

Short Bio-Mecanics Dictionnary

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CONJUNCTIVE TISSUE This tissue wraps-in and separates muscle fibres, acts as supporting material, and helps movements, protects muscles against shocks and too important tension.

MYOFIBRE Scientific name of the muscle fibre. Multiplied thousands of times, it makes up the whole muscle. It is wrapped around by a protective girdle called [conjunctive tissue](#). They are made of fibrils, constituted of thin threads themselves made of proteic molecules. Their size (at adult age) ranges from 10 to 100 angstrom in diameter (with up to 20cm length). At the origin, during the very first stages of embryo development, muscle fibres develop out of undifferentiated cells called myoblasts, which merge into one another. After birth these grow in size but not in number. There is a possibility to regenerate them after an injury, out of other undifferentiated cells called "satellite cells". Yet, generally speaking, if the loss of muscle fibre is too important, it is thanks to hypertrophia (increase in size) that compensation occurs.

ENDOPLASMIC RETICULUM This refers to the sub-partition of cells. It encloses and separates a volume from the cytoplasm. In certain types of muscle fibres, the endoplasmic reticulum of the "smooth" type used to store [calcium](#) is called "sarcoplasmic reticulum" (found in muscle cells). It is in charge of storing and releasing [calcium](#).

MYOFIBRILS They are parallel to one another, and laid in the same direction. A [Myofibril](#) is made of a succession of [sarcomeres](#) which are the minimal muscular contraction unit. These [sarcomeres](#) are laid in chains on the whole length of the fibre.

CYTOSOL This refers to the volume situated between [Myofibrils](#) and the endoplasmic reticulum in which [calcium](#) is released by the [sarcoplasmic reticulum](#) wrapped around [Myofibrils](#). [Cytosol](#) only contains soluble substances. Water amounts generally to around 85 % of [cytosol](#) contents. With its suspended macromolecules in a aqueux and salty environment, it has a viscosity four times more important than that of water and this corresponds to that of a celloïd gel.

SARCOPLASMIC RETICULUM Sarcoplasmic reticulum is the name given to the smooth endoplasmic reticulum found in striated skeletal muscle cells. This zone is a store of Ca²⁺ ions (hence is it called a "calciosome") which are released into the cytoplasm in reaction to a plasma membrane [depolarisation](#), caused by the binding of ACh on muscle cells nicotinic receptors. This increase in [cytoplasmic calcium](#) enables the interaction between [myosin](#) and [actin](#) threads. [Calcium](#) is then pumped (thanks to a "pump" using ADP to operate) back to the sarcoplasmic reticulum.

MITOCHONDRIONS These are organites in charge of breathing: filled with enzymes which transform sugar components and fat into [ATP](#) thanks to oxygene. They thus oxydate carbon and glucose to provide energy. It is at that level that carbon [oxydation](#) reactions occur which produce [ATP](#). It is at that level that occurs glucose [oxydation](#) too. Glucose turns into tiny carbonate molecules called « pyruvate ». Pyruvate is then carried into the mitochondrion matrix, where it is gradually deprived of its carbon and

hydrogene components to then create, among many other things, [ATP](#) and CO₂.

SARCOMERE

This is the minimal unit involved in muscular contraction. There is not length modification involed during a contraction but a gliding of threads one along the other, which creates a general contraction. The [sarcomere](#)'s length is reduced by a roughly 20% margin. The speed of contraction is 15 angstrom/second. The more a muscle is divided into [sarcomeres](#), the more it will give the impression of shortening. During the shortening phase of each [sarcomere](#) there is no shortening of either thin or thick threads, but a gliding motion leading them to overlap one another. This could be compared to a rowboat. At the core of each [sarcomere](#) is found the [myosin](#) molecules, each surrounded on both sides by six [actin](#) molecules. The [myosin](#) molecule is going to connect to [actin](#) outstretching its "arms" and draw them inwards. At the very end of the [sarcomère](#) (on both sides) is an area called "Z Line" which enables [actin](#) molecules to connect, thus ensuring a connexion between each [sarcomere](#) with both the following and preceding one.

MYOSIN

The tip of [myosin](#) molecules moves forward on a distance approximatively corresponding to the diametre of the [actin](#) molecules thread. This bending is made possible by the [hydrolysis](#) of an [ATP](#) molecule which binds onto the tip of [myosin](#). Each [myosin](#) molecule is endowed with a "tip" or "tail" running along its axis and fitted with two globular "heads" ([crossbridges](#)). Two globular heads are thus ready for bindings: one for the binding of [ATP](#) and the other for the binding onto [actin](#). The [crossbridge site](#) is located on each side of the tip of each [myosin](#) molecule and draws [actin](#) molecules threads inward and rearward, thus shortening the whole [sarcomere](#).

ACTIN

The [actin](#) molecule is a globular molecule which combines to others to make up a chain. This chain has a coiling pattern, and constitutes what is known as a "thin" thread. Each [actin](#) molecule owns a binding site for [myosin](#). A thin thread owns thus many binding sites. An [actin](#) molecules thread homes two other ones: the [tropomyosin](#) molecule which coils around it (and, by doing so, physically inhibits the [actin's](#) binding sites) and [troponin](#) molecules (of globular shape) acing as connexion between [actin](#) and [tropomyosin](#). For muscle contraction to begin, the [troponin](#) molecule coiled around [actin](#) must move and thus drag the [tropomyosin](#) molecule away from the binding sites on which [myosin](#) will bind. For [troponin](#) molecules to move [calcium](#) has to fix itself onto them. When this is done, the overall shape of [troponin](#) molecules is modified and this one alters its position, hence dragging [tropomyosin](#) along, which in turns uninhibits the [actin](#) binding site, in turn enabling [myosin](#) to get in contact with it. When [calcium](#) leaves [troponin](#) molecules, they get back to their original location and "push" [tropomyosin](#) back in front of binding sites, and thus prevents muscular contraction to take place.

TROPONIN

Globular in shape, it is both fixed to [tropomyosin](#) (coiled around [actin](#), and right on its binding sites) and to [actin](#). [Troponin](#) molecules function as ball-bearings bearing on a larger "cable" ([tropomyosin](#)) to make it move on [actin](#). [Tropomyosin](#) is usually coiled over most of the [actin's binding sites](#), thus making impossible any contact from [myosin's crossbridging sites](#) to [actin](#), and thus preventing muscular contraction to occur. [Troponin](#) is thus the molecule which, thanks to its movements, indirectly uninhibits or inhibits the [actin](#)'s binding sites by altering the position of the coil of [tropomyosin](#). We are here facing a proces similar to that of a latch. When a set of [calcium](#) ions fix themselves onto [troponin](#) the latter rotates (such as the cylinder of a lock) and this movement drags [tropomyosin](#) away (such as a latch that once kept the door closed), and then uninhibits the binding site for [myosin's](#) molecules' [crossbridging](#).

TROPOMYOSIN This is a long coiled molecule acting as a muscular contraction lock. This molecule is coiled around the thin thread molecule, and is moved away by the motions of another molecule to which it is bound. [Tropomyosin](#) can also be considered as the biological equivalent of a plug-mask or a latch, or more simply, a bit of plastic put on a magnet to prevent connection.

CROSSBRIDGE This is the name given to the end part of [myosin](#) molecules, involved in a binding-deconnecting cycle with [actin](#) binding sites, leading to the shortening of [sarcomeres](#) and thus to the creation of power. This [crossbridging site](#) needs [ATP](#) to function, and uses it to find the energy required to move and fetch the [actin](#)'s binding site, then uses another [ATP](#) molecule again to unhook from it. This is what is known as the [crossbridging cycle](#) : the process is as follows: binding of [myosin's crossbridging site](#) onto [actin's binding sites](#), rearward movement, unhooking of the [crossbridging site](#), followed by a forward movement from it to fetch another [actin](#)'s binding site, etc.

ACTIN BINDING SITE This is the area where connection between [myosin](#)'s molecules' [crossbridging sites](#) and [actin](#) occurs. It is at that level that [myosin](#) binds to [actin](#) to then draw it rearward, thus shortening the [sarcomere](#) and creating a pull-force. These [actin](#)'s binding sites are generally inhibited by a molecule called [tropomyosin](#), coiled around [actin](#), which makes muscular contraction impossible as long as it has not withdrawn.

"A" LINE This refers to the division of [myofibre](#) corresponding to the [sarcomere](#).

"H" LINE This refers to the central zone of [sarcomeres](#) : This is the area where one can only find [myosin](#), the area towards which [actin](#) threads will be drawn during muscular contraction. Each [myosin](#) molecule is surrounded by [actin](#) molecules, and when these are drawn inwards by the action of [myosin](#) this movement occurs in the direction of [myosin](#)'s center, or "H-line".

"I" LINE This is the opposite zone to that of the "H-line", that is to say the area where only [actin](#) molecules are to be found, at the end of [sarcomeres](#); it is at that level that inward movements begin.

"Z" LINE This is the area between two [sarcomeres](#) : it is at that level that muscle stretching occurs. When a muscle stretches because of a weight beyond its contractile power, [sarcomeres](#) do not stretch, but the only "elastic" zone does, and it is that between them, called "Z-line".

CALCIUM [Calcium](#) is a fundamental ion for cell functioning. It is indirectly responsible for the "opening" of the [actin](#) molecules binding site, enabling [myosin](#) molecules to bind to them. This opening happens when [calcium](#) fixes itself onto [troponin](#) and, by doing so, alters its general shape, in turn forcing [troponin](#) to settle back, which in turn again triggers a change in [tropomyosin](#) molecules position, that previously inhibited that [actin](#)'s binding site. [Calcium](#) is released from stores located around [Myofibrils](#) ([sarcoplasmic reticulum](#)). It gets fixed on [troponin](#) thanks to electrical phenomena.

LACTIC ACID Lactic acid is the by-product of muscle glycogene consumption. Glycolysis (sugar muscle consumption to create energy) can either be done in a sufficient/non-sufficient oxygene environment (aerobic/anaerobic environment). In the case of aerobic glycolysis this consumption of sugar occurs at the level of mytochondrions, which will completely consume lactic acid indirectly produced. In

the case of an effort without enough oxygen provided, sugar consumption occurs into the cytoplasm and lactic acid can not be eliminated thanks to perspiration.

ADP When an [ATP](#) molecule is [hydrolysed](#) (dissolved into water) it "breaks apart" into an ADP element on the one hand and into a Phosphate element on the other hand, and releases energy. The coupling back of these two elements makes the regeneration of [ATP](#) possible, but it will require the same amount of energy to do so.

ATP Molecule with very energetic atomic links. This is a very energetic phosphate compound. This molecule is used to produce energy. Its breaking up by water (hydrolysis) releases energy (around 30kj/mol), and its synthesis consumes the same amount of energy. ATP Hydrolysis gives an ADP molecule and a phosphate compound.

ACH Neurotranmeter.

HYDROLYSIS Action of water cutting molecules and releasing chemical energy (in the case of [ATP](#) hydrolysis). The basic idea is to disrupt molecules to release energy.

PHOSPHORYLATION occurs when a compound such as ADP becomes [ATP](#). This is the reverse phenomenon of hydrolysis. Energy is here used to merge instead of disrupting.

OXYDATION When [ATP](#) loses an electron, captured by another molecule.

POLARISATION Either loss of electrons (becomes positive) or electron addition (becomes negative).

MOTOR NEURON Transmitting the message of [Calcium](#) release. These are nerve cells the [axons](#) of which divide into branches connecting to a maximum of [myofibrils](#). The more [axons](#) within [myofibres](#) receiving [calcium](#) release messages, the more [sarcomeres](#) contractions will occur, and so the most powerful will contraction be.

AXON This is the unprotected end of motor neuron (unprotected by any girdle), the one in charge of transmitting information via a neurotransmeter. As an electric cable, it corresponds to the end part, where the wires are left unprotected for connection.

MOTOR END PLATE The Motorneuron + [myofibre](#) unit is referred to as a « [motor end plate](#) ». This is the zone on which connection between the nervous system and the muscular system occurs. At the level of [myofibres](#), in the groves of the plasma membrane surface (protecting [Myofibrilles](#)) we can find a « [motor end plate](#) » where motor axons bind. At the level of [axons](#) ends are vesicles releasing a neurotransmitter ([Ach](#)). When the action potential binds to the [motor end plate](#) it [depolarises](#) the plasma membrane thus opening the ducts releasing [calcium](#). These ducts are said to be "potential-dependant", because they need an action potential to move. This [calcium](#) hence released will enable the release of a

neurotransmitter called [Ach](#) binding onto the [motor end plate](#) and transmitting an action potential again. The [motor end plate](#) carries an enzyme (choline) which will use the connection to go up the axon end and be used to create another [Ach](#). As a home electric connection, this would correspond to the electric "contact" parts.

MOTOR UNIT This is the name given to the MotorNeuron--[myofibre](#) system: since each [motor-neuron](#) is connected to a muscle fibre, the complete muscular contraction is the fruit of the simultaneous action of these independant networks of connection: many [motor-nerons](#) will simultaneously stimulate the [myofibre](#) to which they are linked and the sum-total of these stimulation-contraction phases of each single motor-unit will create power. Computed to an internal combustion engine, the [motor unit](#) would roughly correspond to the combustion chambre - sparking plug unit; the sparking plug is the motor-neuron bringing up information, and the [myofibre](#) would be the combustion chamber where chemical reactions occurs, leading to the creation of power. The simultaneous involvement of each plug-chamber system ([motor unit](#)) creates our movements.

ACTION POTENTIAL This is what is usually refered to as "nerve influx", which is in fact made up of a series of action potentials. This corresponds to a change in cell polarity. These are ions (potassium, sodium) which are at the origin of such electric potential difference between the inside and the outside of a cell. The [action potential](#) is made up of a series of events: first occurs a short-lived and local [depolarisation](#), followed by an increase in internal membrane potential, and finally by a repolarisation of the internal membrane. An [action potential](#) lasts between 2 and 3 milliseconds.