ANATOMICAL MOVEMENT ANALYSIS

Movement of body structures is achieved by the contraction of muscles. In general movements are classified by the directions in which the affected structures are moved.
All motions are considered to be a combination of the following types of movement.
Most terms of a motion have clear opposites, and as such, they are reported in the table below in pairs.

NOTE

- In human anatomy, all descriptions of position and movement are based on the assumption that the body is in its complete medial and abduction stage in anatomical position.
- The prefix **hyper** is sometimes added to emphasize movement beyond the normal position, such as in hyperflexion or hyperextension. Such movements can put significant stress on the joints involved.

GENERAL MOTION

Adjusting angle between two parts

Flexion – Bending movement that decreases the angle between two parts.
Bending the elbow is an example of flexion.
When sitting down, the knees are flexed.
Flexion of the hip or shoulder moves the limb forward.
Examples:
- Hip flexors are rectus femoris, sartorius, iliacus and psoas
- Knee flexors are the biceps femoris, semitendinosus and semimembranosus
- Elbow flexors are the brachialis, biceps brachii and brachioradialis.

Extension – The opposite of flexion is a straightening movement that increases the angle between body parts.
In standing position the knees are extended.
Extension of the hip or shoulder moves the limb backward, towards the posterior side of the body.
Examples:
Elbow extensors include the triceps brachii and anconeus.
- The main muscle that extends the hip is the gluteus maximus.
- The muscles that extend the knee are the quadriceps.

Adjusting relation to midline of body

Abduction – A motion that pulls a part away from the midline of the body.
Raising the arms laterally to the sides is an example of abduction.
Examples:
- The arm abductor is the deltoid.
- Some leg abductors are the gluteus medius and the gluteus minimus.

Adduction – A motion that pulls a part toward the midline of the body or a limb.
Dropping the arms to the sides, or bringing the knees together, are examples of adduction.
Examples:
- The inner thigh adductors are the adductor brevis and longus, adductor magnus and pectineus.
- The latissimus dorsi is a good example for the arm.

Rotating body parts

Internal rotation (medial rotation) of the shoulder or hip would point the toes or the flexed forearm inwards, towards the midline.
Examples:
- Medial rotators of the humerus are the pectoralis major and subscapularis.
- The adductor longus and adductor brevis both medially rotate the thigh.

External rotation (lateral rotation) is the opposite of internal rotation. It would turn the toes or the flexed forearm outwards, away from the midline.
Examples:
- The sartorius laterally rotates the femur.
- The infraspinatus and teres minor both laterally rotate the humerus.

Adjusting elevation

Elevation – Movement in a superior direction.
Example:
- The upper muscle of the trapezius elevates the shoulder.

Depression – Movement in an inferior direction, the opposite of elevation.
Example:
- The lower muscle of the trapezius depresses the apex of the shoulder.

Special motions of the hands and feet

Rotation of the forearm:
Pronation – A rotation of the forearm that moves the palm from an anterior position to a posterior position (palm facing down). This is not medial rotation as this must be performed when the arm is half flexed.
Supination – The opposite of pronation, the rotation of the forearm moves the palm anteriorly (palm facing up). The hand is supine (facing anteriorly) in the anatomical position.

Movements of the foot:
Dorsiflexion – Extension of the entire foot upward, as when taking the foot off the acceleration pedal in a car.
Plantarflexion – Flexion of the entire foot downward; occurs at the ankles,as when pressing an acceleration pedal in a car.
Eversion – the movement of the sole of the foot away from the midline of the body.
Inversion – the movement of the sole towards the midline of the body; as when an ankle is twisted. For more details see Ankle- foot Chapter.

Movements of the shoulders and arms

See Chapter of Shoulder Anatomy

Additional motions

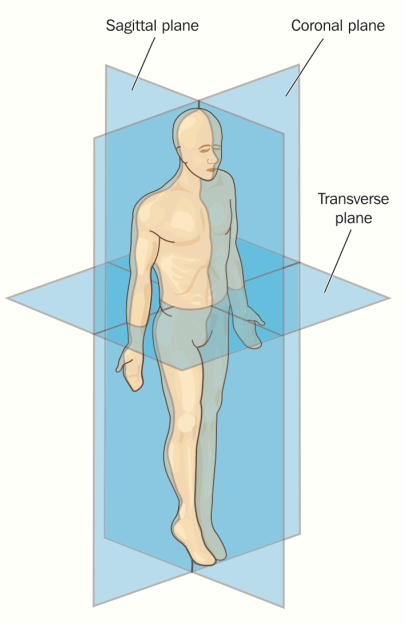
Some additional motions without clear opposites are as follows:
Rotation – A motion that occurs in the transverse plane around the longitudinal axis. Examples are the tilt as anterior, posterior and lateral tilt such as when the head rotates on the neck, as in shaking the head 'no'.
Circumduction – The circular movement consists of a combination of flexion, extension, adduction, and abduction.
Example of circumduction:
- The ball-and-socket joint of the eye.
- Windmilling the arms or rotating the hand from the wrist are examples of circumductive movement.
Lateral Flexion- Lateral movement of the head, neck and trunk in the coronal plane and around the sagittal axis.
Reciprocal motion of a joint – Alternating motion in opposing directions, such as the elbow alternating between flexion and extension

PLANES AND AXES OF MOVEMENT

The **standard terminology** describes the relative positions of the body parts or the relationship between those body parts.

Anterior	Toward or on the front of the body: in front of The pectorals are on the anterior aspect of the body
Posterior	Towards or on the back of the body: behind The rhomboids are on the posterior aspect of the body
Superior	Toward the head or upper part of a structure: above The humerus is superior to the radius
Inferior	Toward the lower part of a structure: below The tibia is inferior to the femur
Medial	Toward or at the midline of the body: inner side The adductors are medial to the abductors
Lateral	Away from the midline of the body: outer side The abductors are on the lateral aspect of the leg
Proximal	Closer to the origin of a point of reference The elbow is proximal to the wrist
Distal	Further from the origin or point of reference The foot is distal to the knee
Ipsilateral	Positioned on the same side of the body The left foot is ipsilateral to the left hand

ANATOMICAL PLANES AND AXES

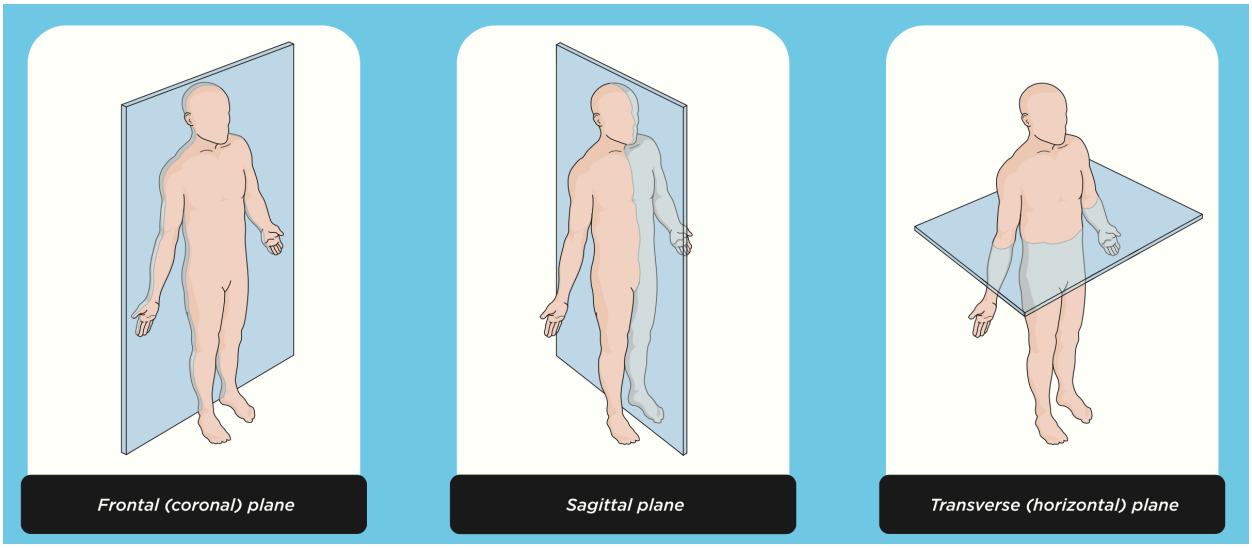


Human movements are described in three dimensions based on a series of planes and axes. There are three planes of motion that pass through the human body: **the sagittal plane, frontal plane and transverse plane.**

The **sagittal plane** lies vertically and divides the body into right and left parts.
Motion: flexion/extension
Axis: Coronal, Frontal
Examples: Walking, Squatting, Front Lunge, Hundred or Roll as ball Pilates exercise.

The **frontal plane** also lies vertically but divides the body into anterior and posterior parts.
Motion: abduction/adduction, lateral flexion, inversion/eversion
Axis: Sagittal, Anterior-posterior
Examples: Lateral arm raise, Side Lunge. Pilates side plank exercises.

The **transverse plane** lies horizontally and divides the body into superior and inferior parts.
Motion: Internal rotation / External rotation, Left / Right rotation, Horizontal Adduction and Abduction, Supination / Pronation.
Axis: Longitudinal
Examples: Spine twist, trunk rotation, throwing, swing, golf swing. Pilates twist exercises.



An axis is a straight line around which an object rotates. Movements at the joint take place in a plane about an axis. There are three axes of rotation: sagittal axis, frontal axis and vertical axis.
The **sagittal axis** passes horizontally from posterior to anterior and is formed by the intersection of the sagittal and transverse planes.
The **frontal axis** passes horizontally from left to right and is formed by the intersection of the frontal and transverse planes.
The **vertical axis** passes vertically from inferior to superior and is formed by the intersection of the sagittal and frontal planes.

FUNCTION OF PLANES OF MOTION

Understanding the anatomical directional terms and body planes facilitates the study of anatomy applied to movement.

When describing a movement the tendency is to refer to the particular plane that it is dominated by, for example walking is described as a sagittal plane movement. In reality this is only a description of the gross direction of movement, in fact at joint level, movement will be occurring in several planes not only in the sagittal plane.
It is essential that a good Pilates teacher is aware of the concept that all functional movements are three dimensional. For example during the action of walking, the hip will be flexing/extending in the sagittal plane, adducting/abducting in the frontal plane and internally/externally rotating in the transverse plane.
Rolling, walking, twisting, jumping, kicking, squatting, pushing and pulling are all activities that require motion in all three planes simultaneously. Multi-plane movement dominates activities of life and sport. Current popular training methods don’t take this into account enough, proposing exercises that dominate in the sagittal plane and often ignore entirely the transverse plane.
The focus of KinetiCode® Pilates on multi-plane movement is an essential component of its functional training and furthermore the transverse plane is important key to a good Pilates program.

