“The movement, the motor system, muscles and nervous”
The movement, motor systems, muscle and nerves

Motor systems, including muscle function and nervous reflexes related to the movement
Movement is a very important phenomenon to understand.

We know that time has passed, because things in place, moved.
In physics, the movement is the change in spatial position of an object or material point in time.

In the world described by relativity physics, the movement is nothing more than the change in position of a body on a point called "anchor".
The motor system uses information from the sensory system to select an appropriate response and make adjustments on the move.

The motor system has three levels that are organized hierarchically and in parallel:

- Marrow
- Brainstem
- Cerebral cortex (motor area)
Marrow

Automatic movements, stereotyped and reflections
Brainstem

Controls:

– Breath
– Cardiovascular system
– Gastrointestinal function
– Stereotyped movements of the body
– Balance
– Eye Movements
Cerebral Cortex

- The outermost layer of the brain;
- Rich in neurons;
- Local neuronal processing more sophisticated and distinctive;
- Responsible for carrying out movements;
- Plays a central role in complex functions such as memory, attention, consciousness, language, perception and thought.
Cerebellum

- It is the area responsible for the accuracy of the movement. Acts in the brain stem and cortical motor areas.
- The cerebellum needs to learn a sequence of movements so you can run the patches.
Muscles convert energy into motion.

They do the same thing as a car engine or an electric motor, although they work differently.
Muscles are the tissues responsible for movement. Without muscles we are unable to *open the mouth*, speak, *walk*, *smile*, or even *digest food*.

We could not move anything inside or outside the body. In fact, without muscles, could not live more than a few minutes.

**How many muscles have?**

On average, 40% of body weight is muscle.

The human body has over 630 muscles.
The property of the muscle tissue to contract is called the *contractility* and the property it can be stretched is called *elasticity*.

Muscle contraction occurs with the output of an *electrical impulse* from CNS to the muscle that is conducted through a nerve. That electrical stimulation triggers the *action potential*, resulting in *calcium* (necessary for contraction) inside the cell and *potassium* out of it.
There are three types of muscle:

- Skeletal muscle
- Cardiac striated muscle
- Smooth muscle
A nerve is a structure similar to a cable, consisting of axons and dendrites. The origin or termination of the spinal cord nerves has relation to its function. The polio virus causes lesions in the ventral root of spinal nerves, which leads to paralysis and muscle atrophy.
Afferent nerves carry sensory signals (skin or sense organs, for example).

They are known as action potentials: fast-conducting electrical impulses, which usually begin in the neuron cell body and spread rapidly through the axon to its tip or "terminal".
Nervous System

- Sistema Nervoso
  - Sistema Nervoso Central (SNC)
    - Telecéfalo
    - Diencéfalo
    - Mesencéfalo
    - Metencéfalo
    - Mielencéfalo
  - Encéfalo: Cérebro, Cerebelo, Tronco cerebral

- Sistema Nervoso Periférico
  - Sistema Nervoso Autônomo - SNA
    - Cérebro
    - Mesencéfalo
    - Cerebelo e Ponte
    - Bulbo
  - Sistema Nervoso Somático - SNS
    - Movimentos Involuntários
  - Sistema Nervoso Autônomo Simpático
  - Sistema Nervoso Autônomo Parassimpático
  - Sistema Nervoso Autônomo Entérico
- The autonomic nervous system is divided into the **sympathetic nervous system** and **parasympathetic nervous system**.
  In general, these two systems have **opposing functions** (antagonistic).
  One corrects the excesses of another.

- Example:
  If the **sympathetic system** accelerates the heart beat too, the **parasympathetic system** kicks in, reducing the heart rate.
Parassimpático

- Contraí a pupila
- Estimula a salivação
- Reduz os batimentos cardíacos
- Contraí os brônquios
- Estimula a atividade do estômago e do pâncreas
- Estimula a vesícula biliar
- Contraí a bexiga
- Promove a ereção

Simpático

- Dilata a pupila
- Inibe a salivação
- Relaxe os brônquios
- Acelere os batimentos cardíacos
- Inibe a atividade do estômago e do pâncreas
- Estimula a liberação de glicose pelo figado
- Estimula a produção de adrenalina e noradrenalina
- Relaxe a bexiga
- Promove a ejaculação
Nervous system

• Set of nerves, ganglia and nerve centers which provide command and coordination of vital functions.

• Neurons:
  o Structural and functional units of the nervous system
  o Highly specialized cells in electrical signaling over long distances.
Somatic motor nervous system

- Transduction of neuronal signals in contractile force that are manifested in the form of movements and body posture.

- Motor system: all the structures (muscle fibers and neurons) involved in motor function.

- All the commands for movement is transmitted to the muscles by motor neurons (α and γ).
Motor unit

- Motor neurone + muscle fibers innervated by it.
- It is the smallest unit of force that can produce movement.

A muscle is composed of different types of muscle fibers --»»» is controlled by more than one motor neuron.
Neuromuscular junction
The musculoskeletal system: lower limb muscles
The musculoskeletal system: bones of lower limb

- Coxa
  - Fémur
  - Tíbia
  - Perônio

- Pé

- Anca ou cintura pélvica
  - Ilíaco

- Tarso (7 ossos)
- Metatarso (5 ossos)
- Falanges (2 ossos no dedo grande e 3 nos outros dedos)
The musculoskeletal system: Joints
And when some of these failure mechanisms???

What is the solution???
Prostheses

Prosthesis is the artificial component which aims to meet the needs and functions of individuals with sequel of amputations, traumatic or not.
• When a person loses a limb, is put in place a mechanical prosthesis.
• This prosthesis should respond to any nerve impulse, making it the ideal replacement, with the advantage of being more resistant.
The prostheses can also be built to replace bone joints.
PROSTHESSES

- a prosthesis is something that will replace a body part;
- the types of materials more used in prostheses are:
  - endoskeleton (tubular frame that supports the weight, coated externally by flexible foam);
  - exoskeleton (made of wood or plastic - conventional prostheses).
**ENDOSKELETON PROSTHESIS**

- Can be used for all levels of amputation, with the exception of amputation partial foot and ankle;
- The materials used can be found in steel, titanium and aluminum;
- The dentures are considered superior to endoskeleton under the conventional point of view function and cosmetics, especially in the dislocations of the knee and hip and transfemoral amputations;
- Adapters rotation and torsion can be used in prostheses endoskeleton seeking greater freedom of movement and comfort of use, respectively.
ENDOSKELETON PROSTHESIS
ENDOSKELETON PROSTHESIS

• The walls of the prostheses exoskeletons provide, in addition to sustaining the aesthetic finish;

• Can be used for all types of amputations, but for some levels, it is recommended the use of modular components, for example, in patients with transfemoral amputations, dislocation of the knee and hip;

• Can be made of wood or plastic, are simpler and do not allow patients to carry out more sophisticated activities;

• We can cite as advantages of the exoskeleton strength, durability and low maintenance of the prostheses, however, we find an aesthetic disadvantages as less pleasant, less choice of components, realignments difficulty and impossibility of rapid exchange of components.
EXOSKELETON PROSTHESIS
The Human Gait

- Set up cycles;
- The unity of this cycle is defined by ‘stride’

Criteria

- Musculo-skeletal integrity;
- Neurological control;
- Balance;
- Locomotion.
Definition and Stages

Phases:

• Period since the contact of one foot on the ground until the next contact of the same foot;

Phases:

• Stance phase
  » foot in contact with the floor

• Swing phase
  » foot with no floor contact
When it comes to walking and running, humans are still much more effective than nowadays robots.

Our tendons and muscles are able to store and release when necessary, up to 40% of the energy we use to walk.
Basic blocks of a mobile robot
✓ excessive expenditure of metabolic energy;
✓ reduced speed of locomotion;
✓ disparate movements desired;
✓ impossible to maintain body posture;
✓ alignment of the spine and pelvis is destroyed.
Robots

Use engines

You can ride a "human" but there is great energy consumption and heavy weight of the robot

- The actuators are used but have limited accuracy;
- The work with this spring is the future in the area of locomotion.
Modern robotic prosthesis, such as the ones of MIT, are some of the most advanced projects that provide:

- Comfort;
- Natural way of walking;
- Better balance;
- Less fatigue.

✓ It uses a spring system driven by an engine that mimics the functioning of the tendons of the foot.
Natural Dentures require up to 30% more energy on the floor in the walking process.

The new prosthetic robotic stores energy produced by the person by projecting forward in the act of walking.

This energy is then released when the body now moves to a position in front of the foot, driving the person.
ASIMO

- This robot tries to imitate the *human being* and have already had a long evolution;
- Nevertheless, it is still far to reproduce a *human* accurately.
ASIMO

- Able to detect and overcome obstacles;
- Running at a speed of 3 km/h - it has advanced sensors and balancing mechanisms;
- It measures 1.30 meters high and can run for 1 hour.

HONDA
The Power of Dreams
Thank you!

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Walking aid device designed to give more mobility to the elderly and avoid the fatigue of workers who need to spend much time standing.

The equipment has a seat, like the saddle of a bicycle. An intelligent mechanism drives the force of auxiliary equipment for the center of gravity of the person controlling this force in a fully synchronized manner.
Knee of the C-Leg is equipped with a microprocessor that adjusts the hydraulic systems according to the type of activity which is exerted by the user.

Incorporates its own power supply, sensors, actuators and a computer with an artificial intelligence program that allows patients to walk naturally and safely.
Once the implant detects the contact with the ground through sensors, it frees the motion at any flexion angle, conveying the sense of utter stability.

Additional torque sensors ensure that the movement will not be caught or is exaggerated, allowing a natural rhythm of walking.

The complex set of sensors ensures that the actuators of the prosthesis will always be operated in full measure.

**AI Program focuses on security and stability**
• Allows walking faster without increasing fatigue;
• Restores dynamics for level ground walking;
• Provides capability to climb a flight of stairs foot over foot;
• Allows sitting down and standing up from a chair more efficiently;
• Reduces pressure at the stump and skin injuries;
• Ensures natural gait which provides a normal posture and a significant reduction of back pain incidence;
• Increases the overall locomotion speed;
• Ensures capability to perform tasks previously impossible