DESCRIPTION OF THE TOPICS

Fluid and biological flows

This theme focuses on understanding the role of fluids and structures involved in the dynamics of biological flows. The associated translational research applies these innovative concepts for diagnostic or prognostic purposes. This field of research generally includes:

- Flow dynamics at the macroscopic and microscopic scales
- Interaction of organs, tissues, and cells in contact with biological flows
- Medical devices interacting with biological flows

Cellular biomechanics and mechanobiology

This theme aims to develop a fundamental understanding of biomechanics across a wide range of length and time scales, from the molecular to the cellular level. It specifically includes the following areas:

- Biomechanical characterization and simulation of cells, membranes and subcellular structures.
- Effects of the environment on cellular and/or molecular response.
- Regenerative medicine.

Tissue Biomechanics

This research area focuses on imaging, characterizing, and modeling soft and hard biological tissues. It also encompasses developing and characterizing prosthetic materials and their interactions with biological tissues. Key topics include:

- Study of the mechanical properties of biological tissues (using ex vivo and in vivo characterization methods) and their evolution (growth, remodeling, etc.)
- Study of hard and soft tissues (bones, teeth, cartilage, tendons, muscles, fat, etc.)
- Numerical modeling and simulation (deformable bodies)
- Substitute and repair materials

Injury biomechanics and traumatology

This topic covers all areas of research devoted to understanding and modelling injury mechanisms, using all types of experimental and numerical approaches. All energy levels and boundary conditions can be considered, for the study of all types of injuries and traumatologies. Considering loads, the effects of geometry and material properties, but also physiological and cognitive parameters, muscle contractions or neuromotor control, it is interested in various fields such as:

- The capacity of the human body to withstand a shock with short application times (dynamics undergone)
- Potentially injurious human movements (subject actor of his movement)
- Movements and positions in constrained quasi-static environments

Methodological approaches for motion analysis

This theme encompasses research dedicated to the development and validation of biomechanical methods and models for the study of human or animal movement at the multibody scale. This concerns in particular:

- Kinematics and dynamics modeling
- Data acquisition methods for kinematics, forces, and electromyography
- Musculoskeletal modeling (rigid or deformable) at the multibody scale
- Motion simulation / optimal control

Biomechanics of Normal and Pathological Movement

This theme focuses on the analysis and evaluation of locomotion, balance, and grasping in populations (human and animal), with and without impairments. It particularly addresses:

- The study of mechanisms and impairments involved in various activities such as locomotion, maintenance of balance, and grasping.
- The proposal, optimization, and evaluation of preventive, surgical (orthopedics, neurosurgery, etc.), and rehabilitation interventions, including assistive technologies (wheelchairs, prostheses, orthoses, etc.).
- The measurement, analysis, and simulation of biomechanical movement impairments and compensatory strategies; and the development and validation of clinical assessment methods.

Sports and Arts Biomechanics

This theme encompasses all research applying the laws of mechanics to sports and artistic movements, with the primary goal of improving the understanding of gestures, enhancing performance, preventing injuries, or facilitating return to practice. This theme particularly includes the following areas:

- Analysis of sport and artistic gestures using multi-segmental or integrated methods
- Relationship between the mechanical properties of muscles, tendons, or bones and joints, and performance or injury risk in athletes or artists
- Motor control and simulation of sports gestures
- Interaction between the athlete or artist and their equipment or environment

Biomechanics of human–system interaction, ergonomics and robotics

This theme addresses interactions between humans and any physical system, with a focus on ergonomics and robotics. It includes, in particular, the following areas:

- Analysis of physical interactions between humans and mechanical systems (such as collaborative robots, rehabilitation robots, passive or active exoskeletons)
- Design, control and actuation of anthropomorphic and/or bio-inspired robotic structures aimed at reproducing human or animal motor function (locomotion, grasping, dexterous manipulation, etc.)
- Evaluation and optimization of devices and techniques intended to reduce the incidence of musculoskeletal disorders from an ergonomic perspective