



# REGENHAB



**Regeneration and Rehabilitation to Restore Mobility in diseases with musculo-skeletal tissue dysfunction**

**Coordinator: C Jorgensen**

**Deputy Coordinator: A Lacampagne**

# RATIONALE

---



- ✓ Movements are essential for life.
- ✓ Reduction in mobility as in sarcopenia associated with aging, muscle dysfunction or osteoarthritis is associated with reduced quality of life as well as life expectancy.
- ✓ restoring impaired tissues and organs function requires concerted strategic efforts between clinicians and basic scientists.
- ✓ full movement recovery needs an optimized rehabilitation program associated with innovative regenerative stem cell biology, robotics, as well as non-pharmacological medicine.

# Objectives : RESTORE MOBILITY



Improve mobile organ function  
Assess movement  
Improve clinical rehabilitation of mobile tissues

Stem cell biology



Robotics, electrostimulation  
Implantable medical device

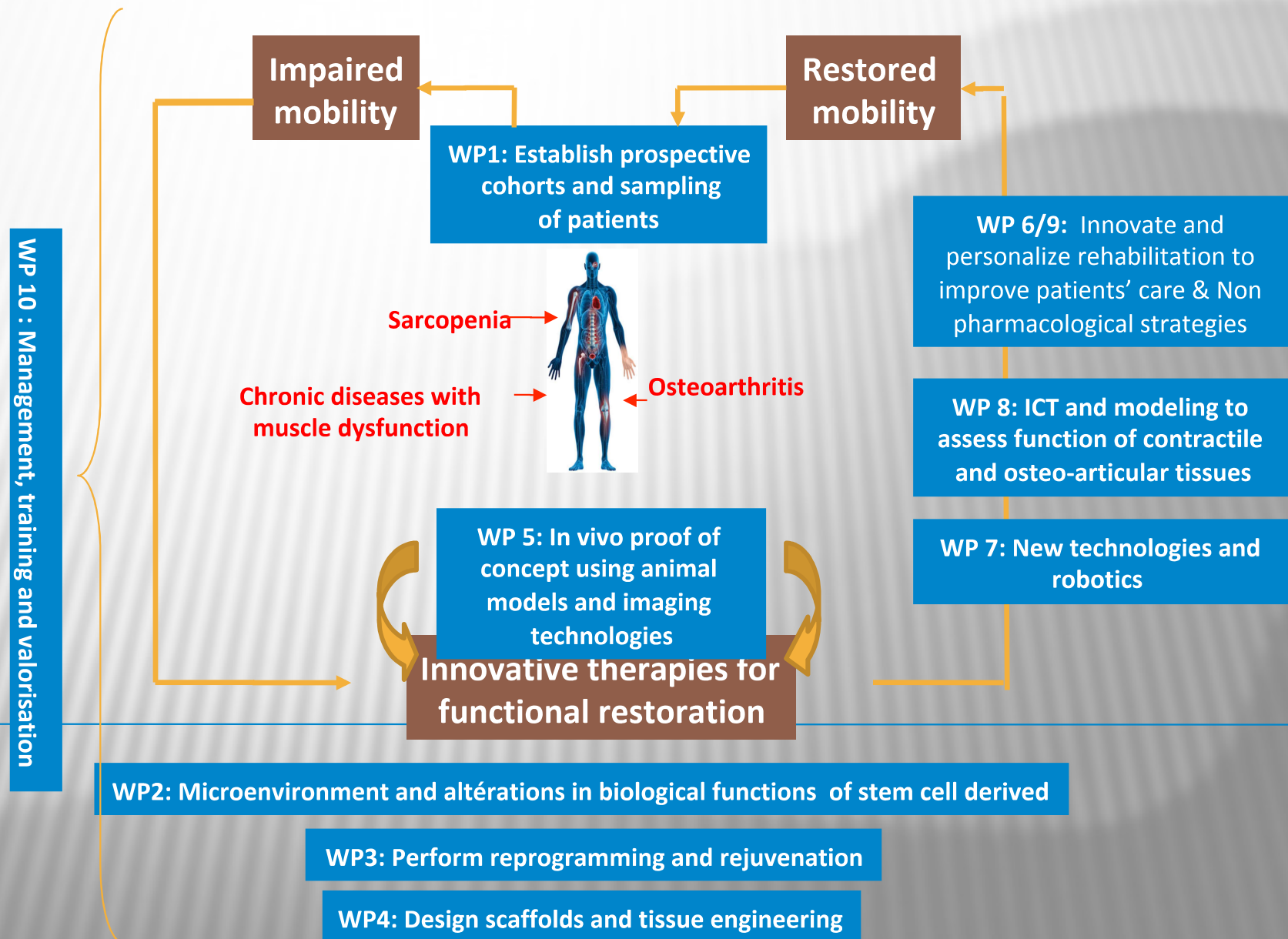
Scaffolds,  
Smart biomaterials for mobile tissues  
Tissue engineering muscle & cartilage

# Objectives : RESTORE MOBILITY

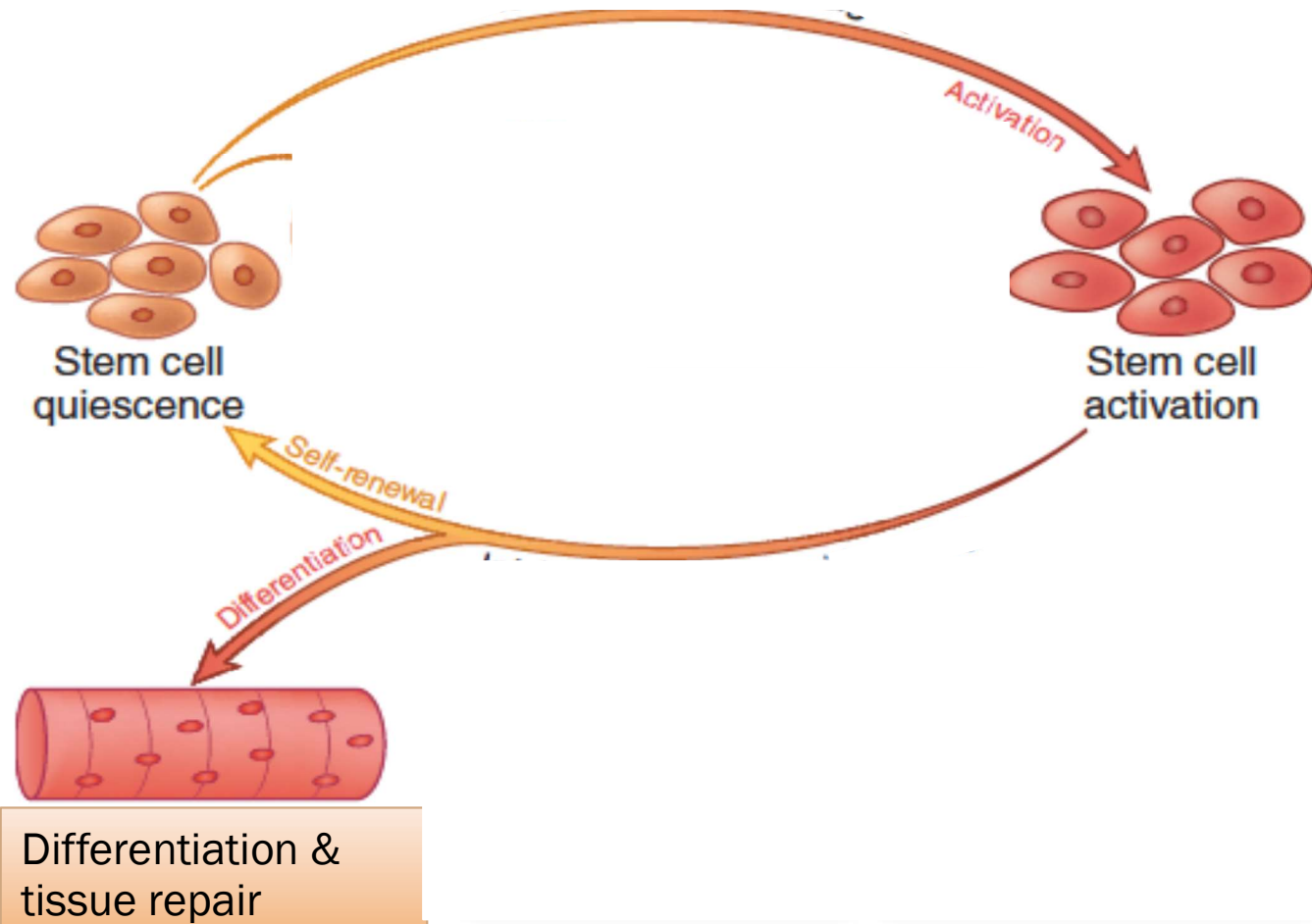


- Identify pathways associated with loss of function of stem cells in **muscle** and **cartilage** diseases.
- Identify new targets for muscle and skeletal tissue regeneration in preclinical animal models,
- Develop **biomaterials** adapted to mobile tissue
- Develop *new assistive technologies* for rehabilitation
- Develop tools to *model movement* in muscle dysfunction and OA
- **Translational research** applied to muscle dysfunction, osteoarthritis (MSC based therapy)
- Propose *new strategies for patient's rehabilitation* based on ICT and movement modelling

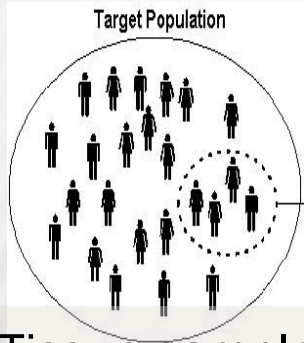
# WORKPLAN of ReGenHab



# PROJECT : Musculo-skeletal Stem cell biology: understand stem cells microenvironment

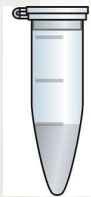


# PROJECT : Musculo-skeletal Stem cell biology: understand stem cells microenvironment



Cohorts:  
 CKD  
 ROAD  
 FSHD  
 DIAGSTOLE

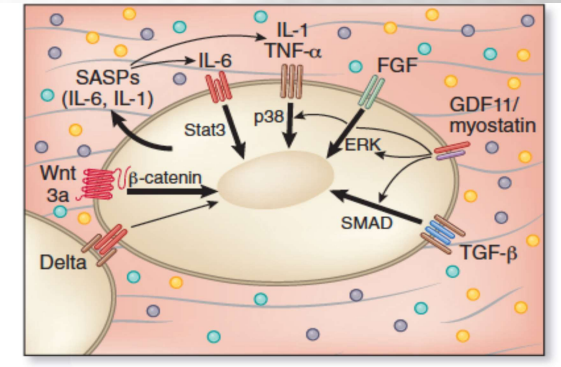
Tissue samples  
 (adipose, muscle)



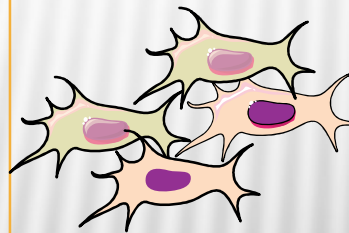
- .Elderly
- .OA
- .Muscle dysfunction

## Extrinsic changes

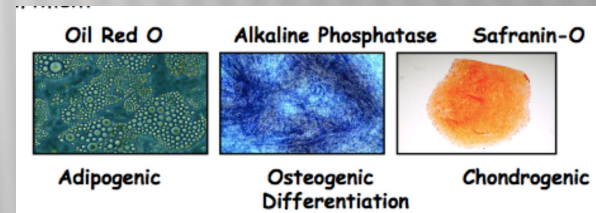
- .Cytokines
- .ROS
- .Growth factors
- .Insulin



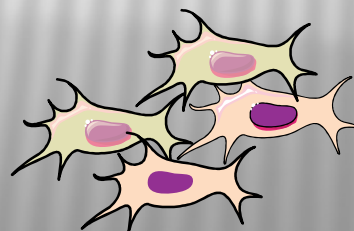
## Intrinsic abnormalities of progenitors



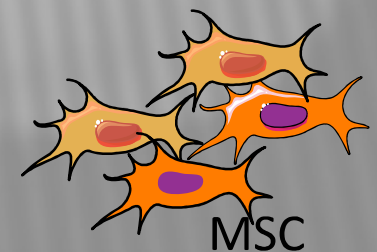
- .Functions
- .Epigenetics
- .Transcriptome
- .Cell metabolism



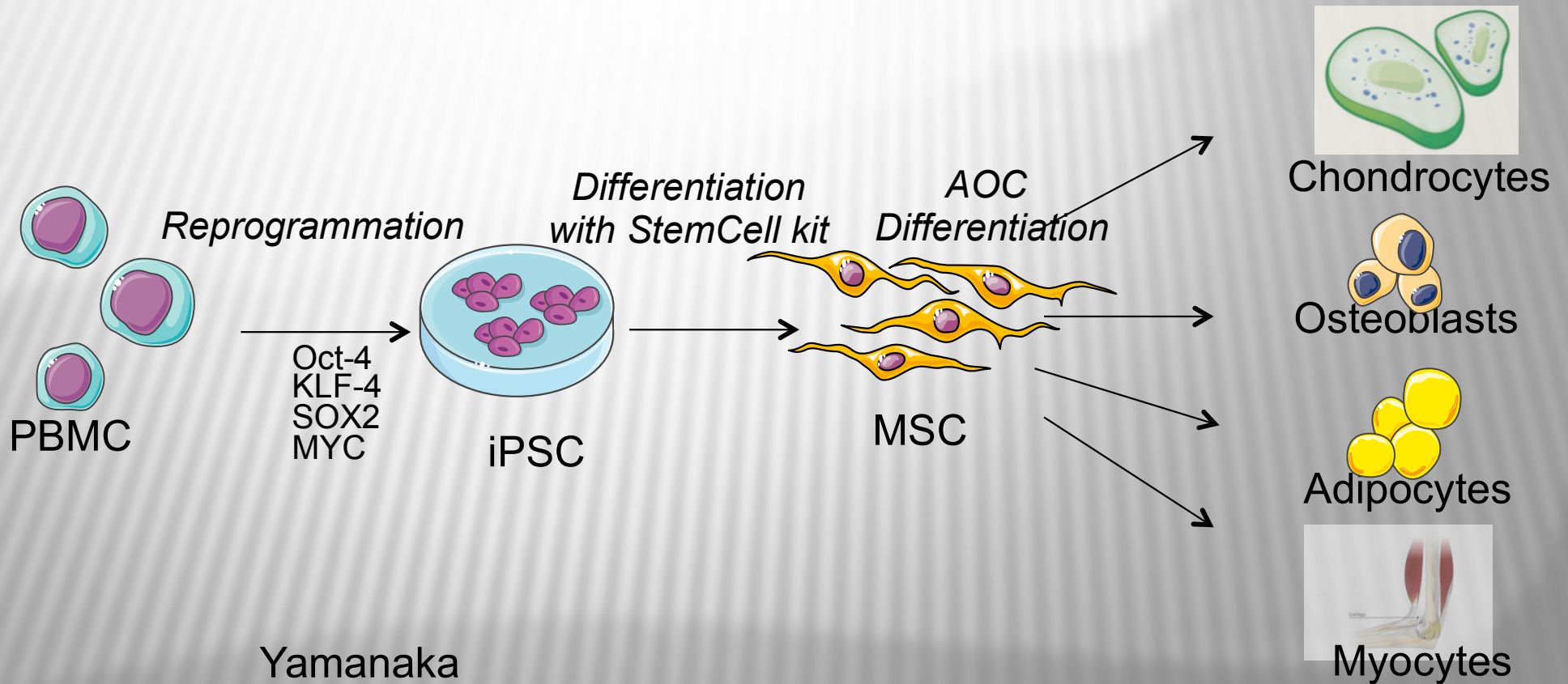
## Reprogramming, modelisation



Oct4, Sox2, Klf4, c-Myc  
 + Nanog, Lin28



# iPS as a source for MSC

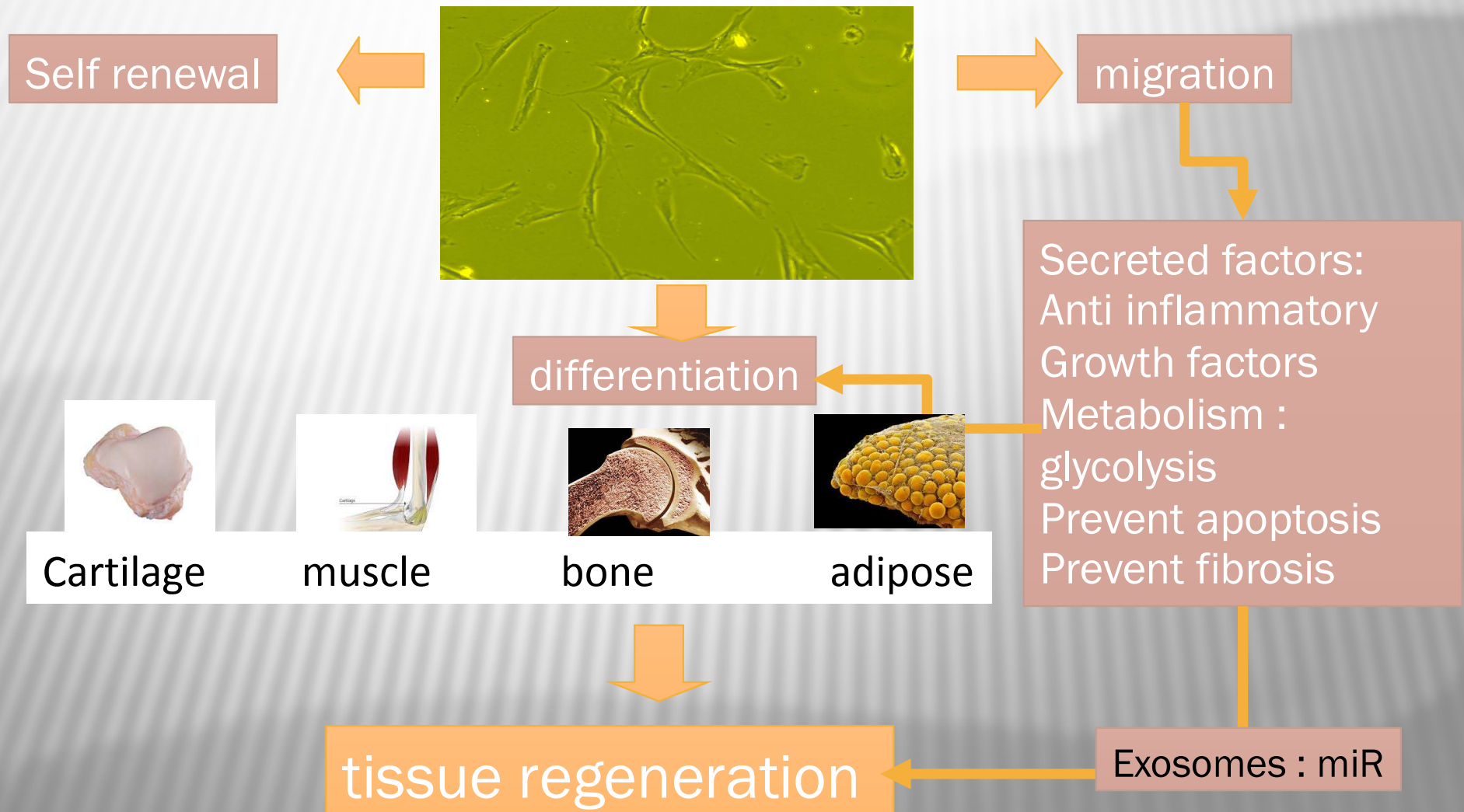


Yamanaka

Cellules souches pluripotentes induites (IPS)



# IMPROVE CARE: IMPROVE PATIENTSCARE THROUGH MSC FOR CELL MEDIATED THERAPY



# PROJECT: ROBOTICS WITHIN REGENHAB



## DEXTER research group

### Develop **COMPLEX** and **INNOVATIVE** robotic systems :

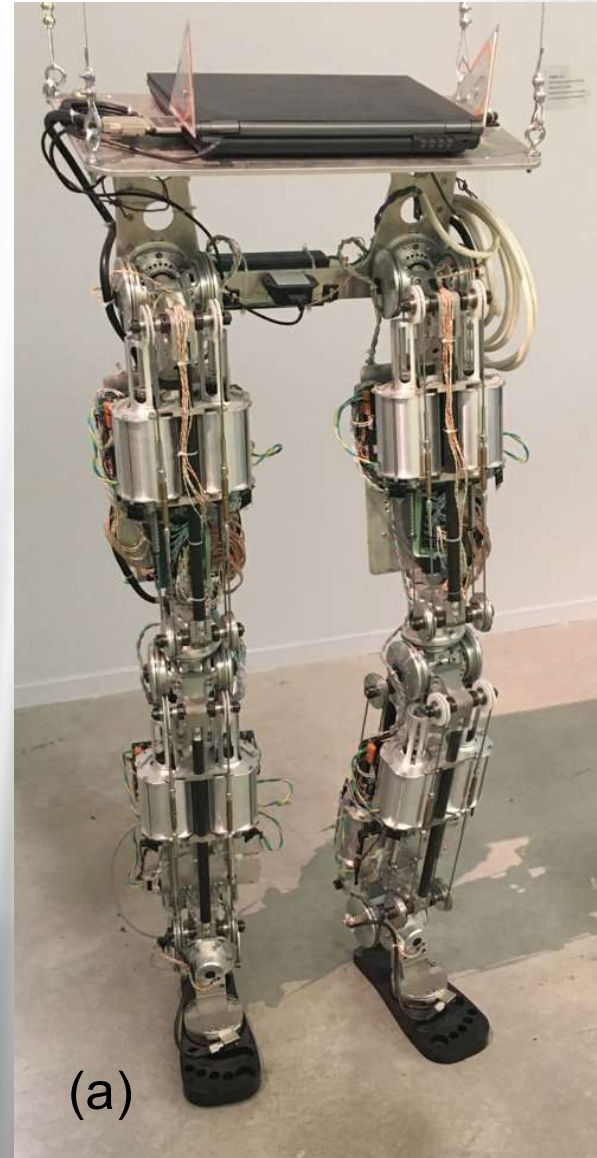
- for rehabilitation
- daily living including exoskeletons,
- brain computer interfaces,
- actuated prostheses
- Design/prototyping

### Key strengths

- Innovation
- Prototyping
- Transfer
- System interaction

### Realizations/Experience

- fully backdrivable walking machine
- low energy assistive system
- intelligent locking prosthetic device



(a)

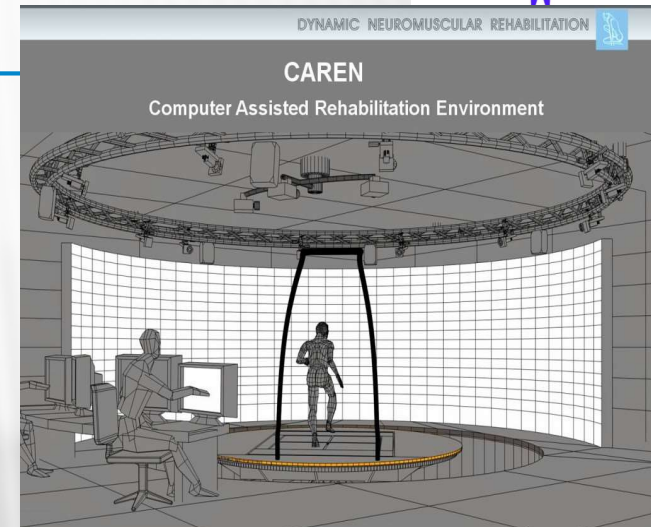


(b)



(c)

# IMPROVE CARE: Innovate and personalize rehabilitation.



- ✓ Develop tools to *model movement* in muscle dysfunction and OA
- ✓ *Rehabilitation programs* to recover movement using sensori-motor and behavioral approaches
- ✓ Integrative programs dedicated to home based located strategy.
- ✓ Innovation: development of rehab. programs including exercise training, electrostimulation, *serious game-interaction*
- ✓ Individualized rehab. programs using *ICTs facilitating tele-monitoring and assistance* and collaborative self-management approaches after tissue repair of muscle or cartilage

# REGENHAB: improve patients care



combine stem cell & assistive technologies

mobile & connected scaffolds + cells

iPS derived MSC

CRISPR/CAS technology

MSC engineering

Mesenchymal stem cells : adult stem cells

# REGENHAB PARTNERS / CONSORTIUM

**EUROMOV**

**LIRMM**  
Laboratoire d'Informatique de Robotique et de Microélectronique de Montpellier

**UMR INRA 866**  
Muscle Dynamic & Metabolism

**IRMB**  
UMR Inserm 1183  
I.R.M.B. FOR REGENERATIVE MEDICINE & BIOTHERAPY

**UMR 1046, PhyMedExp.**  
PHYSIOLOGIE & MÉDECINE EXPÉRIMENTALE  
CŒUR MUSCLES MONTPELLIER

**Univ. Hospital. Cohorts & functional evaluation**

**ICG Montpellier**

**IBMM**  
Institut des Biomolécules  
Max Mousseron

**Equipe "Matériaux Avancés pour la Catalyse et la Santé" UMR 5253**

**IBMM Institut des Biomolécules Max Mousseron**  
UMR CNRS 5247



**IRMB**  
INSTITUTE  
FOR REGENERATIVE  
MEDICINE &  
BIOTHERAPY

- Scientists & physicians: 18 CR/DR Inserm & CNRS, 19 HU, 30 students
- Engineers & technicians: 29 & Staff management: 10
- Participation to national initiatives including **Labex**, and 2 **Infrastructures of excellence**
- **80+ publications since 2013 / 4 patents**
- **3 EU projects FP7, H2020**

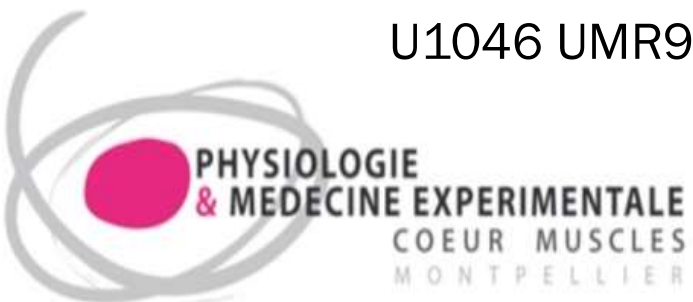


*Institut de recherche de médecine régénératrice et de biothérapie de Montpellier*

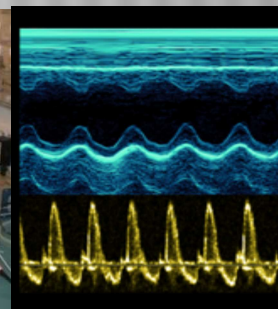
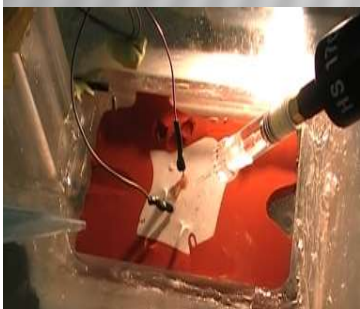
  
I.R.M.B.

1. **Adult mesenchymal stem cell tissue homeostasis and regeneration**
2. **Genome and stem cell plasticity in development and ageing**
3. **Genetic and immunopathology of inflammatory osteoarticular diseases**
4. **Lymphocytes differentiation, tolerance and metabolism: basis for immunotherapy**

U1046 UMR9214



18 Researchers/48 Teachers Researchers  
and clinicians  
19 PhD students/4 post-doc  
18 Technicians and engineers  
> 400 papers and 10 patents between  
2010-2013





# *EuroMov: Research, Technology & Innovation in Movement Sciences*



- 70 researchers (3 IUF members) / 15 entrepreneurs
- Interface between Health and Technology (Mines Telecom)
- 180+ publications since 2013 / 3 patents
- 7 EU projects (3 in coordination) / 4 ANR projects
- LABEX NUMEV (Health team) / FHU REGENHAB





- design and development of neuroprosthetic solutions for sensorimotor deficiencies / improving the functional evaluation and/or quality of life

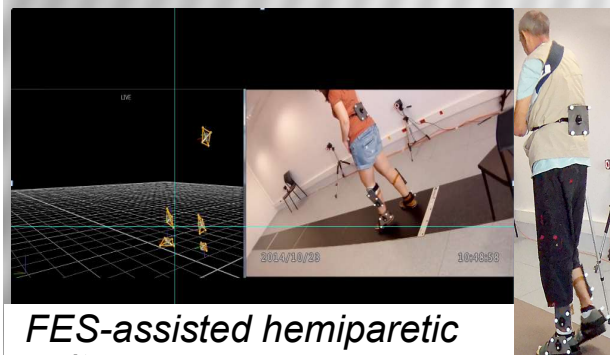
- exploration and understanding of the origins and control of movement
- movement assistance and/or restoration.



*FES-assisted cycling in SCI subject*



*Robotic hand EMG interface in tetraplegic subject*



*FES-assisted hemiparetic gait*



*FES-assisted Transfer in SCI subject*

# WP 10 : Training educational initiatives

## Students supervising

- PhD: 70 HDR
- CIFRE
- master2

## Patient education:

- iCare: app & ICT for active follow up of patients with chronic inflammatory diseases
- Interactions with patients associations

ED CBS2

ED 463 SMH

ÉCOLE  
DOCTORALE  
Sciences du  
Mouvement  
Humain



## Congress & seminars organisation :

- Regenhav biannual interdisciplinary meetings
- EULAR study group cell & gene therapy
- IMID meeting organization board
- European workshop OrthoCells
- Annual IRMB seminars regenerative medicine & Immunotherapy

## Teaching:

- first and 2d cycle medicine : medical therapy, rheumatology & human genetics, rehabilitation
- Masters
  - **Master IDEFI TIL Gerontology** (C Jeandel)
  - **Master Biologie Santé** parcours:
    - Médecine expérimentale et régénératrice (JY Le Guennec/ A Sultan).
    - Métiers de la santé associés à la Recherche (Ch Jorgensen/MC Picot)
    - Génétique, épigénétique (M Koenig, M Cossée)
  - **Master Ingénierie de la Santé:** dispositifs médicaux (X.Garric)
  - **Master SMH: Sciences du Mouvement Humain** (S Perrey).
  - **Master STIC** (M Hayot)