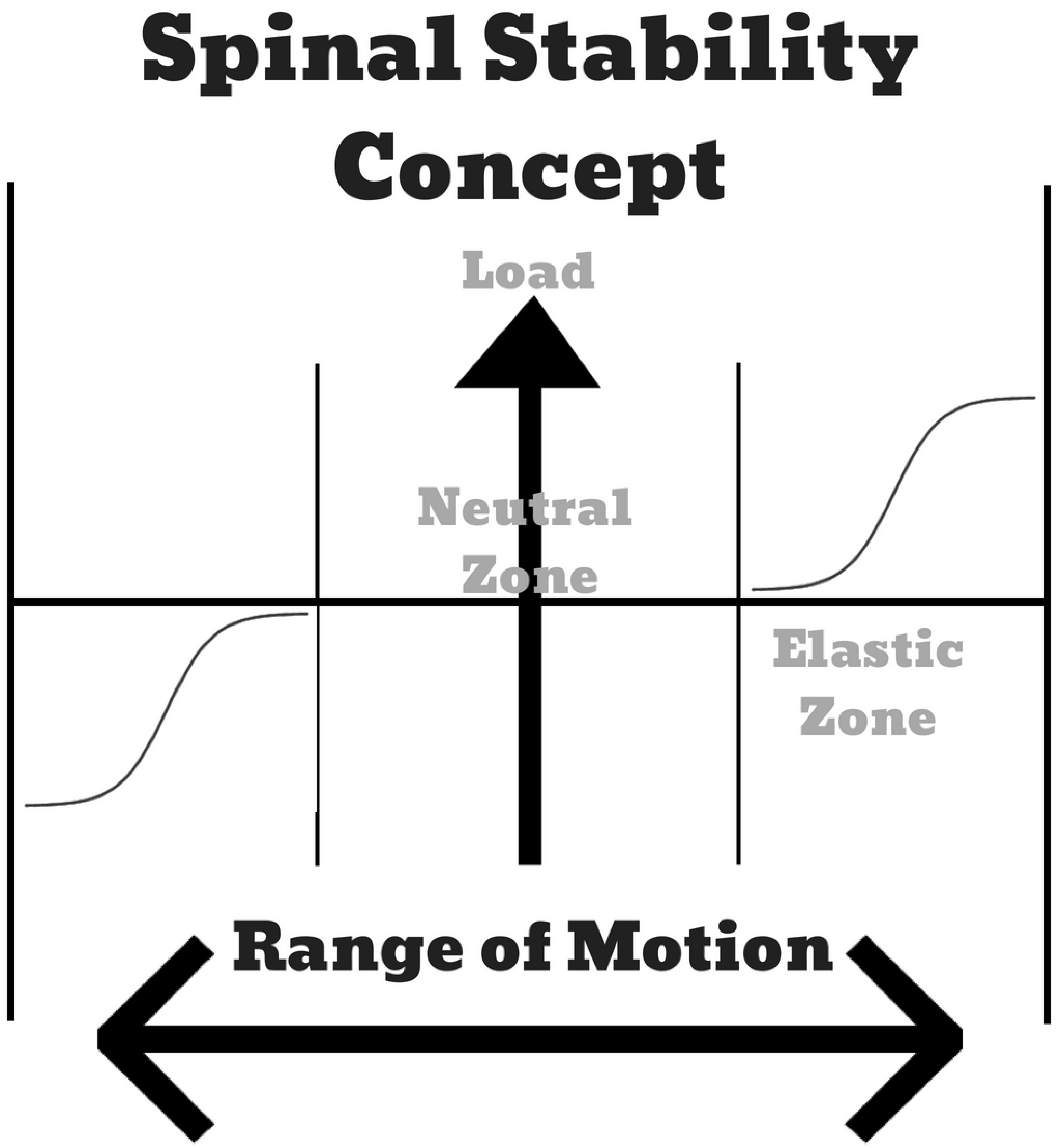


Concept of Neutral Spine

The concept of the neutral spine is as important as understanding all of the above. The spine, made up of three curves the cervical thoracic and lumbar curves is at its best when these curves are in neutral position.

Neutral position does not mean flat. It actually means that they are in the most natural position where the structures suffer least stress and tension, pressure is dissipated, as a result creep does not set in. It's a position where all vertebral body surfaces are parallel to each other, dissipating the weight as much as possible. It is also the strongest position the spine can be in both in standing and in lifting.

You find the neutral spine position by lying on the floor flattening the back on to the floor and letting the curvature find its natural position off the floor.



Concept of Neutral Spine

Having said that on the neutral spine, an old but still pertinent concept nowadays, one still needs to realise that sitting within the neutral spine zone can still cause creep and damage, and shear forces are still occurring. The position of sitting is in itself unsustainable for long periods of time, whichever position is adopted. The mere position of sitting puts more stress on discs and spinal structures, whilst at the same time regressing lower limb blood flow, general circulation, and causes undue pressures on skin and musculature that would not be there when standing or lying.

It is also understandable that today's lifestyle demands more sitting and more forward flexion stances during the day.

The elimination or restriction of movement whilst sitting, may protect in the short period but effectively causes harm over time. It is therefore always advisable to take frequent breaks to mobilise, and where possible mobilise whilst also during sitting.

Final concept : LOAD x TIME x RANGE

Keeping at least two of the above as low as possible reduces drastically the chances of injury, because forces (especially creep) are delimited.

LOAD x TIME x RANGE

- If a high load is lifted for a very short period of time without going out of the safe midrange neutral zone is usually considered safe.
  (importance of good form and technique at the gym!)

LOAD x TIME x RANGE

- Bending out of neutral zone for a short period of time whilst carrying no load (that includes body weight) carries minimal risk
  (ex. Forward flexion on a desk with elbows resting on desk)

LOAD x TIME x RANGE

- Having no load in neutral zone for longer periods of time, carries minimal risk.
  (lying down obviously delivers less forces through the body, and can be sustained for much longer)