

# Pimp Your Ride: a Futuristic look at Bioengineering the Human Body



John Min and Maurizio Fazio  
DayCon 2016



Photo by MichaelGaida (left), Diapicard (right)– CC



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# Part 1- Fixing the broken old car: Stem cells and 3D printing technologies



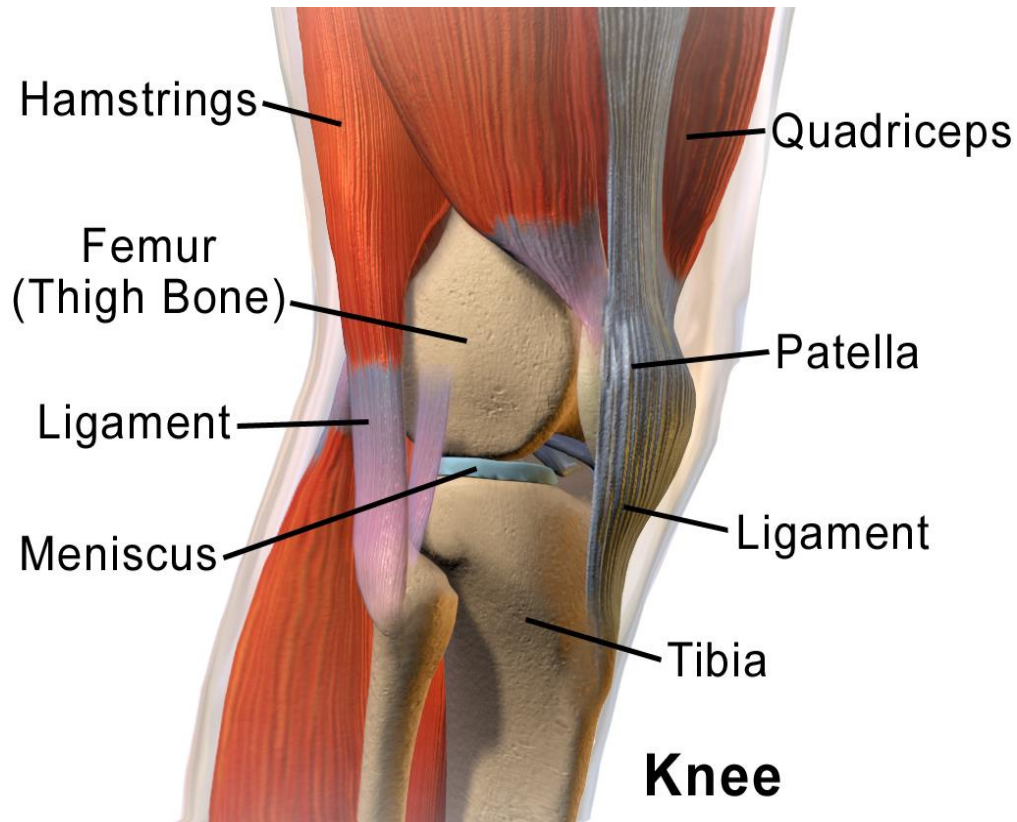
- Wear and Tear → Aging
- Car accident → Acute trauma

## Part 2 - Increasing your car's performance: Bionics and exoskeletons



Photo by MichaelGaida (left), William Hoiles (right)– CC

# A common example: the knee joint



- Sport Injury
- Arthrosis

# Surgery doesn't sound too bad, right?

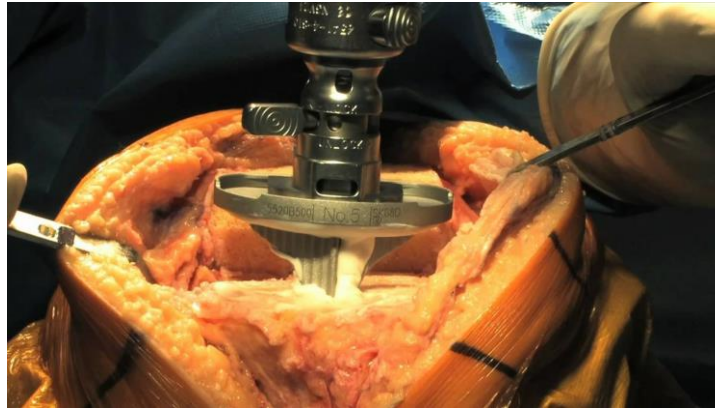


# Surgery doesn't sound too bad, right?

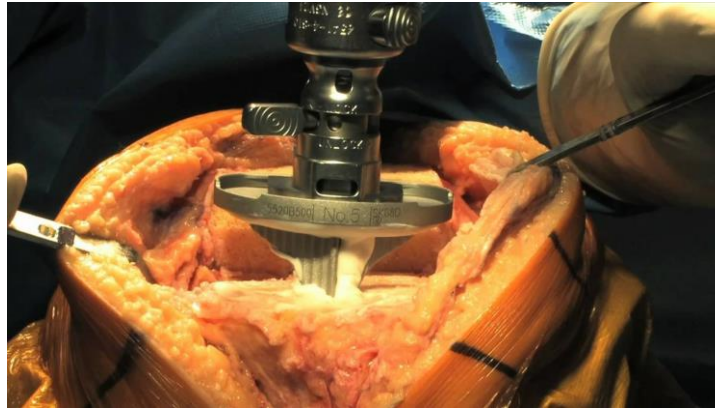




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# Why care?

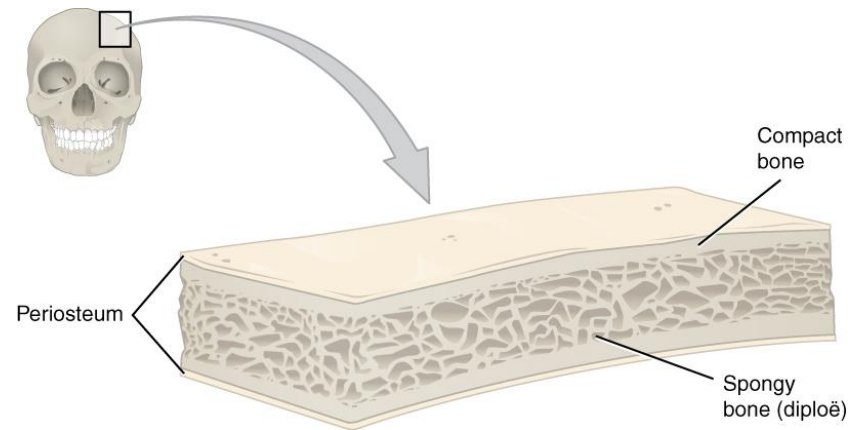
- 10% lifetime risk of Total Knee Replacement
- ~720.000 Arthroplasty per year (~ 5% of all surgeries )
- 5 million American living with artificial knee

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- ~720.000 Arthroplasty per year (~ 5% of all surgeries )
- 5 million American living with artificial knee
- 50.000 \$ per surgery
- By 2030 3.5 Million knee replacements per year



# From biology inspired engineering to engineering living tissues



# Tissue engineering

- Biomechanical Properties

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- Tissue architecture
  - Spatial architecture
  - Matrix composition
  - Cell types

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# Tissue engineering

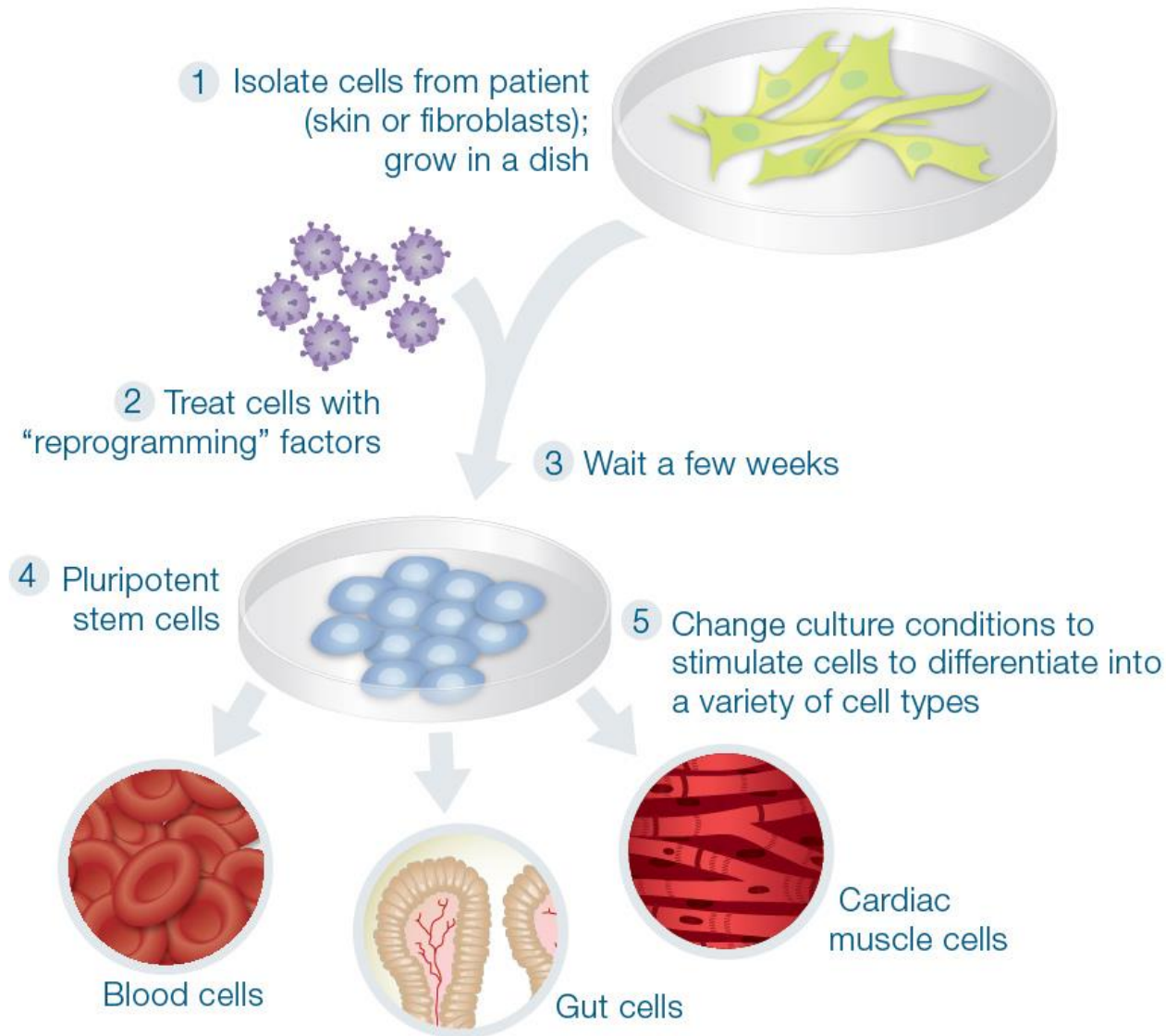
- Biomechanical Properties
- Tissue architecture
  - Spatial architecture
  - Matrix composition
  - Cell types
- Living Tissue
- Immuno-compatibility

# Tissue engineering

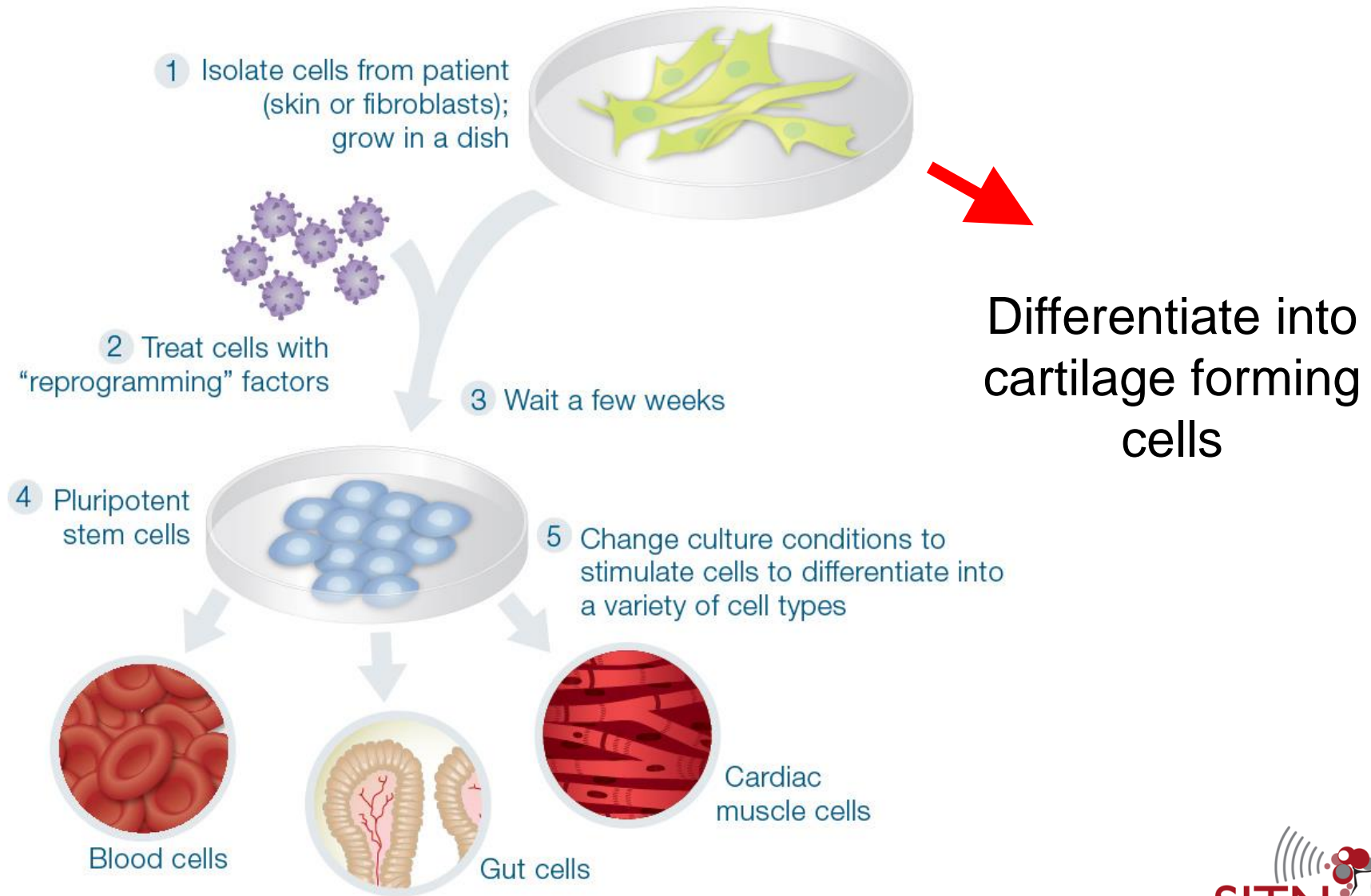
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**Induced Pluripotent Stem  
Cells (iPS Cells)  
Directed differentiation**

# Creating **iPS** cells



# Creating **iPS** cells

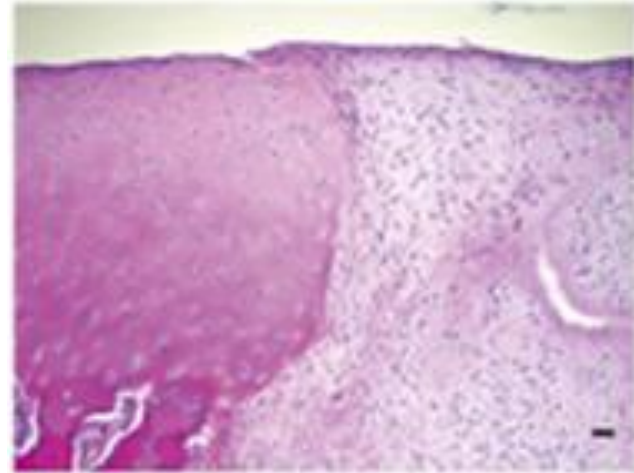




# Making human knee cartilage in a dish



Human iPS cartilage implant  
into mini-pig



# Tissue engineering

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**3D printing**

# 3D printing meniscus implants

1. MR imaging
1. 3D model of patient specific implant
1. 3D printing of bio-scaffold
1. Colonization with cells
1. Implant into patient



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Columbia University Medical Center - <https://youtu.be/srVZRU6d40Y>





Questions?

## Part 2 - Increasing your car's performance: Bionics and exoskeletons



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# Can We Further Enhance the Human Body?

- Armor / Exoskeleton



By: Pikawil @ Flickr



By: DOD/SOCom

- Iron Man?

# Soft Exoskeleton Enhancement

- Tactical Assault Light Operator Suit (TALOS)
- Launched in 2013
- Aims for 2018 delivery
- Reapply energy to enhance motion efficiency



By: DOD/SOCom

# DIY Exo-suit

- James Hobson, aka 'the Hacksmith' made a battery powered exoskeleton
- He used it to lift a ~2600lb mini cooper in January of 2016



By: The Hacksmith / © Youtube

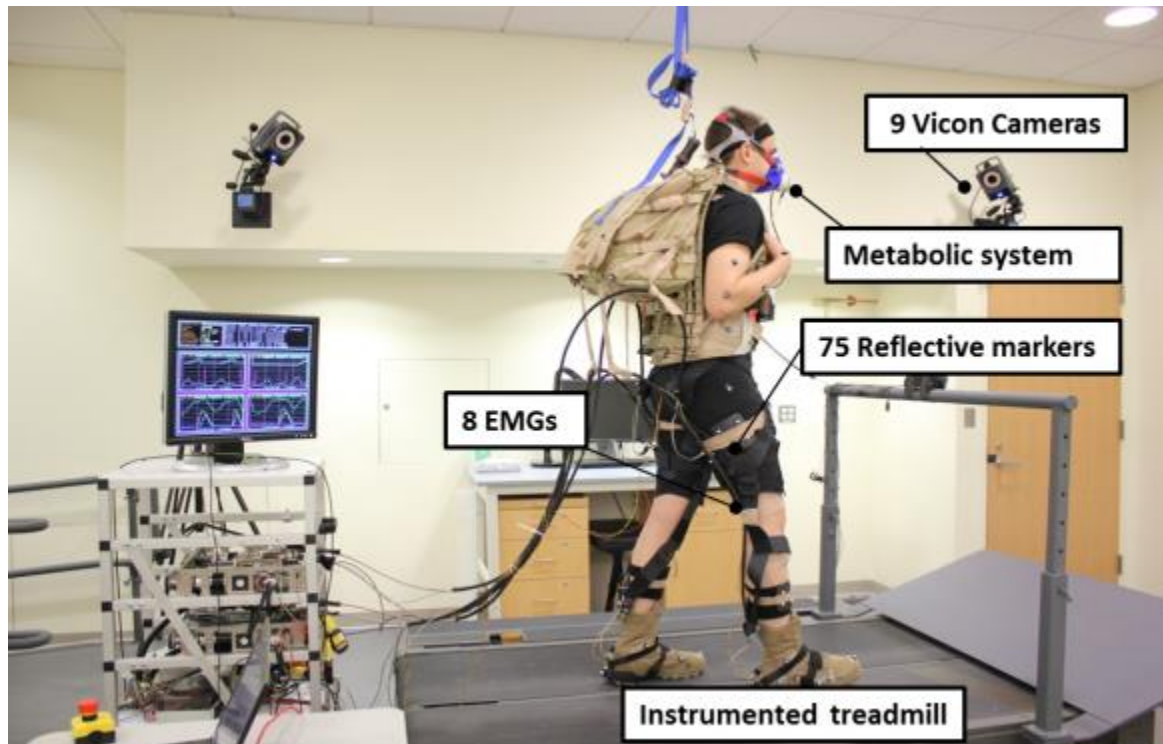


# Manufacturing: Hyundai





# Research at Harvard



By Harvard BioDesign @ SEAS / Wyss Institute

# Consumer products



By Harvard BioDesign @ SEAS / Wyss Institute (Awaiting Permission)

# “Cyborg Olympics”

- October 2016 is the inaugural Cybathlon hosted by the Swiss in Zurich
- Events include:
  - Virtual racing with brain-wave control
  - Bike race with muscle stimulation
  - Prosthetic arms trail
  - Prosthetic legs trail
  - Exoskeleton Trail
  - Wheelchair Parcours



# Summary

3D printing + Stem Cells  
Tissue Regeneration

Exoskeletons + Wearable Soft-Robotics  
Performance Enhancement

# Thank you!

*SITN would like to acknowledge the following organizations for their generous support.*

## **Harvard Medical School**

Office of Communications and External Relations  
Division of Medical Sciences

## **The Harvard Graduate School of Arts and Sciences (GSAS)**

## **The Harvard Graduate Student Council (GSC)**

## **The Harvard Biomedical Graduate Students Organization (BGSO)**

## **The Harvard/MIT COOP**