



ANALYSIS OF HUMAN MOTION

GLOSSARY OF MEDICAL TERMS

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Introduction

The present glossary was developed in the framework of **ORTHO- eMAN LLP-LdV/ToI/2011/RO/008** and has been made specifically for educational purposes and personal development.

Introduction of this glossary in the structure of the present course was necessary not only to explain the terms used within the course, but also for the reformulation of the aspects known through the light of paper context. Thus, we tried to emphasize the notions that explain the body position in space, the descriptive anatomy of bone and joints, but also to explain terms of functional anatomy, biomechanics, movement analyze and math used in the paper, the explications sometimes exceed the simple definition of term and contain references of recent researches that have not permitted due to time reasons a reformulation of the definitions.

The definitions used in this glossary of terminology either have been provided by the authors of the ORTHO e-man training module, or have been extracted wholly or in part, or paraphrased from different internet reliable sources.



I. Terms used to indicate the position and orientation of human body parts and structures

In order to mark points and draw axis and orientation plans of human body parts, are used the following terms:

- **Verticalis**, term used to indicate the perpendicular direction of a horizontal plan of an anatomic formation;
- **Horizontalis**, term used to name an axis, a plane or to indicate the direction of an anatomic formation with a trajectory parallel with ground or more exactly with the surface of a liquid in repose;
- **Medianus**, term used to name the median plan of body (exactly the mediosagittal plan), which divides the body in two half, right and left. It is also used to indicate the position of anatomic formations placed in the middle of a region or to name a line that divide a region in two equal parts;
- **Coronalis**, term used to indicate the trajectory of an anatomic formation of crown shape; in case of development anatomy it means frontal;
- **Sagitalis**, term used to name a plan which is parallel with the median plan or to present anatomic formations localised in this plan (lat. = arrow shape);
- **Frontalis**, term used to name the frontal plan which is perpendicular on the median and horizontal ones;
- **Transversalis**, term used to name the transversal or horizontal plan which is perpendicular on the median and frontal plans; for limbs region this plan is perpendicular on the longitudinal axis of the region;
- **Medialis**, term used for anatomic descriptions to show the position of a formation much closer to the median plan;
- **Lateralis**, term used to indicate the position of an anatomic formation much far away from the median plan;
- **Intermedius**, term used to indicate the middle position of a formation, to name some nerves (N. intermedius) or some bony prominent;
- **Anterior**, term used to show that a formation is placed before another; all formations placed before the frontal plan are anteriorly;
- **Posterior**, term used to show that a formation is placed behind other; is considered that all formations placed behind the plan are posteriorly;
- **Dorsalis**, term used for the posterior parts of trunk and neck, the term is equally used for head (skull convexity), hand and foot surfaces;
- **Ventralis**, term rarely used for human anatomy being replaces with anterior term, exceptions exist for nervous system, radix ventralis nerves spinalis, anterior nucleus of thalamus;
- **Internus**, term synonymous with *profound*, pointing that a formation is placed inside a structure, it must not be used for medial meaning;
- **Externus**, term synonymous with *superficial* and used to show that a formation is placed in a more superficial layer than the one of other formation, must not be used for lateral meaning;



- ***Dexter, Sinister***, terms used to indicate the position of a an anatomic formation localized to the right or left of the median plan;
- ***Longitudinalis***, term used to name the body length axis or the direction of a formation placed along a human body region;
- ***Transversus***, term used to indicate the direction of a formation placed across a region;
- ***Caudal***, term rarely used for human anatomy, means superior and inferior, is used more frequently for development anatomy where cranial term has a rostral meaning;
- ***Superior, Inferior***, terms used to indicate the position of some formations placed along body or limbs longitudinal axis or at sagittal plans;
- ***Superficial, Profundus***, terms used to show the position and direction of an anatomic formation localized at the surface of a region (superficial) or in depth of a region (profound).

For orientation and topographic description of limbs anatomic formations will be used the following terms:

- ***Proximalis et Distalis***, for phalanges orientation (these terms will not be used as superior and inferior meaning for limbs);
- ***Radialis et Ulnaris***, for description of anatomic formations localized at forearm and hand, have lateral meaning and medial one, these terms have the advantage that not take into consideration the space orientation of hand when an anatomic formation is described;
- ***Tibialis et Fibularis***, for anatomic formations description localized at shank and foot, have a double meaning of medial (tibialis) and lateral (fibularis);
- ***Palmaris***, for formations description from anterior region of hand (Palma manus);
- ***Plantaris***, for description of the formations situated at the region of the foot inferior face (Plantae).



II. Medical terms (descriptive and functional anatomy, pathology)

A

Active support - contribution of muscle action to joint stability.

Actin – contractile protein that forms the backbone of the thin filaments within a sarcomere.

Abduction – movement in frontal plan that moves away a body region from the median line of the body.

Achilles (tendon) - One of the longest tendons in the body, it attaches the calf muscles to the heel bone.

Acetabulum – cotyloid cavity- articular cavity of coxal bone for the joint with femoral head.

Adduction - movement in frontal plan that approaches a body region to the median line of the body.

Agonist – muscle actively involved in producing or controlling a movement. *Ex: thigh flexion, psoas muscle, flexor, is agonist; gluteus maximus, extensor, is antagonist.*

Algia – pain.

Amphiarthrosis – functional classification of a joint with limited movement.

Amyoshtenia – decrease of muscular strength.

Amyotonia – decrease or disparition of muscle tone, synonymous: myotonia.

Amyotrophy – severe decrease of the volume of a striate muscle, through quantity and quality diminishing of its fibers. Synonymous: muscle atrophy.

Anatomy - the study of the structure and parts of the body.

Analgesia - the inability to feel pain.

Anatomic position – standard equilibrium position to which is reported the description of the body movement. Body is in orthostatic position with the inferior limbs attached, parallel and superior limbs along the body, palms looking outside.

Ankle - the joint formed by the articulation of the lower leg bones with the talus. The ankle connects the foot with the leg.

Ankylosis – partial or total limitation of movements at a joint due to an inflammation process of articular cavity exudates, capsule atrophy or welding of articular surfaces surgically excised.

Angulation - deviation from a straight line, as in a badly set bone.

Abnormal – deviating from the normal, average, or expected.

Anomaly – deviation from the normal, characteristic form, structure or position, resulting from an embryonary or exogenous develop disorder.

Antagonist - muscle that opposes or fights the action of another.

Antalgic – that prevents or calm down pain.

Anteversion – partially or totally anterior move of an organ; anteversion of femoral head–increase over 15 degrees of femoral neck inclination angle, meet at hip congenital dislocation.

Aponeurosis - sheets of tendon like material that cover a muscle surface or connect muscle to another muscle, or muscle to bone

Apoptosis - a normal series of events in a cell that leads to its death.



Appendicular skeleton - the bones of the limbs and supporting thoracic (pectoral) and pelvic girdles.

Areoles (Bone) - cavities from spongy tissue structure, with different diameters, shape and contain (lat. *areola* – small surface).

Obs. Areoles shape can be tubular-cylindrical, ovoid or spherical; diameters increase from surface to depth; the contain is represented by bone marrow or air (mastoid).

Articular (cartilage) – smooth, shiny layer of hyaline cartilage covering the joint surfaces of articulating bones.

Articulation/joint - The area where two bones are attached for the purpose of permitting body parts to move.

Obs. A joint is usually formed of fibrous connective tissue and cartilage. Joints are grouped according to their type of motion: ball-and-socket joint; hinge joint; condyloid joint, which permits all forms of angular movement except axial rotation; pivot joint; gliding joint; or saddle joint. Joints can move in only four ways: gliding, in which one bony surface glides on another, without angular or rotatory movement; angular, a movement that occurs only between long bones, increasing or decreasing the angle between the bones; circumduction, which occurs in joints composed of the head of a bone and an articular cavity, with the long bone describing a series of circles and the whole forming a cone; and rotation, in which a bone moves about a central axis without moving from this axis.

Arthrodesis - surgical replacement of a joint by a rigid connection between two bones

Arthritis – acute, subacute or chronic inflammatory processes of component elements of a joint, with different etiology and common clinic panel represented by edema, inflammation and painful joint (arthralgia)

Obs. Causes are incompletely known, include articular trauma, bacterial infections, tuberculosis, genetically causes, hormonal or metabolic disorders. From forms point of view can be dry, serous, infected; mono, oligo or poliarticular.

Arthritis (rheumatoid) - consequence of an autoimmune attack at articular tissues, followed by thickness of synovial membrane, synovial liquid accumulation, articular cartilage destruction

Arthritis (gout) - appears due to nucleoproteins metabolism disorders, increasing of sanguine uric acid and sodium urates crystals deposition at joint level, especially at small joints of hand and foot (hallux)

Arthrogryposis - arthrogryposis multiplex congenital- include nonprogressive pathological conditions characterized by multiple joint contractures in the entire body at birth

Arthropathy – the generic name of any articular affection

Arthroplasty - surgical orthopedic technique of joint reconstruction for functional recovery, practiced especially for bone ankylosis

Arthrocentesis – surgical intervention through which are maintain in correct position the strained bone extremities, after previous reduction.

Arthroscopy – diagnostic and treatment method of articular affections that imply a limited incision at articular capsule, followed by the introduction of an apparatus named arthroscope that visualizes the articular cartilage, synovial membrane and other formations (meniscus, crossed ligament at knee joint).

Arthrosis – articular affection with chronic evolution, part of degenerative chronic rheumatism (of wear).

Obs. Is characterized by deformed bone extremities, irregular articular outlines, narrowed articular space and osteophytes.

Astasia – impossibility to keep the orthostatic posture due to a motor deficit.



Asthenia – pathologic diminishing of physic and psychic effort capacity; myalgic – a form of asthenia characterized by general fatigue and muscular pains.

Ataxia: failure of active movements' coordination.

Obs. Presents as clinic forms:

- **cerebellar ataxia** ataxia due to disease of the cerebellum.
- **Brun's frontal ataxia** a disturbance of equilibrium and gait due to a lesion in the frontal lobe, characterized by assumption of a broad-based gait with the feet flat on the ground and a tendency to retropulsion.
- **Friedreich's ataxia** hereditary sclerosis of the dorsal and lateral columns of the spine, usually beginning in childhood or youth; it is attended with ataxia, speech impairment, scoliosis, peculiar movements, paralysis, and often hypertrophic cardiomyopathy.
- **locomotor ataxia** tabes dorsalis.
- **motor ataxia** inability to control the coordinate movements of the muscles.
- **sensory ataxia** ataxia due to loss of proprioception (joint position sensation) between the motor cortex and peripheral nerves, resulting in poorly judged movements, the incoordination becoming aggravated when the eyes are closed.
- **ataxia-telangiectasia** a severe autosomal recessive progressive cerebellar ataxia, associated with oculocutaneous telangiectasia, abnormal eye movements, sinopulmonary disease, and immunodeficiency.

Athetosis - a constant succession of slow, writhing, involuntary movements of flexion, extension, pronation, and supination of fingers and hands, and sometimes of toes and feet.

Atony - loss of tonus.

Atrophy – progressive, acquired decrease in the size of a normally developed cell, tissue, or organ.

Obs. Atrophy may result from a decrease in cell size, number of cells or both with serious consequences over their function. Can be limited to a certain organ, due to disease interference with the metabolism of the organ or can interested the entire limb, if its nutrition and innervation is affected. The natural aging of tissues and body organs leads to atrophy of senescentis or simple senescentis. The inactivity of a tissue or organ will lead in time to a local atrophy, for example muscular dystrophy that causes atrophy, decreasing of volume and muscular strength due to sarcoplasm loss.

Atrophy (bone) - 1. the bone resorption internally (in density) and externally (in form) (e.g., of residual ridges); 2. a loss of bone substance or volume.

Obs. Atrophy of bone ordinarily occurs without a corresponding change in the volume or external dimensions of bone, but the mass of bone tissue may be reduced by as much as 75%. The internal architecture of the bone gradually becomes attenuated and finally disappears. Atrophied bone is brittle and has a more spongy consistency than normal bone. In cross-section the cortex is thin, and the periosteal surface is smooth and unchanged, but the intramedullary substance is composed of a yellow, fatty, cancellous bone tissue. Bone atrophy may be systemic, regional, or local.

Atrophy (muscular) - a wasting of muscle tissue, especially resulting from lack of use.

Obs. There are numerous causes for simple atrophy of muscle, such as chronic malnutrition, immobilization, and denervation.

Atrophy (tissue) - an atrophy resulting from a lack of function of a tissue, organ, or body part.

Axial skeleton - the bones of the body axis, including the skull, vertebral column, ribs, and sternum.



Axis (anatomic) – for the description of anatomic formations are used three orientation space axis, that pass through center of gravity (S_1), intersect themselves under right angles and are named: longitudinal, sagittal and transversal. These axes define plans.

Obs. Body length axis or longitudinal axis lies between a superior polar point, named vertex and an inferior polar point, situated in the center of sustain basis; is perpendicular on the ground horizontal. The depth body axis or the sagittal axis passes through the center of gravity and has an anterior-posterior direction. The width body axis or transversal one passes through weight center and is parallel with the ground horizontal.

B

Balance - maintenance of postural stability or equilibrium. Also postural control.

Basal metabolic rate - the lowest rate at which a person can possibly use energy and remain alive; at this rate, only absolutely necessary functions such as breathing are maintained.

Biarticular - having action at two joints.

Bone - is the substance that forms the skeleton of the body. It is composed chiefly of calcium phosphate and calcium carbonate. It also serves as a storage area for calcium, playing a large role in calcium balance in the blood.

Bone nutritive arteries – arteries that assure the bone nutrition.

Observation. Can be diaphysis, metaphysis or epiphysis ones, result from periosteum or periarticular vascular arches.

Bone growth - all cell activities that will determine the increase of dimensions and/or mass of skeleton component.

Observation. Increasing is a temporo-spacial phenomenon, that is why a special importance is given to kinetic increase, characterized by speed and growth acceleration.

Bone flap – a window created by the temporary surgical displacement of a section of bone, which remains attached along one edge to provide a blood-supply during the procedure.

Bone marrow - reticular tissue that occupies the free spaces from inside bones (medullar canal of long bones shafts, areola cavities of spongy tissue).

Observation. At birth the marrow bone has a hematopoietic character (red); after age of 7 years the marrow of long bones changes in adipose tissue (yellow marrow); at senescence important parts of hematopoietic marrow and adipose one transforms into connective tissue (fibrous marrow or gray).

Bone nutritive arteries – arteries that assure the bone nutrition.

Observation. Can be diaphysal, metaphysal or epiphysal ones, result from periosteum or periarticular vascular arches.

Bursa - a bursa is a closed fluid-filled sac that functions as a gliding surface to reduce friction between tissues of the body.

Bursitis - inflammation of a bursa due to excessive pressure or friction, or from injury.

C

Cadence walking – gait tempo measured in steps per minute.

Calcification (physiologic) – biologic process through which calcium salts deposit during ossification.



Calcification (pathological) - abnormal deposits of calcium and magnesium salts in tissue.

Callus – new osseous tissue that weld the ends resulted from a bone fracture; *vicious* – imperfect welding of a fracture.

Cartilage – medium hard conjunctive tissue formed of cells, fibers and fundamental substance, has no vascularization and its nutrition is assured by diffusion from surrounding tissues.

Obs. Fundamental substance contains proteoglycans in the structure of whom are proteins, hyaluronic acid and chondroitin sulfate. The chondrocytes contain enzymes implied in the synthesis and degradation of proteoglycans. This turnover usually lasts months or even years, increases moderately due to intern or extern trauma agents' action. Even after cartilage turnover acceleration, the cartilage recovers slowly, due to the indirect supply of nutritive substances (diffusion). Depending on the fibers nature and arrangement there are three types of cartilage: hyaline, elastic and fibrous.

Hyaline cartilage – cartilage with the lowest resistance, but biggest spreading in human body. It is found at costal, nasal, laryngeal, tracheal and bronchial cartilages.

Articular cartilage – a particular type of hyaline cartilage containing collagen fibers with high resistance

Elastic cartilage – cartilage formed mostly of elastic fibers. It is found at ear auricle, Eustachian tube, epiglottis.

Fibrous cartilage – the most resistant type of cartilage, contains many collagen fibers and a reduced amount of fundamental substance. It is found at areas subdued to some pressure solicitations, such as intervertebral discs, pubic symphysis.

Central nervous system - brain, spinal cord and their nerve endings Abbreviated CNS

Cerebral palsy (CP) - term used for a group of nonprogressive disorders of movement and posture caused by abnormal development of, or damage to, motor control centers of the brain. CP is caused by events before, during, or after birth. The abnormalities of muscle control that define CP are often accompanied by other neurological and physical abnormalities.

Chondrocytes - Cartilage cells, structural components of cartilage.

Chondromalacia - abnormal softening or degeneration of cartilage of the joints, especially of the knee patellae.

Obs. It occurs in young adults after knee injury and is characterized by swelling, pain, and degenerative changes, which are revealed on x-ray examination.

Chondromalacia patellae - pathological softening and thinning of the cartilage (gristle) lining the back of the kneecap.

Chorea – name given to some diseases or syndromes of central nervous system, of different etiology, of whom dominant syndrome is represented by involuntary moves, with segmental character, arrhythmic, rapidly unorganized, without finality; the ceaseless occurrence of rapid, jerky, dyskinetic, involuntary movements.

Obs. As clinic forms present:

- **acute chorea Sydenham's chorea** a self-limited disorder, occurring between the ages of 5 and 15, or during pregnancy, linked with rheumatic fever, and marked by involuntary movements that gradually become severe, affecting all motor activities.
- **chronic chorea, chronic progressive hereditary chorea** Huntington's chorea.- hereditary disease marked by chronic progressive chorea and mental deterioration to dementia.

Circumduction - special form of angular motion in which the distal end of a limb or segment moves in a circular pattern about a relatively fixed proximal end, tracing out a cone-shaped pattern; successive combination of many fundamental moves through which



a segment passes (flexion, abduction, extension, adduction) and returns to flexion position; can be executed backwards leaving from any position

Claudication – temporal disorders that appear during an intense activity and disappear or diminish after repose.

Claudication (intermittent) - temporal disorders that appear after intense solicitations of some organs and disappear or diminish after a certain repose; painful cramp of shank muscles, during effort, due to chronic arterial insufficiency, that disappear during repose, pain, tension, and weakness in the legs on walking, which intensifies to produce lameness and is relieved by rest; it is seen in occlusive arterial disease.

Claudication (neurogenic) - disorder accompanied by pain and paresthesias in the back, buttocks, and legs that is relieved by stooping, caused by mechanical disturbances due to posture or by ischemia of the cauda equine.

Clinical - having to do with the examination and treatment of patients.

Clonus - 1. alternate involuntary muscular contraction and relaxation in rapid succession after forcible extension or flexion of a part; 2. a continuous rhythmic reflex tremor initiated by the spinal cord below an area of spinal cord injury, set in motion by reflex testing. Similar *clonospasm*.

Clonus (ankle) or foot clonus - a series of abnormal reflex movements of the foot, induced by sudden dorsiflexion, causing alternate contraction and relaxation of the triceps surae muscle.

Clubfoot (talipes equinovarus) - a genetic disorder in which the foot is twisted and misshapen.

Coactivation - simultaneous action of agonists and antagonists at a given point.

Collagen – protein of scleroproteins group that contain glycol, proline, oxiprolin; generic name that include a big variety of protein molecules that enter extracellular matrix structure, having as base structural unit three polypeptide chains with triple helix configuration.

Observation. Till present were identified 19 collagen types, formed of minimum 33 distinct polypeptide chains.

Compact osseous substance – variety of hard connective tissue (osseous), adapted at maximum to the sustain and resistance function, with homogenous macroscopic structure, formed of attached osseous lamellas, without delimiting interior cavities. Synonymous cortical bone; lamellar bone.

Observation. Microscopic is formed of osseous lamellas disposed concentric around Haversian canals (osteons), presenting thus cavities of reduced dimensions (Haversian canals, osseous gaps, Volkmann canals).

Computerized Axial Tomography - scan CAT or CT scan - pictures of structures within the body created by a computer that takes the data from multiple X-ray images and turns them into pictures on a screen. CT stands for computerized tomography.

Congenital – term that refers to an apparent or latent disorder of new born, due to a pathologic process spent during intrauterine life.

Congenital crooked foot - corresponds to malformations that modified the foot orientation compared with the shank. There are four directions where the foot can be deviated compared with the shank: in extension, with support on the forefoot (equine); in dorsal flexion; in adduction (varus); in abduction (valgus).



Congenital varus equine foot – congenital deformation of one or both feet that associate equine and varus calcaneus, forefoot and middle foot adduction and inversion, atrophy of the shank affected muscles and a foot length smaller than the one of the healthy foot.

Contractile component – structure within a muscle that can produce force. The fundamental contractile component of a skeletal muscle is the sarcomere.

Contention – in orthopedic means maintaining in contact the fragments of a fracture; is performed through immobilization orthopedic ways or surgically through osteosynthesis.

Contractility – muscular tissue propriety to answer to stimulation through form changing, usually shortening; a muscle's ability to generate a pulling or tension force.

Contracture – permanent tonic contraction of a muscle or muscles group of pathological cause; can be antalgic, myogenic, neurogenic or ischemic.

Contraction (concentric) – contraction realized by the responsible muscle for this contraction. *The muscular insertions approach and the muscle shorts.* The torque produced by the muscle is greater than the external torque, and therefore, the muscle is able to shorten while overcoming the external load.

Ex: trunk flexion from clinostatic represents a concentric contraction of rectus abdominis muscle.

Contraction (eccentric) – contraction performed by a muscle through progressive decreasing of its contraction state; the muscular insertions move away. The torque produced by the muscle is less than external torque; the joint movement occurs more slowly than the external torque would tend to

Contraction (muscular) – internal state in which a muscle actively exerts a force, regardless of whether it shortens or lengthens.

Coordination - muscle working together with correct timing and intensity to produce or control a movement.

Coxa plana - flattening of the head of the femur resulting from osteochondrosis of its epiphysis.

Coxa valga - deformity of the hip joint with increase in the angle of inclination between the neck and shaft of the femur, producing a straighter bone.

Coxa vara - deformity of the hip joint with decrease in the angle of inclination between the neck and shaft of the femur.

Crutches – help sustain the body during static position and walking by axillary and hands support.

D

Decalcification – dystrophic process of osseous tissue, during which under the various influences (mechanic, chemical, nervous) calcium from the respective tissue decreases progressively till disappears. Synonymous osseous demineralization.

Diarthrosis – functional classification of a freely movable joint.

Diastasis – the equivalent of dislocation for fixed joints. Frequently occur at tibiofibular joints.

Diplegia - paralysis of both sides of any body part or of like parts on the opposite sides of the body.

Disjunction - the equivalent of sprain for fixed joints.



Dyskinesia (motor) - An impairment in the ability to control movements, characterized by spasmodic or repetitive motions or lack of coordination.

Dysmetria - an aspect of ataxia, in which the ability to control the distance, power, and speed of an act is impaired; usually used to describe abnormalities of movement caused by cerebellar disorders.

Dislocation – displacement of parts that form a unit; of fragments – radiologic sign that emphasize the displacement level of a fracture fragments.

Dorsal flexion (dorsiflexion) – joint motion at the ankle where the foot moves toward the lower leg.

Dorsum of foot - an anatomical term referring to the upper surface of the foot. Similar dorsum pedis.

Double step (stride) – all moves performed between two successive leanings of the same foot; functional unit of locomotion during walking; formed of 2 simple steps. Similarly contact with heel, attack with heel, contact with foot, attack with foot.

Double support - period when the body's weight is supported by both legs.

E

Endoconnective ossification (synonymous - desmal; of membrane) – ossification type characterized by direct metaplasia of connective tissue at osseous tissue.

Enchondral ossification (synonymous: endocartilage; of cartilage) - type of ossification hold at the surface and inside a cartilaginous model that is destroyed and replaced with fibrous or spongy tissue.

Endomysium – fibrous connective tissue sheath that surrounds each muscle fiber located within a fascicle in a skeletal muscle

Endoprosthesis - prosthesis introduced inside human body (gr. *endon* - inside; at interior).

Electromyography (EMG) – graphic or optic recording method of muscular action potentials, in repose and during voluntary contraction Can diagnosis both muscular affections and peripheral neuron ones (motor units activity).

Epiphysis – long bones extremity formed by a compact osseous tissue layer at periphery and a spongy osseous tissue at interior (gr. *epiphysis* - excrescent).

Epimysium – fibrous connective tissue sheath that surrounds a whole skeletal muscle.

Eversion – move through which the foot lateral edge lifts (dorsal flexion, abduction and pronation of foot).

Extension - move in sagittal plan that moves away a body region posteriorly from the anatomic position.

Excitability - describes the ability of muscle to respond to a stimulus.

Extensibility – describes the ability of muscle to lengthen or stretch and as a consequence to generate force over a range of lengths.

Extent - therapeutic way used for fracture or dislocation joint reduction or for the immobilization of a limb by applying a traction. Can be extemporaneous or continuous, manually or mechanic (pulleys, orthopedic mass, elongation apparatuses).

External rotation (lateral) - movement in a transversal plan that moves outside a part of the body.



Extracellular matrix – a complex material formed of an organic component that include insoluble fibers, micro fibrils, soluble proteins and glycoproteins to which is attached an anorganic component represented by hydroxyapatite crystals and calcium-phosphate amorphous; is responsible for mechanic and physiochemical properties specific to each tissue and offers a support for cell attachment.

Observation. The most frequent proteins from extracellular matrix structure are the ones of the collagen family (type I, II, III) and exists as fibers fascicules. Other are represented by proteoglycans, hyaluronan, elastin, fibronectin, thrombospondin, laminin, osseous sialoprotein, tenascin, etc.

Extrapyramidal system – system of nervous fibers that descend from motor cortex to effectors (muscles) and serve to involuntary motility and muscular tone.

Extrapyramidal disease (extrapyramidal syndrome) - any of a group of clinical disorders marked by abnormal involuntary movements, alterations in muscle tone, and postural disturbances; the group includes PARKINSONISM, CHOREA, ATHETOSIS, and others.

Equines foot – foot position in which the forefoot is lower than the heel. In gait, at initial contact, the foot is plantar flexed.

F

Femur - bone of the leg situated between the pelvis and knee in humans. It is the largest and strongest bone in the body.

Flat foot - Absence of an arch in the sole of the foot that causes the foot to lie flat when the person is standing.

Fibroblast – a type of cell found in connective tissue throughout the body that produces collagen and other proteins found in the extracellular (between cells) spaces.

Fibula - the smaller of the two bones in the lower leg, located externally. The end of the fibula forms the bony prominence of the outer ankle.

Film - slang shortening of X-ray film.

Film of antero-posterior incidence - an X-ray picture in which the beams pass from front-to-back (anteroposterior). As opposed to a PA (posteroanterior) film in which the rays pass through the body from back-to-front.

Film of profile - an X-ray picture taken from the side.

Fixation – the act or surgery of immobilization in a certain position.

Fixation (internal) – a surgical procedure that stabilizes and joins the ends of fractured (broken) bones by mechanical devices such as metal plates, pins, rods, wires or screws
External fixation is as opposed to internal fixation in which the ends of the fractured bone are joined by mechanical devices such as metal plates, pins, rods, wires or screws.

Fixation (external) - a procedure that stabilizes and joins the ends of fractured (broken) bones by a splint or cast.

Flexion – a move in sagittal plan that moves away a body region anteriorly from anatomic position. Other process of bending, or the state of being bent.

Flexibility (joint) - the ability to move a joint smoothly through its complete range of motion. Flexibility is determined by the nature of the joint structure, the condition of the ligaments and fascia that surround the joint, and muscle extensibility. Flexibility may also be limited by the skin, connective tissue, and bones around the joint. Flexibility is one of the main components of physical fitness and is believed to be important for optimum health. Flexibility exercises have been prescribed for the relief of dysmenorrhea, general



neuromuscular tension, and low back pain. However, an athlete who concentrates on flexibility exercises at the expense of strength training may reduce joint stability and increase the risk of dislocations.

Flexibility (dynamic) - the range of motion that can be achieved by actively moving a body segment using muscle actions. Dynamic flexibility also refers to the relative ease of making rapid or repeated movements over any range, rather than the range itself. It is determined by the forces that oppose or resist the movements, and is affected by the ability of muscles to recover quickly. Dynamic flexibility is an important ability underlying many gross motor skills, and is important for developing speed and power.

Flexibility (extent) - the maximum range of motion possible at a particular joint or series of joints working together. Extent flexibility is largely joint-specific; good flexibility at one joint does not guarantee good flexibility elsewhere. Use of the term is sometimes restricted to the ability to flex and stretch the trunk and back muscles as far as possible in any direction.

Flexibility (static) - the range of motion of a joint when a body segment is passively moved (e.g. by an exercise partner) and held in position. It is measured using a dexometer or goniometer.

Flight phase of walking - period of the running gait cycle when both feet are off the ground.

Foot - the lower extremity of the human leg that is in direct contact with the ground in standing or walking.

Forefoot- the forefoot consists of five metatarsals and phalanges, or toes. The big toe provides the most propulsion, while the second through fourth toes provide stability while walking or standing.

Foot deformity - a term that includes a range of conditions that may affect the bones, tendons, and muscles of the foot. There are **foot acquired deformations** – affections that appear during life, others than the ones secondary to vicious consolidated fractures. Include hallux valgus, hammer fingers, supraductus and infraductus ones, hallux varus, flat foot, flat forefoot, round forefoot, complex deformed forefoot, metatarsus primus varus, etc. and **foot congenital deformations** (congenital crooked foot, calcaneus valgus, etc.).

Obs. All babies have flat feet because their arches are not yet built up (and their feet tend to be plump). This condition may persist into adulthood, or an arch may form as the child grows. Flat feet can also be acquired, as in jobs that require a great deal of walking and carrying of heavy objects. Also called pes planus.

Foramina nutrient - orifice placed at the surface of bone through which enter inside him 1-2 nutritive arteries, passing into nutritive canals.

Forefoot - the portion of the foot that includes the metatarsus and toes.

Fracture – interruption of bone continuity. A fracture is a break in the bone or cartilage. Is named by the trauma event that caused the bone breakage. Although usually a result of trauma, a fracture can be the result of an acquired disease of bone, such as osteoporosis, or of abnormal formation of bone in a congenital disease of bone, such as osteogenesis imperfecta ('brittle bone disease'). Fractures are classified according to their character and location (for example, greenstick fracture of the radius).



Freedom of movement (biomedical) - term referring to the distance and direction a joint can move between the flexed position and the extended position. The act of attempting to increase this distance through therapeutic exercises (range of motion therapy—stretching from flexion to extension for physiological gain) is also sometimes called range of motion. Each specific joint has a normal range of motion that is expressed in degrees.

Devices to measure range of motion in the joints of the body include the goniometer and inclinometer which use a stationary arm, protractor, fulcrum, and movement arm to measure angle from axis of the joint. As measurement results will vary by the degree of resistance, two levels of range of motion results are recorded in most cases.

Limited range of motion refers to a joint that has a reduction in its ability to move. The reduced motion may be a mechanical problem with the specific joint or it may be caused by injury or diseases such as osteoarthritis, rheumatoid arthritis, or other types of arthritis. Pain, swelling, and stiffness associated with arthritis can limit the range of motion of a particular joint and impair function and the ability to perform usual daily activities. Similarly freedom of movement degree.

G

Gait – all forms of bipedal locomotion where there is not a period of time in which both legs are in the air (flying phase): cyclic locomotion move which is realized by successive move of a leg before the other.

Gait cycle - the period between foot initial contact with ground and the following initial contact of the same foot with ground.

Gait disorder - an abnormality in the manner or style of walking, usually due to diseases or injuries to the legs, feet, brain, spinal cord, or inner ear; usually results from neuromuscular, arthritic, or other body changes. The body's center of gravity may change over the years, causing a change in the degree of knee flexion needed to maintain one's balance when walking. Some individuals with neuromuscular disorders walk with a shuffling gait or move with lurching actions. At times a gait disorder may be the result of a medication that causes confusion or loss of coordination or an eye or ear disturbance that affects the sense of balance. Similar Walking abnormalities.

Genu recurvatum – hyperextensibility of the knee joint more than 180, due to exaggerated laxity of capsule and posterior ligaments. Sequel of poliomyelitis.

Genu valgum - a childhood deformity in which shank axis deviates external from the femur one, thus the shanks form an obtuse angle open to exterior (if it is bilaterally result shank in X). Internal faces of the knee stick together during orthostatic position, the knees rub together or “knock” in walking and the ankles are far apart; the most common causes are irregularity in growth of the long bones of the lower limb (sometimes from injury to the bone ends at the knee) and weak ligaments with no properly support of the weight of the body.

Genu varum - an outward curvature of one or both lower limbs near the knee, in which shank axis deviates internal from the femur one, thus the shanks form an obtuse angle open to interior (if it is bilaterally result shank in O). The internal edges of ankles (malleolus) stick together during orthostatic position, while the knees are apart.



Glycoproteins – conjugate proteins of mucoproteins type that contain carbohydrates into the molecule.

Observation. The most representative glycoproteins are: osteonectin, osteocalcin, L 2HS-glycoprotein.

Graft – surgery transplant of an organ or tissue.

Surgery transplant of an organ or tissue from one part of the body to another part of the body at the same person is named autograft; to another person identically antigenetic – isograft; of the same species – home graft; of another species – heterograft. The best results were recorded in case of auto and isografts, the other grafts cause immune reactions that can determine the graft rejection. There are some immune depressive ways through which the rejection reaction can be delayed or reduced.

Observation. In case of osseous pathology the grafts are used to remediate the effects of some trauma, for osseous tumors are used resections.

Growing pains - mysterious pains in growing children, usually in the legs, likely occurring as a result of overuse. Growing pains are typically somewhat diffuse, and they are not associated with physical changes of the area, such as swelling or redness. The pains are usually easily relieved by massage, acetaminophen, or rest.

H

Hallux – the first finger (big toe) of foot.

Haversian canal - neurovascular canal from osseous structure, produced by collagen fibers, around which are disposed concentric lamellae; contains 1-2 sanguine capillaries, nervous fibers.

Hemarthrosis - blood accumulation in a joint.

Hemiplegia - paralysis of one side of the body (flaccid or spastic) usually caused by a neurological, tumoral, inflammatory or traumatic lesion located in the brain or cervical segment of the spinal cord. The paralysis occurs on the side opposite the brain disorder.

- **alternate hemiplegia** paralysis of one side of the face and the opposite side of the body. **crossed hemiplegia.**
- **cerebral hemiplegia** that due to a brain lesion.
- **facial hemiplegia** paralysis of one side of the face.
- **spastic hemiplegia** hemiplegia with spasticity of the affected muscles and increased tendon reflexes.
- **spinal hemiplegia** that due to a lesion of the spinal cord.

Hidrathrosis – serous accumulation in an articular cavity due to an inflammation or local trauma.

Hip – part of human body placed between trunk and hip; anatomic region corresponding to the joint of inferior limbs with trunk (coxofemoral joint).

Hip congenital dislocation - congenital dislocation or subluxation of the hip (congenital acetabula dysplasia) - a complete or partial displacement of the femoral head out of the acetabulum in newborns.

Hydroxyapatite – anorganic component of extracellular matrix, disposed under crystals which are orientated with their long axis parallel with the one of collagen fibers.

Observation. Exists under amorphous or crystalline form. By the association of hydroxyapatite complex with calcium and phosphate ions results the osseous crystalline unit.

Hyaluronic acid - a viscous slippery substance that lubricates the joints, is a key component of connective tissue. On a more technical level, hyaluric acid is a



glycosaminoglycan (formerly called a mucopolysaccharide), a long unbranched polysaccharide (complex sugar), composed of repeating dimeric units of glucuronic acid and N acetyl glucosamine.

Hyperkinesia – exaggerate motility caused by intense activity of striated or smooth muscles.

Hypoplasia - insufficient development of a tissue or organ, often of congenital cause.

I

Iatrogenic - due to the activity of a physician or therapy.

Idiopathic – generic name given to normal or pathologic phenomena of unknown cause

Immobilization (orthopedic) - an action that cause a static position; can refer to one or more joints or to the entire body; is symptomatic (disease) or therapeutic, when is realized through conservatory ways (gypsum or orthopedic apparatus) or orthopedic, continuous extension or through surgical ways (arthrodesis).

Implant – an object or material inserted or grafted into the body for prosthetic, therapeutic, diagnostic, or experimental purposes. The implant may be of tissue, such as in a bone graft, or of an artificial substance, such as in a hip prosthesis

Incidence (radiology) - the position of a body part that needs to be irradiated from the irradiation source. Are described anterior-posterior, posterior-anterior, lateral, oblique, eccentric, cranial-caudal, caudal-cranial radiological incidences.

Inclination pelvis – ventral inclined position of pelvis from the axial skeleton; it is appreciated after its straits inclination from the horizontal (with which the superior strait makes an angle of 60 degrees and with the inferior one an angle of 10 degrees).

Initial contact - first phase of gait cycle that starts from the moment the forefoot reaches the ground, usually through the heel and lasts till the vertical moment, when all plantae is placed on the ground. To end the swing phase and begin the stance phase.

Injury - harm or hurt. To harm, hurt, or wound. The word injure may be in physical or emotional sense. From the Latin injuria meaning injury.

Instability (joint) - any motion occurring in a joint in response to the reactive force of gravity at a time when that joint should be stable under such a load.

Internal rotation (medial) - movement in a transversal plan that moves inside a part of the body

Inversion (move) – move through which the medial edge of foot lifts (plantar flexion, adduction and supination of foot).

Isokinetic contraction - describes a contraction performed with a constant angular velocity.

Isotonic contraction - literally means constant tension. This condition does not occur in intact human subjects (i.e.in vivo) because the level of muscle force varies continuously and rarely, if ever, is constant through a movement.

Isometric contraction – position fixed through a muscle contraction: synonymous static contraction. Muscle insertions are not moving away, length muscle remains constant and the locomotion is not produced. Torque produced by the muscle is equal and opposite to the external torque.



J

Joint - see articulation.

Joint dislocation - articular lesion that refer to the dislocation of articular surfaces which are fixed in this vicious position through a muscle contraction.

Joint laxity - slackness or displacement in the motion of a joint.

Joint locked - joint in which the elements joined are interlocked.

Ex. "locked knee" is a term used to describe a patient's inability to either bend or straighten their knee. There are two general types of locked knees. The locked knee can either be caused by a mechanical block to knee motion, or a locked knee can be caused by pain that is too severe to allow knee motion.

K

Knee - the joint between the thigh and the lower leg, formed by the articulation of the femur and the tibia and covered anteriorly by the patella.

Knee (lax) – unstable knee and unable of active moves, due to a musclecapsuleligament excessive laxity (congenital or due to strong trauma) or to all muscular groups (poliomyelitis)

Kinesitherapy - generic term used for treatment through locomotion. Uses active and passive movements in order to obtain a function recovery as complete as possible.

L

Labrum - in medicine, a ring of fibrocartilage (fibrous cartilage) around the edge of the articular (joint) surface of a bone. The term labrum is used in anatomy to designate a lip, edge, or brim. Plural: labra.

Leg - the part of the limb between the knee and foot in vertebrates.

Ligament - a tough band of connective tissue that connects two bones

Ligamentoplasty – surgical procedure of repairing torn or relaxed ligaments of a joint, especially the knee ones.

Limbs inequality – occurs during life or is congenital, when either one of the superior limbs or the inferior limbs is shorter than the other one. Causes can be congenital (hypoplasia of a limb, congenital pseudoarthrosis) or acquired (posttrauma: vicious consolidated fractures or after bacillary osteoarthritis with ankylosis, osteomyelitis with premature joined of growth cartilage, etc.).

Limp – asymmetric walk with unequal support and trunk abnormal oscillations, due to an affection that interests the spine, pelvic belt, one inferior limb or both unequally. It usually results from pain, weakness, neuromuscular imbalance, or a skeletal deformity. A type of asymmetric abnormality of the gait

Lumbar pain - backache affecting the lumbar region or lower back; can be caused by muscle strain or arthritis or vascular insufficiency or a ruptured intervertebral disc. **Also lumbago.**

M

Malleolus – osseous prominence of tibia and fibula, placed at the inferior part of ankle.

Mechanic unit – all fascicles that form a distinct functional portion, acting in the same direction. The mechanic units of a muscle have opposite action. Decomposition in



mechanic units is meet at voluminous and wide muscles composed of portions with different orientation.

Meniscus (articular) – disc fibrocartilaginos located at the junction of two bones in a joint. The meniscus acts to absorb shock.

Metatarsals - five cylindrical bones that extend from the heel to the toes. The metatarsals are numbered from the inside out, so the first metatarsal extends to the big toe.

Medullary cavity – central cavity of long bones shaft, contains the bone marrow.

Middle foot – part of the foot located *in* the middle of the plantar surface, also known as the tarsus. Several interlocking tarsal bones, which are irregular in size and shape, form a stable yet flexible platform for locomotion. This platform is called the arch of the foot.

Midstance - first part of unilateral sustain from gait cycle.

Obs. This phase starts when the opposite foot leaves the ground and continuousness while the body weight is progressively projected on the whole support limb plantar length till the forefoot. Is overlapped to the flat foot phase from traditional classification. Some authors distinguished a phase of precocious/initial flat foot and a late/final flat foot phase

Mineral bone content – the ratio between the weight of osseous anorganic component and the dehydrated osseous tissue one, per volume unit.

Misalignment – vicious consolidation of a fracture that compromise the normal function axis of a limb.

Mobility (joint) - ability of a joint to move through a range of motion.

Mobility (movement) - ability to move readily.

Motion (range) - measure of joint mobility

Morphogenesis - formation process of body morphologic structures (gr. *morphe* - form + *genos* - origin); macro and microscopic study of body growth and formation, following the causes that determine its shape and structure and the laws that control the causes; study of shape changes appeared at live tissues during growth and develop processes, posttrauma recovery, regeneration or pathologic processes.

Morphophysiology - science that study the structure and function of organs, tissues and body cells.

Motor (behavior) - study of the behavioral aspects of movement, including development, learning and control

Motor (control) - study of the neural, physical and behavioral aspects of movement.

Motor (development) – study of changes in movement behavior throughout the life span

Motor (learning) - study of how motor skills are learned

Motor unit - doubled α -motor neurons and all of the corresponding muscle fibers it innervates; all of these fibers will be of the same type (either fast twitch or slow twitch).

Obs. When a motor unit is activated, all of its fibers contract. Groups of motor units often work together to coordinate the contractions of a single muscle; all of the motor units that subserve a single muscle are considered a motor unit pool. he number of muscle fibers within each unit can vary: thigh muscles can have a thousand fibers in each unit, eye muscles might have ten. In general, the number of muscle fibers innervated by a motor unit is a function of a muscle's need for refined motion. The smaller the motor unit, the more precise the action of the muscle.

Movement direction – sense (direction) of a move; it depends on the muscle settlement from the joint axis.

Observation. Move plan is always perpendicular on move axis (biomechanical axis, articular axis). In the same plan and around the same axis can be performed always two moves of opposite direction by two



different muscular groups. In sagittal plan, the movements are realized around a transversal axis and are flexion and extension (for some segments, are named ante and retroprojection, ex: the shoulder moves in sagittal plan). In frontal plan, the moves are realized around a sagittal axis; for limbs are named abduction and adduction and for trunk and neck, laterally inclination moves. The corresponding moves of the fingers are related to hand and foot axis. In transversal plan, moves realized around a longitudinal axis and are named internal and external rotation moves. Pronation and supination are special rotation moves that occur at forearm and foot.

Muscular dystrophy – a group of muscular progressive diseases, non inflammatory, without a central or peripheral nervous pathology; during final stages of affection, the muscular fibers are replaced with adipose tissue and conjunctive one; a group of inherited disorders in which strength and muscle bulk gradually decline. Nine types of muscular dystrophies are generally recognized.

Obs. Present as clinic forms:

- *Duchenne muscular dystrophy (DMD): the best-known form of muscular dystrophy, due to mutation in a gene on the X chromosome that prevents the production of dystrophin, a normal protein in muscle; DMD affects young boys, causing progressive muscle weakness in the pelvis and upper limbs, resulting in clumsiness, frequent falling, an unusual gait and general weakness.*
- *Becker muscular dystrophy (BMD): similar to Duchenne muscular dystrophy but starts later in life and advances more slowly.*
- *Limb-girdle muscular dystrophy (LGMD): LGMD begins in late childhood to early adulthood and affects both men and women, causing weakness in the muscles around the hips and shoulders. It is the most variable of the muscular dystrophies, and there are several different forms of the disease now recognized.*
- *Myotonic dystrophy: also known as Steinert's disease, affects both men and women, causing generalized weakness first seen in the face, feet, and hands. It is accompanied by the inability to relax the affected muscles (myotonia). Symptoms may begin from birth through adulthood.*
- *Distal muscular dystrophy (DD): DD begins in middle age or later, causing weakness in the muscles of the feet and hands.*
- *Congenital muscular dystrophy (CMD): CMD is present from birth, results in generalized weakness, and usually progresses slowly.*

Muscular (redundancy) - situation in which more muscles are available to perform actions that are minimally necessary.

Muscular (synergy) – cooperative action of several muscles working together as a single unit.

Musculotendinous (junction) – region where a muscle and a tendon connect.

Myasthenia – serious muscular fatigue.

Myasthenia gravis - a disease characterized by progressive fatigue and generalized weakness of the skeletal muscles, especially those of the face, neck, arms, and legs, caused by impaired transmission of nerve impulses caused by a deficiency of acetylcholine at the neuromuscular junctions.

Myopathy – generic named for chronic affections of muscular system or of other muscles with progressive character.

Myosin – contractile protein that forms the thick filaments within a sarcomere.

Myositis - Inflammation of muscle tissue. Many factors can lead to myositis, including injury and side effects of medication. It is also a key sign of autoimmune conditions as a rare disease in which the muscle fibers and skin are inflamed and damaged, resulting in muscle weakness. There are several types of myositis that affect different parts of the body.



N

Necrosis - destruction of tissue area that has no environmental conditions, nutrition and oxygen essential for life.

Neurapraxia - temporary suppression of conduction through peripheral nerve in some cases of injury, keeping nerve anatomical integrity.

Neoarthrosis - newly created joint between two bone extremities found in normal anatomical relations, joint arthroplasty created by a bony ankylosis.

Neurodegenerative diseases - chronic progressive neuropathy characterized by selective and generally symmetrical loss of neurons in motor, sensory, or cognitive systems Types by area: Cerebral cortex–Alzheimer's disease, Pick's disease, Lewy body dementia Basal ganglia–Huntington's disease, Parkinson's disease Brainstem & cerebellum–dentatorubropallidolusian atrophy, Freidreich's ataxia, multiple system atrophy, types 1, 2, 3, 6, 7 spinocerebellar ataxia Motor–amyotrophic lateral sclerosis, familial spastic paraparesis, spinal muscular atrophy, spinal & bulbar muscular atrophy.

Neuromotor - relating to a nerve fiber or impulse passing toward motor effectors; "neuromotor impulses".

Neutral position – reference position for joints in anatomical position.

Nutrient canals - canals from bone structure, crossed by the bone nutritive arteries, that made the connection between nutrient foramen and medullary.

O

Orthosis - an orthopedic apparatus that controls a position or a movement.

Orthosynthesis – surgical intervention through which are fixed the osseous fragments of a fracture.

Ossification – formation process of osseous tissue.

Osteoarthritis - acute or subacute infectious process of articular bone extremities or of joint soft tissues with osseous extension; degradation of articular cartilage caused by mechanical action.

Osteoblast – young osseous cell with major role in ossification process, being responsible of synthesis, deposition and mineralization of matrix (gr. *blastos* - bud).

Observation. Some osteoblasts participate at hematoma barrier, adjusting the ions transfer between blood and extracellular matrix; once the value of external mechanic stimulus increases, the osseous tissue increases its density due to osteoblasts activity; the adulterated response of osteoblasts at elder persons at mechanic stimulus is responsible for the diminishing of osseous tissue formation with implications in osteoporosis; under the action of a mechanic solicitation releases the growth factor with role in the initial stages of postfracture osseous differentiations.

Osteocyte – adult osseous cell, with many ramified extensions, placed in cavities named osteoplasts.

Osteoclast – giant osseous cell, multinucleated, with a rich enzymatic equipment and role for active erosion of bone (osseous reshuffling).

Observation. In many studies is described the osteoclasts activation and osseous tissue resorption, under mechanic stimulus impulse.

Osteochondritis – inflammation of bones and cartilages; spinal juvenile deformation/dissect epiphysis – articular disease (knee, hip, elbow) consists of the necrosis of a



portion of articular epiphysis which in some cases detaches and becomes an articular free corp.

Osteodystrophy – osseous dystrophy – generic term for osseous affections characterized by shape, dimension, consistence change or bone increasing; cystic juvenile – localized form of fibrocystic osteopathy observed at young, characterized by multiple cystic formations.

Osteogenesis – all processes of bone growth and differentiation as organ (gr. *osteon* - bone + *genesis* - birth)

Osteogenesis imperfect - a group of inherited connective tissue diseases, all of which result from mutations that affect collagen in connective tissue in the body, and all of which result in fragile bones. The best known types of osteogenesis imperfecta are types I and II.

Osteolysis – 1. Mineral and organic resorption process of bone, produced through disabling activity of granulated tissue rich vascularized appeared as a result of an inflammatory reaction; the histologic aspect of the bone is characterized by the presence of some lacunar spaces in the bony walls of the canals from the haversian systems. 2. Radiographic image of central or marginal osseous transparency, with disappeared or smooth edges, expression of a pathologic osteoplasy resorption.

Osteitis - generic term used for naming the osseous tissue inflammations. There are more forms of osteitis: chronic, fibrocystic, neuralgic, etc.

Osteon - morphofunctional unit of compact bone; ensemble formed of a Havers canal, osseous lamellas with concentric disposition around it and components placed in these formations (gr. *osteon* - bone).

Observation. It is named also haversian system. The correct name is secondary osteon to make the distinction from the primary osteon which organizes during bone formation.

Osteomyelitis – marrow bone inflammation is propagated through blood or from an articular inflammatory process. Mostly is produced by pyogenic germs (staphylococcus, streptococcus) or tuberculosis bacillus. Osteomyelitis caused by pyogenic germs produces abscesses of bone marrow, as of bone substance that necroses and removes under the form of fragments named seizures.

Osteopathy - generic term used to designate any osseous disease.

Osteoplasts - stellate or fusiform cavities from osseous lamellae structure where there are the osteocytes; present many extensions (ducts) that represent the main path for sanguine gases and nutritive substances diffusion between vascular system and osteons.

Osteoplasty - represents the replacement of a sick bone with a healthy one or with a synthetic material able to take the sustain function (gr. *plastos* - modeled).

Osteoplasty – plasty through osseous graft.

Osteoporosis - pathologic process characterized by an incorrect ratio between osteoformation and osteolysis, with predominance of the latter, osseous demineralization, apparition of some osseous cavities of big dimensions and the decrease of osseous resistance at fractures (gr. *phoros* - pore, canal).

Osteoprogenitors cells – STEM cells (origin, precursor ones) that form the osseous cells.

Observation. From morphologic and kinetic point of view, were identified 2 types of osteoprogenitors cells: preosteoblasts and preosteoclasts; thus is suggesting that osteoblasts come from a stromal conjunctive cell and osteoclasts from monocytes.



Osteosynthesis – surgical procedure through which are fixed the bony fragments of a fracture.

Osteotendinous junction - region where a bone and tendon connect.

Osteotomy – surgical procedure which consists of a bone division into sections in order to obtain centering, derotation, elongation, shortening or its support.

P

Paresis - motor deficiency with a degree smaller than the one caused by paralysis; slight or incomplete paralysis.

Parkinson's disease - a progressive nervous disease occurring most often after the age of 50, associated with the destruction of brain cells that produce dopamine and characterized by muscular tremor, slowing of movement, partial facial paralysis, peculiarity of gait and posture, and weakness. Also called *paralysis agitans*, *shaking palsy*.

Passive support – contribution of noncontractile tissues to joint stability.

Paralysis – diminishing or loss of muscle motor force, due to central or peripheral nervous system lesions. Is accompanied by nonfunctional muscles rigidity, that can be painful or not and leads to a muscle atrophy.

Periosteum – connective vascular membrane that wraps on the bones, with role for nutrition and osseous tissue formation (growth increase).

Phalanges – from anatomic point of view, represent the hand and foot fingers bones. There are 3 phalanges (proximal, intermediate, distal) for fingers 2-5 and two phalanges for thumb and hallux.

Pelvis - basin-shaped structure of the vertebrate skeleton, composed of the innominate bones on the sides, the pubis in front, and the sacrum and coccyx behind, that rests on the lower limbs and supports the spinal column.

Periostitis – periosteum inflammation, usually occurred during an inflammatory or posttrauma process.

Perimysium – fibrous connective tissue sheath that surrounds each fascicle within a skeletal muscle

Peripheral nervous system - the portion of the nervous system that is outside the brain and spinal cord. Abbreviated PNS. The nerves in the PNS connect the central nervous system (CNS) to sensory organs, such as the eye and ear, and to other organs of the body, muscles, blood vessels, and glands. The peripheral nerves include the 12 cranial nerves, the spinal nerves and roots, and the autonomic nerves.

Plan (anatomic) - surface that divides into sections/intersects imaginary the human body under a certain incidence. Moves happens in these plans around an axis perpendicular on the respective plan.

Obs. Plans that divide the body in two half are named medio-sagittal (right and left), medio-frontal (anterior and posterior) and medio-transversal (superior and inferior). At the intersection of the three plans there is the gravity center of the body (S2).

Sagittal plan is the one that divides the body in a left part and a right one. By extension we name the sagittal plan any plan parallel with the mentioned one. It is the plan where take place the moves visible from profile, around a transversal axis (*frontal*).

Frontal plan is the one that divides the body into an anterior part and a posterior one.

It is the plan where perform the moves visible from anterior, around a sagittal axis (antero-posterior).



Transversal plan is the plan that divides the body into a superior part and an inferior one. Is the plan where are realized moves visible from up or from down, around a vertical axis (*longitudinal*).

For distal joints the movements are performed in a single plan (pure moves). At proximal joints (shoulder, hip) are realized complex moves, simultaneously in more plans, while for intermediary articulations (elbow, knee) movements are made in two plans.

Plantar support – orthopedic apparatus composed usually of a hard aluminum lama, gridded after a gypsum molding, to sustain the flat foot arch .

Plantar surface - anatomical term for the bottom surface of the foot. When the foot is facing the floor, the part that contacts the floor is the plantar surface.

Plasticity – ability to adapt to environmental stimuli and events.

Plantar flexion – motion at the ankle where the foot moves away from the lower leg

Poliomyelitis – epidemic or contagious infectious disease caused by a specific virus, that produces anatomic lesions of gray substance of spinal marrow gray substance, attacking the motor nervous cells, manifests through fever, digestive disorders, somnolence and painful limbs muscles, followed by localized paralysis, usually at inferior limb; infantile paralysis.

Polyarticular – with action at many joints level.

Polyarthritis – simultaneous inflammation of more joints; disease with chronic progressive rheumatoid evolution, with symmetric polyarticular determinations, of inflammatory type and serious alteration of general condition, leading in time to deformations and ankylosis.

Porosity (bone) – measure of the soft tissue in bone; inverse of density.

Posture - alignment or position of the body and its parts.

Posture (static) – postures involving little or no movement.

Postural (control) – maintenance of postural stability or equilibrium. Also balance.

Postural (adaptive control) – strategy to maintain balance by modifying movement in response to situational changes

Postural (reactive control) – strategy to maintain balance (e.g. to prevent a fall) using muscle action

Postural (static control) - strategy to maintain as center of gravity projection kept within the base of support static posture with the body

Preswing (phase) - final element of supporting phase (50-60% of gait cycle) and it is from functional point of view more related to the oscillation phase than the support one. Synonymous toes lifting from ground; terminal contact.

Pronation – to turn or rotate (the hand or forearm) so that the palm faces down or back; to turn or rotate (the foot) by abduction and eversion so that the inner edge of the sole bears the body's weight.

Proprioception - the kinesthetic sense. The sense that deals with sensations of body position, posture, balance, and motion, sensation pertaining to stimuli originating from within the body related to spatial position, muscular activity and movement.

Proprioceptive deficit - a defect of proprioception in which the animal acts as though it does not know where its feet are (in contrast to a cerebellar defect when the feet do not end up where the animal appears to intend that they should go).

Proprioceptive positioning - positioning of the limbs or head and neck in response to proprioceptive inputs. The basis of postural reflexes.



Proprioceptive reflex - a reflex that is initiated by stimuli arising from some function of the reflex mechanism itself.

Propulsion phase of walking - dynamic or oscillation phase when foot leaves the ground and oscillates towards anteriorly without having any contact with the support surface.

Prosthesis - a device that replaces an organ, assuming its functions.

Prosthetic - procedure through which an organ is replaced.

Pyramidal tract - two well-defined bands formed by motor axons from the cerebral cortex that enter the medulla oblongata and end in the spinal cord (**anterior corticospinal tract** and **lateral corticospinal tract**).

Obs. The majority of the fibers in these tracts cross to the opposite side; therefore damage to the right cerebral HEMISPHERE affects motor control of the left half of the body.

Pyramidal syndrome - all the symptoms are caused by partial or complete damage of the pyramidal tract and is suggested by: spasticity, progressively weak muscle, wasted muscles, increased deep tendon reflexes, positive Babinski reflex.

R

Rearfoot - the area in the back (rear) of the foot. The rearfoot includes the "talus" and "calcaneus" bones and surrounding soft tissues.

Rehabilitation - the process of helping a person who has suffered an illness or injury restore lost skills and so regain maximum self-sufficiency. For example, rehabilitation work after a stroke may help the patient walk and speak clearly again.

Reduction (fracture) – restoring in anatomic position the fractures and dislocations, with or without opening the focus (nonbleeding or close reduction and orthopedic, bleeding reduction).

Remodeling (osseous) – represents a succession of alternative sequences of osseous resorption and formation, having as result changes of shape and volume of the osseous tissue structure.

Observation. This type of osseous activity occurs in the human skeleton from formation until death, interesting both the compact bone and the spongy one. From the factors implied in the phenomena genesis we draw attention over the mechanic factors.

Resorption (osseous) - breakdown or demineralization of bone.

S

Sarcomere - the contractile unit of a skeletal muscle fiber. All structures contained between two successive Z membranes.

Obs. Sarcomeres are divided into bands of filaments made of actin or myosin. During muscle contraction, the filaments slide over each other to cause shortening of the sarcomere.

Sciatica - pain that results from irritation of the sciatic nerve and typically radiates from the buttock to the back of the thigh.

Obs. Although sciatica can result from a herniated disc pressing directly on the nerve, any cause of irritation or inflammation of this nerve can reproduce the painful symptoms of sciatica.

Sequestrum (Medicine/Pathology) - a fragment of dead bone separated from healthy bone as a result of injury or disease; a detached piece of necrotic bone that often migrates.

Shaft - the body of long bones, formed by a cylinder of compact osseous tissue crossed by a central canal; (gr. *diaphysis* - interstitium).



Observation. There is a gradually transition between compact osseous tissue and spongy one as the central medullary cavity approaches, thus we can affirm that osseous shafts contain also spongy osseous substance at bone-marrow interface.

Spastic diplegia – pathological gait characterized by abnormally flexed, adducted, and internally rotated hips, hyperflexed knees and equinus of the foot and ankle.

Spasticity - an increase in muscle tone due to hyperexcitability of the stretch reflex and is characterized by a velocity-dependent increase in tonic stretch reflexes.

Splint – orthopedic way of immobilization of a body part. Can be flexible or rigid, made of metal, bandage or gypsum gauze, celluloid, plastic material.

Spongy osseous substance – variety of hard connective tissue (osseous), with macroscopic structure like the texture of a sponge (porous), formed of osseous lamellas (trabeculae) orientated in different directions that delimits a series of cavities of different dimensions and shapes (areoles) where exist the hematopoietic osseous marrow. Synonymous trabecular tissue; osseous spongy.

Observation. Microscopic the organization of this tissue class is basically lamellar, the osseous lamellas are disposed generally in the plan of mechanic forces that action over ground, identified itself with the isostatic lines.

Sprain - articular trauma caused by a move that exceeds the articular mobility limits, without the articular surfaces moves from their normal position.

Stability (joint) - resistance offered by various musculoskeletal tissues that surround a skeletal joint.

Obs. Several subsystems ensure the stability of a joint. These are the passive, active and neural subsystems. The opposite of stability is instability. The bony components that may relate to the potential for joint instability can be measured by use of x-rays. Plain film lateral x-rays can be used to evaluate for translations anteriorly (anterolisthesis) or posteriorly (retrolisthesis). Where plain films indicate the likelihood of these translations being significant, flexion-extension views can be utilized to determine the dynamic range of movement of joints. This allows for a more accurate view of any potential instability issues

Stance phase of walking - static or amortization phase when foot reaches the support surface

Static vertical alignment - view of skeletal placement along a plumb line, viewed from the side, with the body segments stacked on the line of gravity in a non-locomotion stance, and with the weight evenly distributed between the feet.

Steady state - posture involving slight movement.

Step – the period from initial contact of one leg to initial contact of the opposite/contralateral limb.

Stepped walking - walking disorder due to the paralysis of the muscles innervated by the external popliteal nerve; during walking, the foot reaches first the ground with the toe and then with the heel. Synonymous stepped walking.

Stiffness – articular stiffness, movements' limitation at a joint, through intra and periarticular fibrous organization.

Stress fractures - microfractures that appear when the external solicitation level is lower than the static resistance of the osseous material.

Structure – internal way of composing a system, characterized by the nature and proprieties of the component elements, through their space distribution and their connections and interactions.



Supination - to turn or rotate (the hand or forearm) so that the palm faces up or forward; to turn or rotate (the foot) by adduction and inversion so that the outer edge of the sole bears the body's weight.

Support (medical term) - way of sustaining the weight body – total or partial - to carry the weight of; to bear or withstand (pressure, weight, etc.).

Support limb (walking) - inferior limb that sustains the body weight.

Swing limb (walking) - inferior limb that performs the body forwarding.

Synarthrosis – functional classification of a joint with no movement.

Synchondrosis – joint bound by hyaline cartilage, variety of synarthrosis.

Syndesmosis - joint bound by ligaments.

Synovial (joint) - structural classification of joint containing a fibrous joint capsule, synovial membrane, synovial cavity, synovial fluid and articular cartilage.

Synovial (articular cavity) - space between the bones in a synovial joint.

Synovial (liquid) – viscous fluid found in synovial joints that provides lubrication and reduces friction.

Synovial (membrane) - thin membrane, on the inner surface of the fibrous joint capsule of a synovial joint that produces synovial fluid.

T

Tabes - a gradual, progressive wasting of the body in any chronic disease, progressive locomotor ataxia; ~**dorsal** - a slowly progressive nervous disorder, from degeneration of the dorsal columns of the spinal cord and sensory nerve trunks, resulting in disturbances of sensation and interference with reflexes and consequently with movements; called also locomotor ataxia. It is caused by syphilis and may appear 5 to 20 years after initial infection.

Talus - first of the foot tarsus bones. Synonymous astragal.

Talus Valgus – foot deviation directed outside.

Talus Varus - foot deviation directed inside.

Tarsal tunnel syndrome - a complex of symptoms resulting from compression of the posterior tibia nerve or of the plantar nerves in the tarsal tunnel, with pain, numbness, and tingling paresthesia of the sole of the foot.

Tarsus – region composed by the seven bones (talus, calcaneus, navicular, medial, intermediate and lateral cuneiform, and cuboid) between the ankle and metatarsus.

Tendon – cordlike connective tissue that connects muscle to bone. Fibrous tissue band.

Tendinitis – inflammation of a tendon, usually due to overuse.

Thumb – first finger (big toe) of hand.

Tibia - shank bone, placed on the medial part.

Transplantation – represents introduction of an organ or organ fragment through surgical method into a live body, in order to replace the organ that can be used or destroyed and to reestablish the vascular connections of transplanted organ with the receiver body.

Tredelenberg (posture) – pathological gait characterized by pelvic drop during early to midstance due to weakness or paralysis of the hip adductors.

Trendlenburg (sign) - a physical examination finding associated with various hip abnormalities (those associated with abduction muscle weakness or hip pain congenital



dislocation, hip rheumatic arthritis, osteoarthritis) in which the pelvis sags on the side opposite the affected side during single leg stance on the affected side; during gait, compensation occurs by leaning the torso toward the involved side during stance phase on the affected extremity.

Tropomyosin - regulatory protein located on the actin filament. In the relaxed skeletal muscle it covers the myosin head binding sites on the actin molecules.

Troponin – regulatory protein that binds to both tropomyosin and actin, when combined with calcium, troponin influences tropomyosin to initiate muscle contraction.

U

Unilateral support unilateral (walking) - period when the body's weight is supported by one leg.

V

Valgus – deviation of a limb or limb segment outside the normal longitudinal axis, thus the external angle of 180 degrees decreases. There is a certain degree of physiologic valgus (at elbow, knee, ankle); the overcome of this degree has a pathologic signification.

Varus – deviation of a limb or limb segment inside the normal longitudinal axis, thus the internal angle of 180 degrees decreases. There is a certain degree of physiologic varus (at shoulder, hand, hip); the overcome of this degree has a pathologic signification.

Vestibular disorders - Disorders of the body's balance (vestibular) system in the inner ear due to a tremendous range of conditions including vertigo, Meniere's disease, acoustic neuroma, multiple sclerosis, syphilis, trauma, ear infections, medications toxic to the ear (ototoxic drugs), epilepsy (seizure disorders).

Volkman canals - canals with oblique or transversal direction in comparison with the osteons one, that are not surrounded by concentric lamellae, seem to be simple anastomotic canals.

Q

Quadriceps (avoidance) – gait strategy adopted by persons with ACL deficiency to avoid activation of muscles in the quadriceps group.

References

- The Oxford Dictionary of Sports Science & Medicine
- <http://medicine.academic.ru/>
- <http://www.medterms.com/>



ANALYSIS OF HUMAN MOTION

GLOSSARY OF TECHNICAL TERMS

(BIOMEDICAL ENGINEERING TERMS)

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Terms of medical physics and biomechanics

A

Action potential – electrical signal that passes along the membrane of a neuron or a muscle fiber. May also be called a nerve impulse with respect to neuron or a muscle action potential as it relates to a muscle fiber.

Aerodynamic force – force exerted on a body whenever there is a motion of the body through the air.

Analytical model – ensemble of equations that describe the studied physical phenomenon and the behaviour of the material under action of external stress, with additional boundary conditions which describe the interaction of the considered structure with the applied forces. *Remark:* when the variables are time varying, the analytical model must include the initial conditions. This model is the fundament for the development of the numerical model with finite elements, and its predictive capabilities establish the simulation performance of the numerical model.

Analogue – something that is in some way similar to something else.

Angular displacement – angular measure from the starting position to the finishing position of an angular movement. The distance an object moves when following a circular path. It is represented by the length of the arc of a circle drawn to represent the motion of the object about a fixed point.

Angular kinetic energy – $\frac{1}{2} \times (\text{moment of inertia}) \times (\text{angular velocity})^2$. The rotational energy or angular kinetic energy is the kinetic energy due to the rotation of an object and is part of its total kinetic energy.

Angular momentum – or **rotational momentum** is a conserved vector quantity that can be used to describe the overall state of a physical system. The angular momentum of a system of particles (e.g. a rigid body) is the sum of angular momenta of the individual particles. For a rigid body rotating around an axis of symmetry, the angular momentum can be expressed as the product of the body's moment of inertia I and its angular velocity ω .

Anisotropic (material) – physicists use the term anisotropy to describe direction-dependent properties of materials. **Anisotropy** is the property of being directionally dependent, as opposed to isotropy, which implies identical properties in all directions. It can be defined as a difference, when measured along different axes, in a material's physical property (absorbance, refractive index, density, etc.) An example of an anisotropic material is wood, which is easier to split along its grain than against it.

Observation. Human bone is an anisotropic material.

Area moment of inertia – measure of a body's resistance to bending. The **second moment of area**, also known as the **area moment of inertia**, **moment of inertia of plane area**, or **second moment of inertia** is a property of a cross section that can be used to predict the resistance of beams to bending and deflection, around an axis that lies in the cross-sectional plane.

Axis of rotation – an imaginary line perpendicular to the plane of rotation and passing through the centre of rotation about which given system rotates.

B

Basal metabolic rate (BMR) – the BMR refers to the amount of energy the body needs to maintain homeostasis, and accounts for 50-80 per cent of your total daily energy use. The BMR is largely determined by total lean mass, especially muscle mass, because lean mass requires a lot of energy to maintain. So, anything that reduces lean mass will reduce your BMR.

Bi-dimensional model – a model in which the information analysis is achieved in two dimensions.

Biomaterial – a biocompatible material that is used to construct artificial organs, rehabilitation devices, or prostheses and replace natural body tissues.

Biomechanical modelling – method based on the use of biomechanical models; schematic reproduction of a complex system as a simplified analogue system, achieved in order to study the behaviour of the initial system in some conditions. *Remark:* Frequently the initial system is modelled starting from a basic repetitive unit.

Biomechanics – the study of the mechanics of a living body, especially of the forces exerted by muscles and gravity on the skeletal structure; the study of the structure and function of biological systems



such as humans, animals, plants, organs, and cells by means of the methods of mechanics. (gr. *Bios* - life + lat. *mechanicus*-mechanics)

Biomechanic energy – amount of metabolic energy required to perform a given amount of work; energy used during physical activity. During heavy physical exertion, the muscles may burn through as much as 3,000 kJ per hour. Energy used during exercise is the only form of energy expenditure that you have any control over. The energy expenditure of the muscles makes up only 20 per cent or so of the total energy expenditure at rest, but during strenuous exercise, it may increase 50-fold or more. Various activities and the amounts of energy (in kJ per kilogram per hour) typically used during them are:

- Sitting quietly – 1.7
- Writing – 1.7
- Standing relaxed – 2.1
- Driving a car – 3.8
- Vacuuming – 11.3
- Walking rapidly – 14.2
- Running – 29.3
- Swimming (at 4 km/hour) – 33
- Rowing in a race – 67.

Bone – marrow interface – a layer of spongy bone tissue which connect the compact tissue of the diaphysis of long bones with the marrow from the central medullar channel (cavity).

Bone remodelling – totality of processes that lead to the growth of bone tissue, controlling in the same time the bone form involved in the growth process (morpho-physiology term).

Bone density – a measurement corresponding to the mineral density of bone, expressed as mineral mass per unit volume of bone and usually assessed by a radiologic scan of the lower spine or hip. Bone density measurements are used to diagnose and monitor osteoporosis and other bone diseases. Also called *bone mineral density*. Inverse of porosity.

C

Center of gravity – the point in or near a body at which the gravitational potential energy of the body is equal to that of a single particle of the same mass located at that point and through which the resultant of the gravitational forces on the component particles of the body acts. In a uniform gravitational field this is coincident with the body's center of mass. The point at which the whole weight of an object can be considered to act and, therefore, at which all parts of an object are in balance.

The position of the centre of gravity varies according to the shape of the object. In objects with a regular shape, the centre of gravity coincides with its geometric centre. In objects with an irregular and variable shape (as in the human body), the centre of gravity cannot be defined easily and changes with every change in position of the body; it may not even lie within the physical substance of the body. A body's centre of gravity may coincide with its geometric centre, especially if the body is symmetric and composed of homogeneous material. In asymmetric, unhomogeneous, or hollow objects, the centre of gravity may be at some distance from the geometric centre or even at a point in space external to the object, such as between the legs of a chair.

Near the surface of the earth, where the gravity acts downward as a parallel force field, the center of gravity and the center of mass are the same. The study of the dynamics of aircraft, vehicles and vessels assumes that the system moves in near-earth gravity, and therefore the terms center of gravity and center of mass are used interchangeably.

Center of mass – the point in a system of bodies or an extended body at which the mass of the system may be considered to be concentrated and at which external forces may be considered to be applied.

Compression – the application of balanced inward ("pushing") forces to different points a material or structure, that is, forces with no net sum or torque directed so as to reduce its size in one or more directions (mechanics). *Other definition:* the result of the subjection of a material to compressive stress.

Compressive strength – capacity to withstand axially directed pushing forces.



Compliance – measure of the relationship between strain and stress. Inverse of stiffness. In medicine, **compliance** (also **adherence** or **capacitance**) describes the degree to which a patient correctly follows medical advice.

Conservation of energy – a principle stating that the total energy of an isolated system remains constant regardless of changes within the system. The principle of conservation of energy states that energy cannot be created or destroyed, although it can be changed from one form to another.

Conservation of momentum – the principle that, when a system of masses is subject only to internal forces that masses of the system exert on one another, the total vector momentum of the system is constant; no violation of this principle has been found.

Curvilinear motion – motion along a curved line (path).

D

Deformational energy (strain energy) – the external work done on an elastic member in causing it to distort from its unstressed state is transformed into strain energy which is a form of potential energy. The strain energy in the form of elastic deformation is mostly recoverable in the form of mechanical work.

Digitizing or digitization – the representation of an object, image, sound, document or a signal (usually an analog signal) by a discrete set of its points or samples. The result is called *digital representation* or, more specifically, a *digital image*, for the object, and *digital form*, for the signal. Strictly speaking, digitizing means simply capturing an analog signal in digital form. Digitizing is the primary way of storing images in a form suitable for transmission and computer processing, whether scanned from two-dimensional analog originals or captured using an image sensor-equipped device such as a digital camera, tomographical instrument such as a CAT scanner, or acquiring precise dimensions from a real-world object, using a 3D scanning device.

Distance – the extent of space between two objects or places; is a numerical description of how far apart objects are. A scalar measurement of the extent of a body's motion, irrespective of the direction in which it has travelled. Thus, when a body moves from one location to another, the distance through which it moves is the length of path it follows.

Dynamic posture – posture of motion as seen in walking and running.

Dynamic – of or concerned with energy or forces that produce motion, as opposed to static.

Dynamic behavior – a description of how a system or an individual unit functions with respect to time.

Dynamic equilibrium – state in which the accelerations are balanced according to Newton's second law of motion (i.e. force = mass x acceleration). It is a particular example of a system in a steady state.

Dynatomy – study of human anatomy from a dynamic or movement focused perspective.

E

Efficiency – amount of mechanical output produced by a given amount of metabolic input (i.e. how much work can be done using a given amount of energy). The ratio of the useful work done by a machine, engine, device, etc., to the energy supplied to it, often expressed as a percentage.

Elastic modulus – value of the mechanical tension by which the body deformations are reversible.

Elongation – the act or process of increasing in length.

Elevation – movement of a structure in superior or upward direction.

Energy (mechanical) – ability or capacity to do mechanical work. In physics, **mechanical energy** describes the sum of potential energy and kinetic energy present in the components of a *mechanical system*. Mechanical energy is the energy associated with the motion or position of an object.

Equilibrium – the condition of a system in which all competing influences are balanced, in a wide variety of contexts. A rigid body is in mechanical equilibrium when the sum of all forces on all particles of the system is zero, and also the sum of all torques on all particles of the system is zero



F

Failure (structural) – refers to loss of the load-carrying capacity of a component or member within a structure or of the structure itself. Structural failure is initiated when the material is stressed to its strength limit, thus causing fracture or excessive deformations.

Fatigue – physical or mental exhaustion due to exertion; the progressive cracking of a material subjected to alternating stresses; structural damage from repeated loading.

Flexibility – the ability of a material to deform elastically and return to its original shape when the applied stress is removed.

Force – any influence that causes an object to undergo a certain change, either concerning its movement, direction, or geometrical construction. *Other definitions:* mechanical action or effect applied to a body that tends to produce acceleration; what causes mass to accelerate or become deformed.

Force – velocity (relationship) – property of skeletal muscle that shows its force production capability is dependent on its contraction velocity.

Friction – the force resisting the relative motion of solid surfaces, fluid layers, and material elements sliding against each other. *Other definition:* the resistance developed at the interface of two surfaces, acting opposite the direction of motion or impending motion.

Function (biology) – activity achieved at living organisms' level by cells, tissues, organs, systems of organs or by the entire body. *Remark:* The function is related and determined of some anatomic and biochemical structures and it cannot exist without these structures.

G

Gait analysis – evaluation of the manner or style of walking, usually done by observing the individual walking naturally in a straight line.

Geometric model – model represented by the discretized analysis domain.

Gravitation – the mutual attraction between all masses and particles of matter in the universe. Newton's law of universal gravitation states that every two particles of matter in the universe attract each other with a force that acts in the line joining them, the intensity of which varies as the product of their masses and inversely as the square of the distance between them.

Gravitational potential energy – energy possessed by a body as a result (by virtue) of its position. The energy of a particle or system of particles derived from position, or condition, rather than motion. A raised weight, coiled spring, or charged battery has potential energy.

Ground reaction force – equal and opposite force exerted by the ground against an object contacting it. *Other definition:* the force exerted by the ground on a body in contact with it. *Remark:* For example, a person standing motionless on the ground exerts a contact force on it (equal to the person's weight) and at the same time an equal and opposite ground reaction force is exerted by the ground on the person.

H

Histomorphometry – measuring method for size and form of cells by placing parallel lines net over the histological images of a tissue (gr. *histos* - tissue + *morphe* - form + *metron* - measure).

Human motion analysis – investigation of human motion in order to know the structure, functionality and efficiency of its; in the areas of medicine, sports, and video surveillance, human motion analysis has become an investigative and diagnostic tool. Human motion analysis can be divided into three categories: human activity recognition, human motion tracking, and analysis of body and body part movement.

I

Inertia – resistance to a change in a body's state of linear motion.

Isostatic lines – represent the transmission directions inside the bone structures of the mechanical forces applied at the bone surface.

Isotropic (material) – having identical values of a property in all directions. *Remark:* For simplicity reasons, in numerous speciality studies, the bone is considered as an isotropic material.



K

Kinetic energy – energy of motion, equivalent to one-half an object's mass multiplied by its velocity squared.

A system of bodies may have internal kinetic energy due to the relative motion of the bodies in the system.

It sometimes is convenient to split the total kinetic energy of a body into the sum of the body's center-of-mass translational kinetic energy and the energy of rotation around the center of mass (rotational energy):

$$E_k = E_t + E_r$$

where:

E_k is the total kinetic energy

E_t is the translational kinetic energy

E_r is the *rotational energy* or *angular kinetic energy* in the rest frame

Kinetics – the study of motion and its causes; that part of classical mechanics which deals with the relation between the motions of material bodies and the forces acting upon them.

Kinematics – description of motion with respect to space and time, without regard to forces involved. Kinematics is the branch of classical mechanics that describes the motion of points, bodies (objects) and systems of bodies (groups of objects) without consideration of the causes of motion.

Kinematic analysis - the process of measuring the kinematic quantities used to describe motion. In engineering, for instance, kinematic analysis may be used to find the range of movement for a given mechanism, and, working in reverse, kinematic synthesis designs a mechanism for a desired range of motion. It does not deal with the mass or forces causing the motion.

L

Length-tension relationship – property of skeletal muscle that shows its force production capability is dependent on the length of the muscle contractile and non-contractile structures.

Lever – rigid structure fixed at a single point to which two forces are applied at two different points.

Lever arm - mathematically, torque is defined as the cross product of the *lever arm* distance and force, which tends to produce rotation. The magnitude of torque depends on three quantities: the force applied, the length of the *lever arm* connecting the axis to the point of force application, and the angle between the force vector and the lever arm.

Line of force action – line along which a force acts, extending infinitely in both directions along the line of a finite force vector.

Linear displacement – straight line vector measure from the starting point to the finishing point of a movement.

Linear kinetic energy – $\frac{1}{2} \times \text{mass} \times (\text{linear velocity})^2$.

Linear momentum – product of a body mass and its velocity.

Linear motion – motion along a straight or curved line.

Load – force applied externally to a body.

M

Mass moment of inertia – measure of a body's resistance to rotation about an axis.

Material properties – general properties that characterise the material.

Maximal load – the maximum value of the load supported by a tissue before the full breakdown.

Mechanical load – the process of permanent structural changes of a material which is forced to a cyclic mechanical stress; it is expressed as the sum of all applied forces and of their moments.

Mechanical properties – the properties that characterise the mechanical behaviour of a material.

Mechanical stress – force per surface unit. *Remark:* it exist compressive stress, shear stress, tensile stress, ultimate stress.

Model – a system which represents the sum of the representative properties of a much complex system, with whom has structural or functional analogies, achieved in order to simplify the study of the complex system.

Model parameter – numerical values that characterise some mechanical properties of the system model.



Model validation – providing proofs about the precision of the used model by comparison with the real structure. *Remark:* another formulation: model evaluation.

Moment – effect of a force that tends to cause rotation about an axis.

Moment arm – perpendicular distance from the axis of rotation to the line of force action also torque arm.

Moment of inertia – a property of rotating bodies that defines its resistance to a change in angular velocity about an axis of rotation.

Momentum – property of a moving body that is determined by the product of the body mass and its velocity.

Motion (rectilinear) – motion along a straight line.

Motion (rotational) – motion in which a body rotates about an axis. Also angular motion.

Motion analysis - a topic that studies methods and applications in which two or more consecutive images from an image sequences, are processed to produce information based on the apparent motion in the images.

N

Net moment – sum of all the moments (torques) acting on a body.

Numerical model – the results of the transforming process of the analytical model by writing the relationships that describe the model behaviour under action of various mechanical loads.

O

Orthotropic (material) – that has different material properties or strengths in different orthogonal directions (e.g., glass-reinforced plastic, or wood). *Remark:* The assimilation of bone with this type of material offers an intermediate approximation solution.

Oscillation – alternate periodic movement around an equilibrium position; it has three characteristic variables: frequency, magnitude and phase.

P

Pathomechanics – a branch of physical science that deals with static and dynamic forces and their abnormal effect on a human body affected by neurological, muscular and skeletal disorders. As this relates to clinical gait assessment, a potential lower extremity pathomechanical deformity is identified when a lever arm has changed from the "normal" profile of the lower limbs. Such a change is usually caused by neuromuscular, velocity or balance factors and results in excessive vertical or horizontal displacement of the COM.

Pixel – bi-dimensional unit for the evaluation of an image resolution.

Polar moment of inertia – measure of a body's resistance to twisting or torsion.

Projection (center of gravity) – line drawn from the center of gravity vertically downward to the base of support.

S

Shear stress – the component of stress coplanar with a material cross section. *Remark:* Shear stress arises from the force vector component parallel to the cross section. Normal stress, on the other hand, arises from the force vector component perpendicular or anti-parallel to the material cross section on which it acts.

Simulation – the imitation of the operation of a real-world process or system over time. The act of simulating something first requires that a model be developed; this model represents the key characteristics or behaviours/functions of the selected physical or abstract system or process. The model represents the system itself, whereas the simulation represents the operation of the system over time.

Static equilibrium – state of balance in which there is no net acceleration. Usually refers to stationary or non moving balance. A system of particles is in static equilibrium when all the particles of the system are at rest and the total force on each particle is permanently zero.



Stiffness – the rigidity of an object - the extent to which it resists deformation in response to an applied force. The complementary concept is flexibility or pliability: the more flexible an object is, the less stiff it is.

Strain – Height (ΔL) / Original Height (L_0); Strain is a description of deformation in terms of relative displacement of particles in the body that excludes rigid-body motions. In the physical sciences and engineering, a number that describes the relative deformation of elastic, plastic, and fluid materials under applied forces. It arises throughout the material as the particles of the material are displaced from their usual position. Normal strain is caused by forces perpendicular to planes or cross sections of the material, such as in a volume that is under pressure on all sides. Shear strain is caused by forces that are parallel to, and lie in, planes or cross sections, such as in a short metal tube that is twisted about its longitudinal axis.

1. The condition of a material being distorted by forces acting on it. Strain is measured as the ratio of deformation of the material to the dimension of the material in which the forces are being applied. Therefore, compressive strain is the ratio of contraction of the material to the original length of the material; tensile strain is the ratio of elongation of the material to its original length; and shear strain is the ratio of the deflection of the material in the direction of the shear force to the distance between shear forces.

2. Injury to a muscle or tendon due to excessive mechanical stress. (An injury in which a muscle is damaged by being excessively stretched or overworked. It may result from a direct impact that pushes the muscle against an underlying bone.)

Strain rate – the rate of change in strain (deformation) of a material with respect to time.

Strain rate dependent – property of a tissue dictating that its mechanical response to loading depends on the rate at which the tissue is deformed.

Strength (of a material) – ability to withstand an applied stress without failure.

Swing (phase) – period during which the foot is not in contact with the ground during gait.

T

Take off – last foot contact with the ground to end the stance phase and begin the swing phase. Also toe off.

Temporal analysis – assessment based on time duration.

Tensile (tension) – the pulling force exerted by a string, cable, chain, or similar solid object on another object.

Tensile strength – maximum stress while being stretched or pulled before necking.

Three-dimensional model – model in which the information analysis is achieved in three dimensions.

Torque – effect of a force that tends to cause twisting or torsion about an axis. \also used as a synonym for moment as the effect of a force that tends to cause rotation of a body about an axis of rotation.

Torsion – in solid mechanics, torsion is the twisting of an object due to an applied torque, therefore is expressed in N·m. In sections perpendicular to the torque axis, the resultant shear stress in this section is perpendicular to the radius.

Total mechanical energy – sum of a body's linear kinetic energy, angular kinetic energy and positional potential energy.

Transfer (momentum, energy) – exchange of momentum or energy from one body to another.

V

Voxel – three-dimensional unit for the evaluation of an image resolution.

W

Weight – the force of attraction exerted on an object by the gravitational pull of the Earth. Weight is often expressed in units of mass, but this is not scientifically correct. Being a force, weight should be measured in newtons (N), and a body of mass will have a weight mg , where g is the acceleration of free fall ($9.80\ 665\ \text{ms}^{-2}$).



Terms used for Footscan pressure plate

Active contact area [cm²] – the contact area where load is applied.

Center of pressure – in biomechanics, **center of pressure (CoP)** is the term given to the integrated pressure field that an organism exerts on a supporting surface, typically via a foot or other appendage. CoP commonly changes throughout a movement as different parts of the foot are loaded to different degrees. For instance, during human walking, the center of pressure is near the heel at the time of heelstrike and moves more anteriorly throughout the step, being located near the toes at toe-off.

Contact area CA [cm²] – contact surface expressed in cm² for each assessed area

Contact percentage (%) of active surface during stance % C – provides information on the percentage of the total active surface, corresponding to the moment taken into study; the percentage of contact time compared with complete gait cycle.

Dynamic – relating to the study of dynamics; of or concerned with energy or forces that produce motion, as opposed to static.

Dynamic measurements - the dynamic measurement allows more detailed analysis of the aspects of walking or running, recording the sole pressures throughout walking or running.

Foot axis – foot axis starts at the center of the heel between median and lateral heel and passes between metatarsals 2 and 3 (it helps to determine external rotation).

Foot angle – (abduction angle) indicates the deviation from the walking direction (plate direction) and is quantified by values that indicate exo or endo rotation: a positive angle indicates exo rotation of the foot, whenever the angle is negative, it indicates endo rotation.

Foot balance – measures the total balance during stepping gait. It is calculated by the difference between two terms: M1 + M2 + HM and M3 + M4 + M5 + HL. The foot is in pronation if the pressure is higher at the medial heel and supination if the pressure is higher under the lateral heel side.

Forefoot balance – describes the balance of the forefoot, with the formula (M1+M2)-(M3+M4+M5).

Heel rotation – is calculated by comparing the pressure under the medial heel (HM) with the pressure under the lateral heel (HL).

Hallux Stiffness – shows the differences between the pressures applied on the hallux and first metatarsal. Formula is (T1-M1).

Impulse I [Ns/cm] – the loading in pressure and time. The impulse (%) indicates the actual loading under the evaluated area.

Load rate LR [N/cm.s] – The speed of loading in the specific region.

Max P [N/cm²] – the maximum pressure recorded in the study area.

Max F [N] – the maximum force recorded in the study area.

Max peak sensor – maximum measured pressure within each zone by a sensor.

Measurement – is the process or the result of determining the magnitude of a quantity, such as length or mass, relative to a unit of measurement, such as a meter or a kilogram.

Medial forefoot balance – shows the balance between M1 and M2 during walking; calculation formula is M2-M1.

Meta loading – measures the pressure difference between M2 and M3 metatarsals and metatarsals M1, M4 M5. Formula is (M2 + M3) - (M1 + M4 + M5).

Static – having no motion; fixed; stationary; of or relating to bodies at rest or forces that balance each other.

Static measurement – momentary recording; practically grabs a snapshot of the patient's soles. The results of a static measurement are the maximal pressures of the foot contact.

Subtalar joint angle – is angle between talus axis and calcaneus axis; indicates the amount of pronation in the rear foot during impact. During a step it records minimum and maximum values. The higher the value is the more pronation occurs. Minimum and maximum values give also an indication on the position of the rearfoot in relationship to the ground.

Subtalar joint flexibility – refers to the variation of subtalar joint angle and express talus mobility.

Time Max F/P – the time at which it was measured maximum force/pressure, expressed in milliseconds; the current time when registering the maximum force



Mathematical terms used in descriptive and functional anatomy

Approximation – is a representation of something that is not exact, but still close enough to be useful.

Although approximation is most often applied to numbers, it is also frequently applied to such things as mathematical functions, shapes, and physical laws.

ANSYS, Inc. – is an engineering simulation software provider. It develops general-purpose finite element analysis and computational fluid dynamics software. While ANSYS has developed a range of computer-aided engineering (CAE) products, it is perhaps best known for its ANSYS Mechanical and ANSYS Multiphysics products.

APDL – ANSYS PARAMETRIC DESIGN LANGUAGE.

Cholesky decomposition – or **Cholesky triangle** is a decomposition of a Hermitian, positive-definite matrix into the product of a lower triangular matrix and its conjugate transpose. The Cholesky decomposition is mainly used for the numerical solution of linear equations $\mathbf{Ax} = \mathbf{b}$.

Computer-aided engineering (CAE) – is the application of computer software in engineering to evaluate components and assemblies. It encompasses simulation, validation, and optimization of products and manufacturing tools. The primary application of CAE, used in civil, mechanical, aerospace, and electronic engineering, takes the form of FEA alongside computer-aided design (CAD).

Deduction – The process of reasoning from the general to the specific, in which a conclusion follows necessarily from the premises.

Differential equation – is a functional equation involving derivatives of the unknown functions.

Discretization – continuous problems must sometimes be replaced by a discrete problem whose solution is known to approximate that of the continuous problem; this process is called discretization. For example, the solution of a differential equation is a function. This function must be represented by a finite amount of data, for instance by its value at a finite number of points at its domain, even though this domain is a continuum.

Domain of definition or simply the **domain** of a function – is the set of "input" or argument values for which the function is defined.

Dynamics – a branch of mechanics that deals with motion of bodies under the actions of forces or study of effects of forces on the motion of objects.

Finite element analysis (FEA) – is a computer simulation technique used in engineering analysis. It uses a numerical technique called the finite element method (FEM). There are many finite element software packages, both free and proprietary. Development of the finite element method in structural mechanics is usually based on an energy principle such as the virtual work principle or the minimum total potential energy principle.

Gaussian elimination (row reduction) – is an algorithm for solving systems of linear equations. This method can also be used to find the rank of a matrix, to calculate the determinant of a matrix, and to calculate the inverse of an invertible square matrix.

Induction – the process of deriving general principles from particular facts or instances.

Iteration – A computational procedure in which a cycle of operations is repeated, often to approximate the desired result more closely. Each repetition of the process is also called an "iteration" and the results of one iteration are used as the starting point for the next iteration.

Linear equation – is an algebraic equation in which each term is either a constant or the product of a constant and (the first power of) a single variable. Linear equations can have one or more variables.

Macro – a set of instructions that is represented in an abbreviated format.

Matrix – is a rectangular array of numbers, symbols, or expressions, arranged in rows and columns.

Nonlinear system – is one that does not satisfy the superposition principle, or one whose output is not directly proportional to its input; a linear system fulfills these conditions. In other words, a nonlinear system is any problem where the equation(s) to be solved cannot be written as a linear combination of the unknown variables or functions that appear in it (them).

Nodes – points that connect the finite elements considered in the model; define the finite elements connectivity.

Numerical analysis – is the study of algorithms that use numerical approximation for the problems of mathematical analysis.



Sub-domain – a constitutive part of a domain, obtained by subdivision of the considered domain.

Biomaterials Glossary

A

Alloy steels – a high variety of alloys which are based on steel (iron based alloy); can be produced by using different elements combinations and appropriate thermal treatment. The manganese steel contains approx. 1% carbon and 11-14% manganese. It is used for the production of components that can resist to high wear. The stainless steel, known as 18-8, is an iron alloy, with 18% chrome, 8% nickel and 0.08% carbon.

Alumina (Al_2O_3) – a ceramic biomaterial with an excellent corrosion resistance, a good biocompatibility, high strength, and a high abrasion resistance. *Remark:* It is used for over 20 years in orthopaedic surgery.

Aluminium alloys – alloys obtained from aluminium combiner with other metals. *Remark:* Aluminium alloys suitable for foundries contain max. 15% silicon, plus other small quantities of metals, such as copper, iron, nickel and zinc. The aluminium alloys suitable for other modelling processes such as forging, lamination, etc., contain about 7% magnesium and 1% manganese.

Aluminium bronze – alloy of copper and aluminium, and with other small quantities of metals, such as nickel, iron and manganese. *Remark:* This alloy is resistant as the soft steel and has a good resistance to corrosion.

B

Biocompatibility – a property of a material. A material with optimal biocompatibility doesn't involve any adverse reaction of the tissue. In the same time, it is expected that the implanted material to resist to any physiological tension, without substantial dimension changes, deformation or other catastrophic event

Biomaterials – inorganic or organic products with various applications such as prostheses or implants in biological tissues, at humans or animals. Various metals, alloys, ceramics, glass, organic polymers and so on can be used, as it is or as composite products.

Bioinert (biomaterial) – without response (or with a minimum response) from the host; therefore without interaction with the living tissue.

Bioactive (biomaterial) – supposes physical-chemical interactions with the living tissue and gives beneficial responses, recuperation in the contact zone and stimulates the endothelial cells growth.

Bio-tolerated (biomaterial) – separated by the living tissue with an appropriate thick interface such that important compatibility disturbances do not occur.

Bioresorbable (biomaterial) – ensures a resorption/dissolvable process after the introduction in the human body, and with a gradually replacement through the expansion of the living tissue.

Brass – a copper-zinc alloy, often coupled with other metals, such as tin, lead and aluminium. Nickel silver is related to brass, and it is composed by copper, zinc and nickel.

C

Ceramic materials – biomaterials with high strength with respect to their mass, rigidity, shock resistance, corrosion resistant (used in stomatology & dentistry, ophthalmology, measuring devices – thermometers, etc.).

Cobalt based alloys – alloys with a content of 25-30% chrome-Cr, 5-7% molybdenum-Mo and small quantities of other metals such as nickel-Ni, manganese-Mn, zirconium-Zr and tin-Sn. Other cobalt-based alloys are those with approx. 20% chrome-Cr, 10% nickel-Ni and max. 15% wolfram-W.

Composite materials – obtained from two or more different materials, with various properties (metal/metal, metal/polymer, polymer/polymer, polymer/ceramics, etc.).

Copper alloys - alloys based on copper in combination with other various metals. Examples: bronze, brass, and copper-nickel alloys. The bronze, which is the older alloy, consists in 75% copper and 25% tin. The bronze is a generic title for a large variety of copper alloys.



D

Ductility – a solid material's ability to deform under tensile stress; this is often characterized by the material's ability to be stretched into a wire; it depends on plasticity and malleability.

Duralumin – an aluminium alloy obtained by using the effect known as age hardening. Composition of duralumin alloys varies, but they contain aluminium, plus 3.5%-4.5% copper, 0.4%-0.7% magnesium, 0.4%-0.7% manganese, and about 0.7% silicon.

H

Hemocompatibility – the problem of blood coagulation in the presence of foreign bodies. *Remark:* The hemocompatibility study is very complex and it is not limited to coagulation, but also it concerns the immune system response (antibodies, etc.) and the tissues and cells reaction, especially of lymphocytes and leucocytes.

Hydroxyapatite (HAp) – a ceramic biomaterial based on calcium phosphate; the commercial hydroxyapatite is biocompatible, and the bio-degradation is absent or limited.

I

Ions emissions (related to the toxicity) – the lesions caused by the use of metallic alloys due to the emission of ions resulted from corrosion.

M

Malleability – the metal's ability to deform under compressive stress; this is often characterized by the material's ability to form a thin sheet by hammering or rolling at a lower temperature than its melting point.

Metal – an element, compound, or alloy that is a good conductor of both electricity and heat. *Remark:* Metals are usually shiny, malleable and ductile. Many elements and compounds that are not normally classified as metals become metallic under high pressures.

O

Orthoses – orthopaedic appliances or equipments used to support, align, prevent, or correct deformities or to improve function of movable parts of the body.

P

Particles resulting from abrasion (related to the toxicity) – particles produced by the joint prostheses and mobile implants.

Plasticity – a mechanical property of metals and alloys to permanently deforming when are affected by an external stress.

Polymers – materials with poor electrical and thermal conductivity, poor mechanical strength; very ductile and shock resistant (used for contact lenses, hemodialysis membranes, artificial skin and tendons, etc.).

Prosthesis – artificial device destined to replacement of an organ or of a joint (replaces a missing body part lost through trauma, disease, or congenital conditions).

R

Resistivity (specific electrical resistance) – is the resistance to the electrical current of a metal portion with a section of 1 cm² and a length of 1 cm (in $\Omega \cdot \text{cm}$).

S

Sensitiveness and allergies (related to the toxicity) – are defined as strong reactions of the individuals at the substances entered inside the organism.

T

Tenacity – the customary measure of strength of a fibre or yarn. It can be defined as the ultimate (breaking) strength of the fibre (in gram-force units) divided by the denier.



Thermal conductivity – the heat quantity propagated in a second through a cubic centimetre of the metal (in $\text{J} \cdot \text{cm}^{-1} \cdot \text{s}^{-1} \cdot \text{grd}^{-1}$). *Remark:* metals with high thermal conductivity are: silver, copper, gold and aluminium, and with low thermal conductivity: lead and mercury.

Titanium based alloys – alloys with 70-90% titan-Ti, and with small quantities of other metals: aluminium-Al, vanadium-V, niobium-Nb, tantalum-Ta, manganese-Mn, zirconium-Zr and tin-Sn.

Toxicity – the degree to which a substance can damage an organism. Toxicity can refer to the effect on a whole organism, such as an animal, bacterium, or plant, as well as the effect on a substructure of the organism, such as a cell (cytotoxicity) or an organ such as the liver (hepatotoxicity).