

Thermomechanobiology: the next frontier for treating osteoarthritis

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Musculoskeletal conditions

WHO (February 2021):

- Approximately 1.71 billion people have musculoskeletal conditions worldwide.
- Musculoskeletal conditions are the leading contributor to disability worldwide

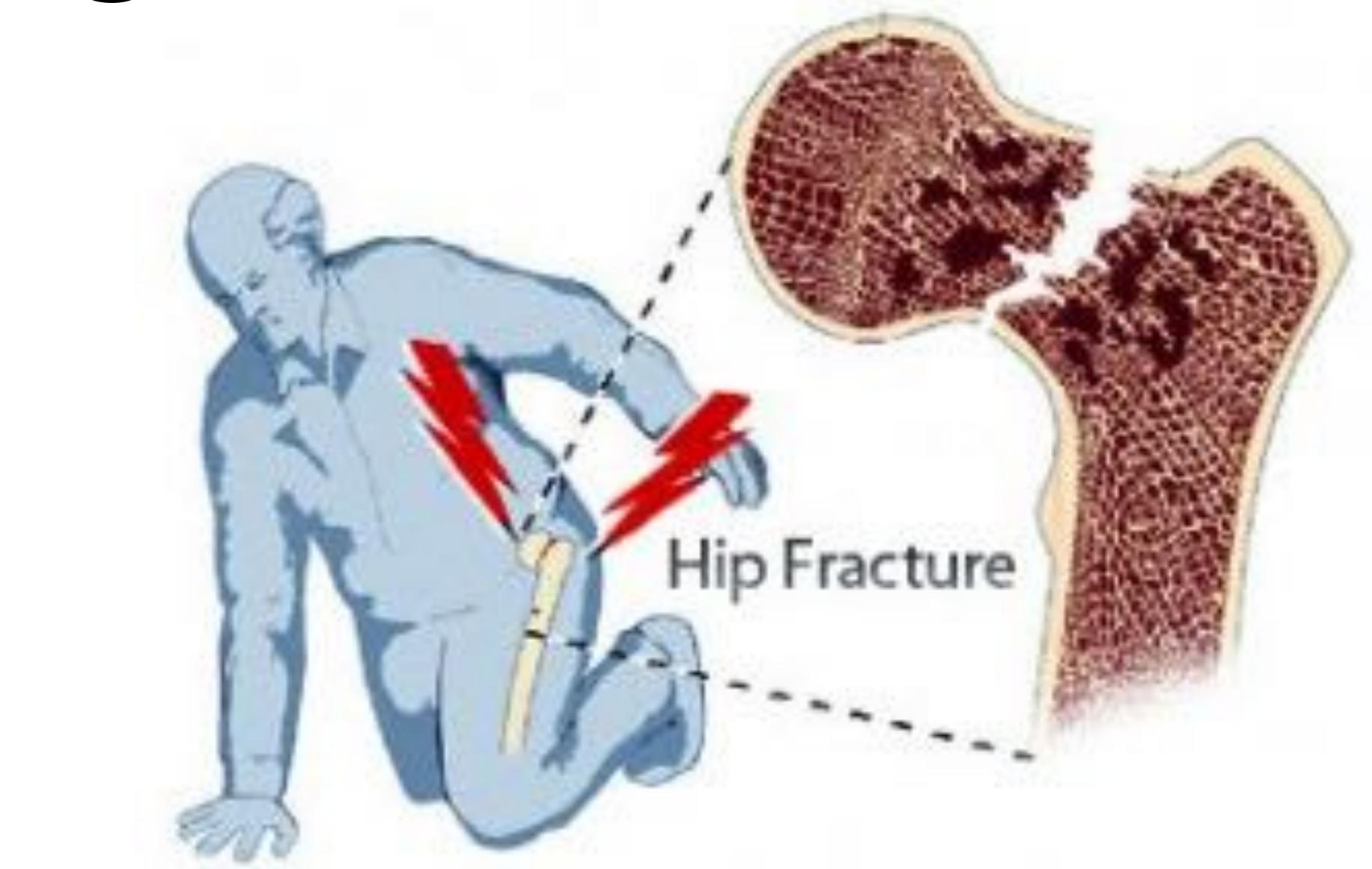
Musculoskeletal conditions include:

- Osteoarthritis
- Osteoporosis, osteopenia and associated fragility fractures, traumatic fractures of soft and hard tissues

All age groups of the population are affected
Biomechanical aspects are involved in most
musculoskeletal conditions



250'000 ACL injuries occur in the USA annually.



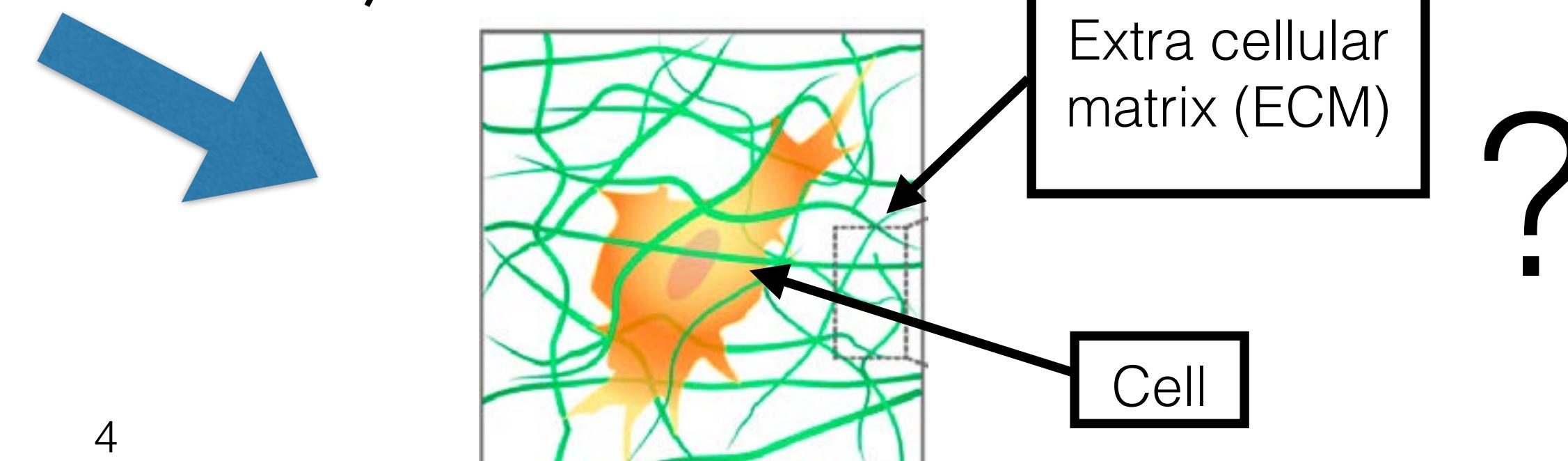
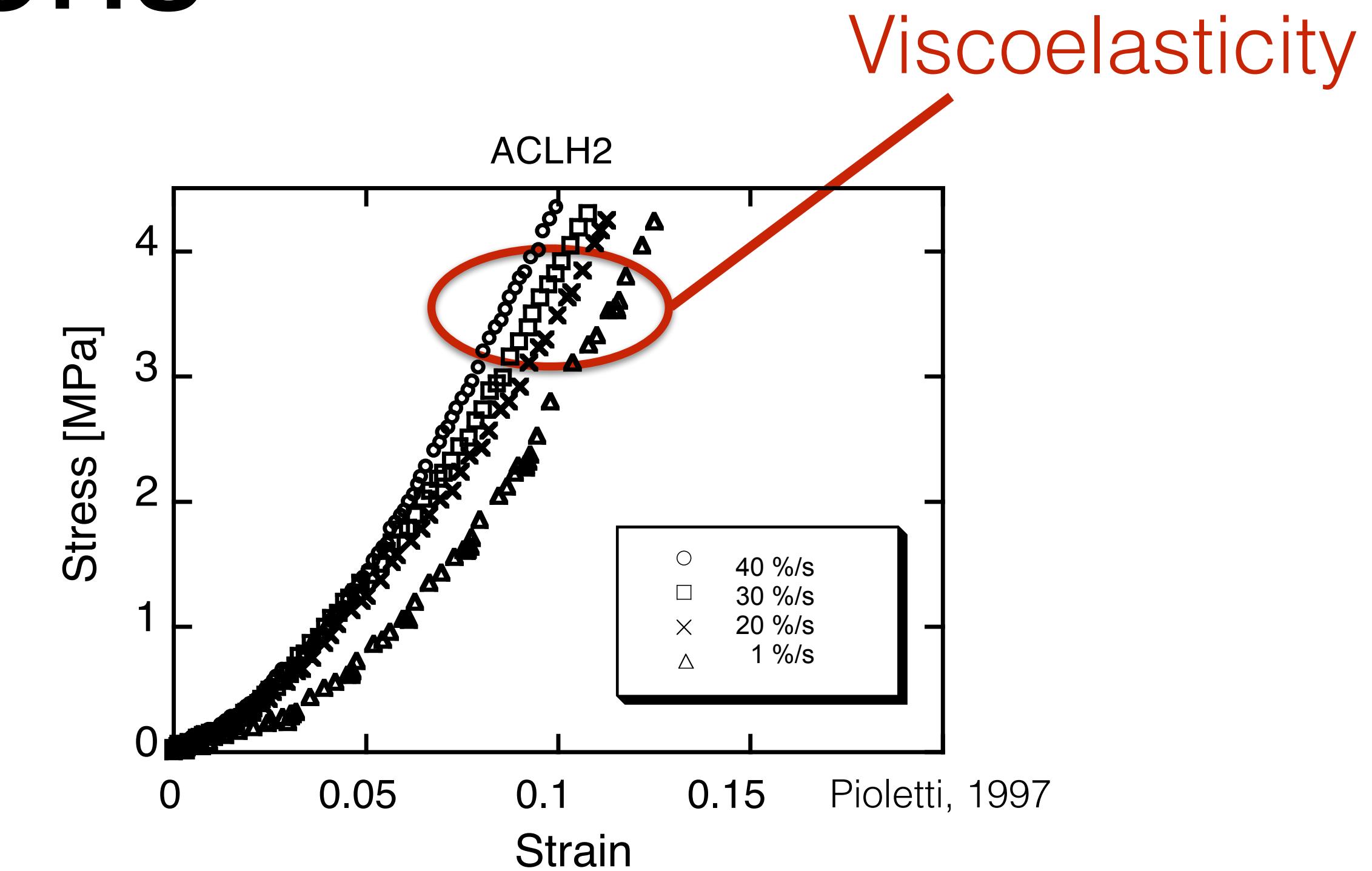
Mortality rate is 20% within 1 year.

Biomechanical aspects are involved in most musculoskeletal conditions

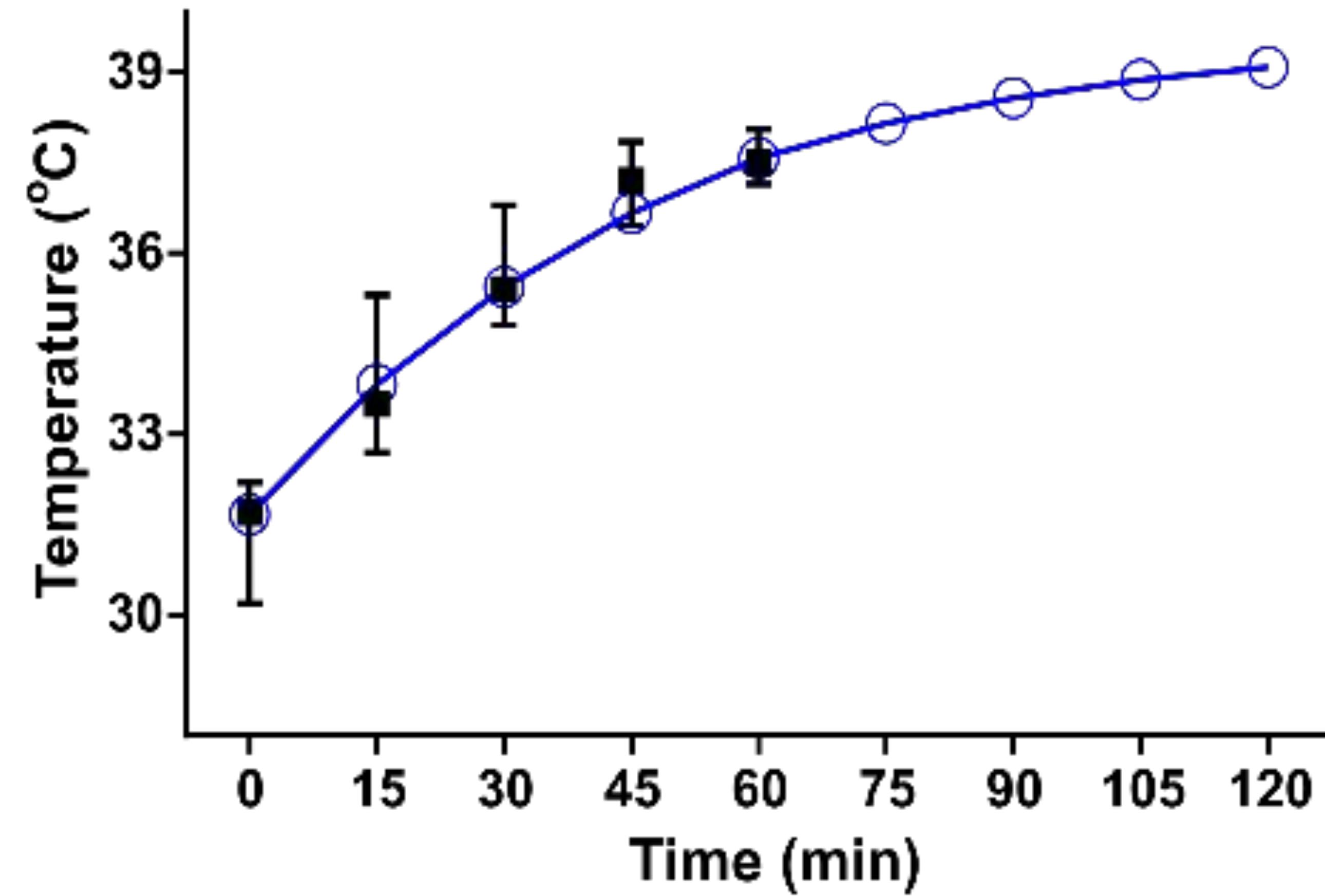


Mechanical

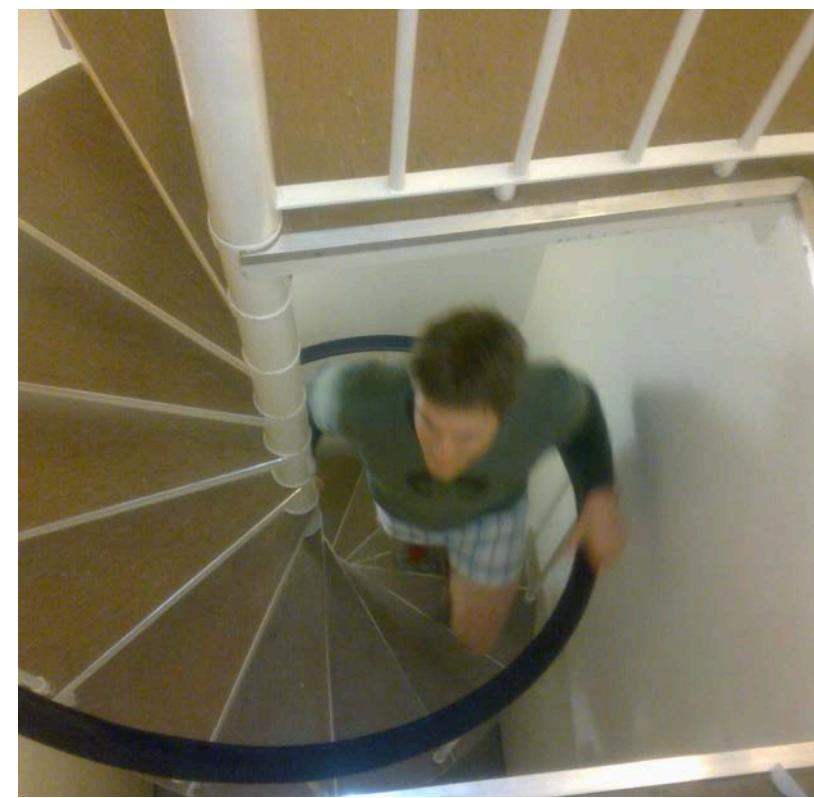
Biological



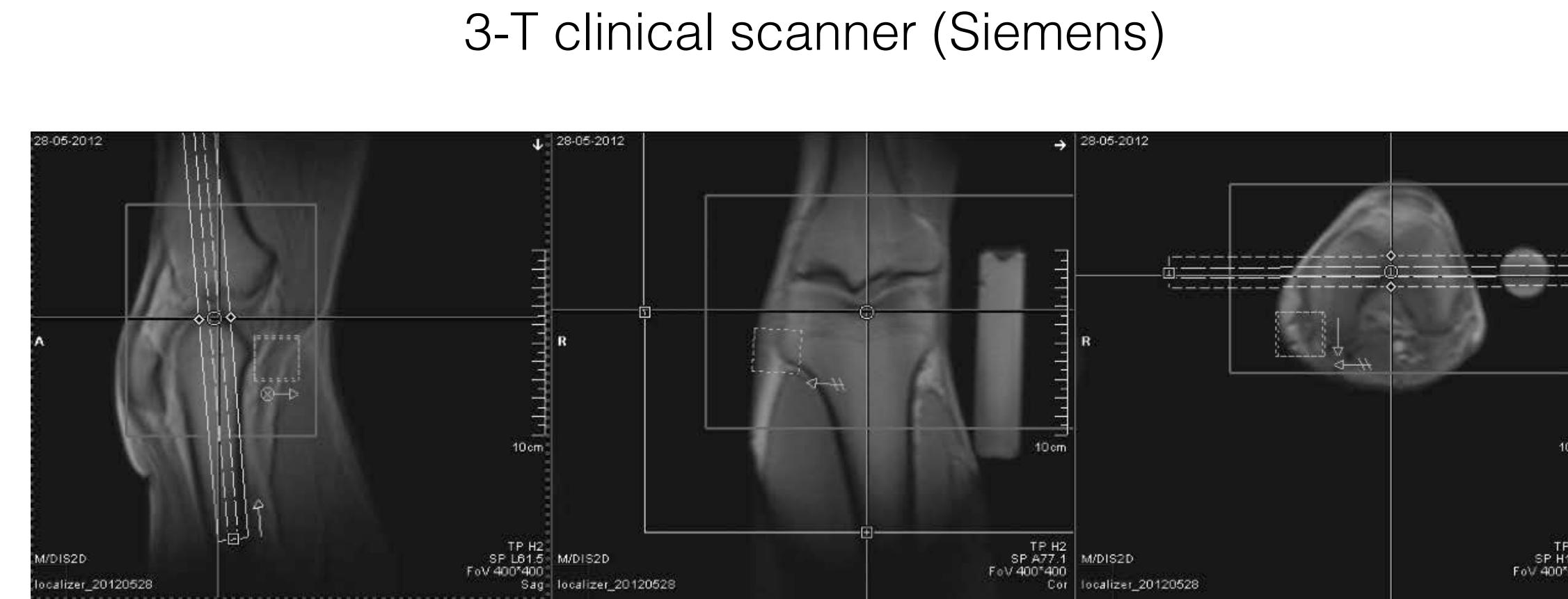
Under **dynamical** mechanical loading, **knee** temperature with healthy cartilage is **not** constant



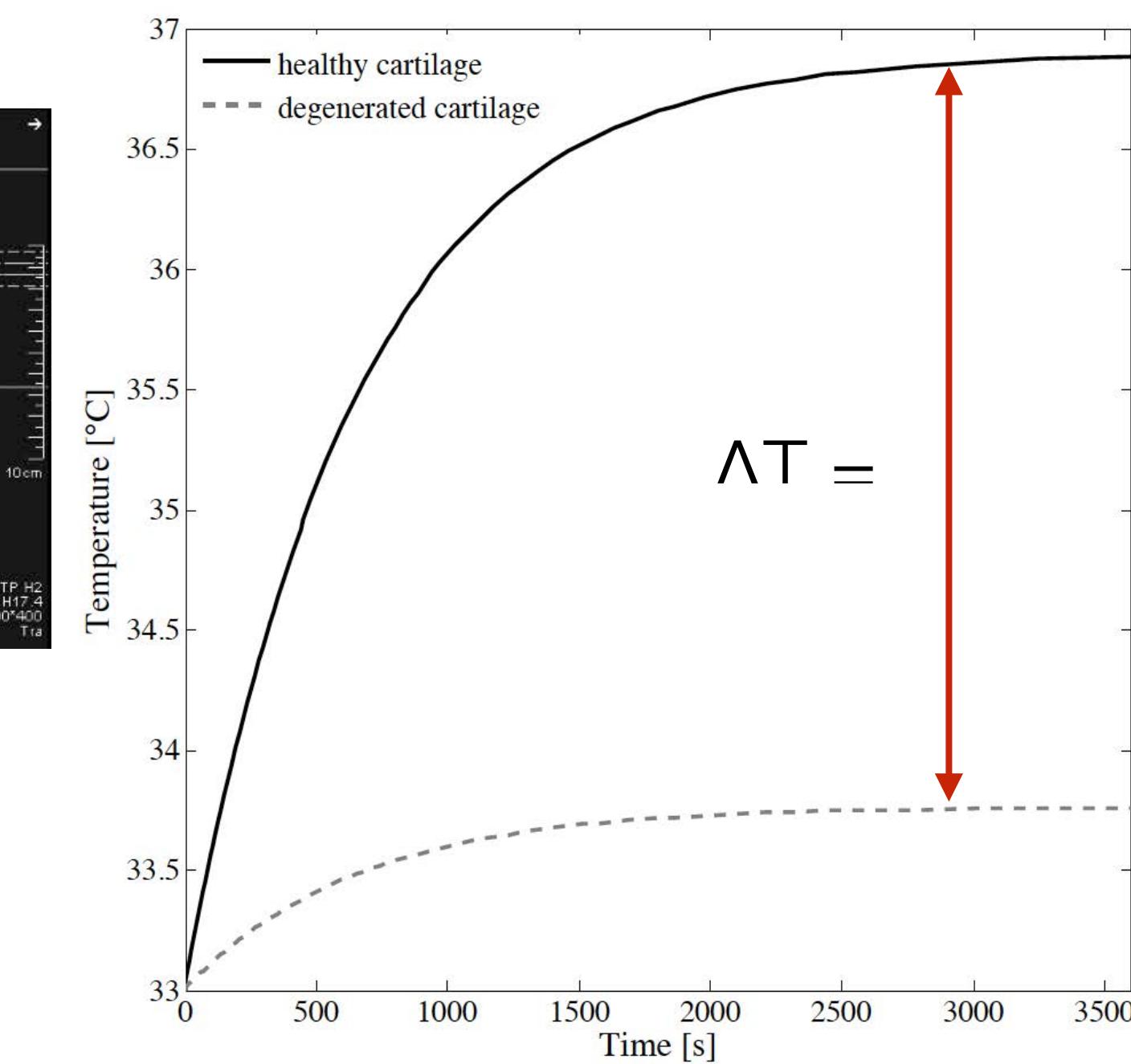
Under **dynamical** mechanical loading, the temperature in healthy **cartilage** is **not** constant



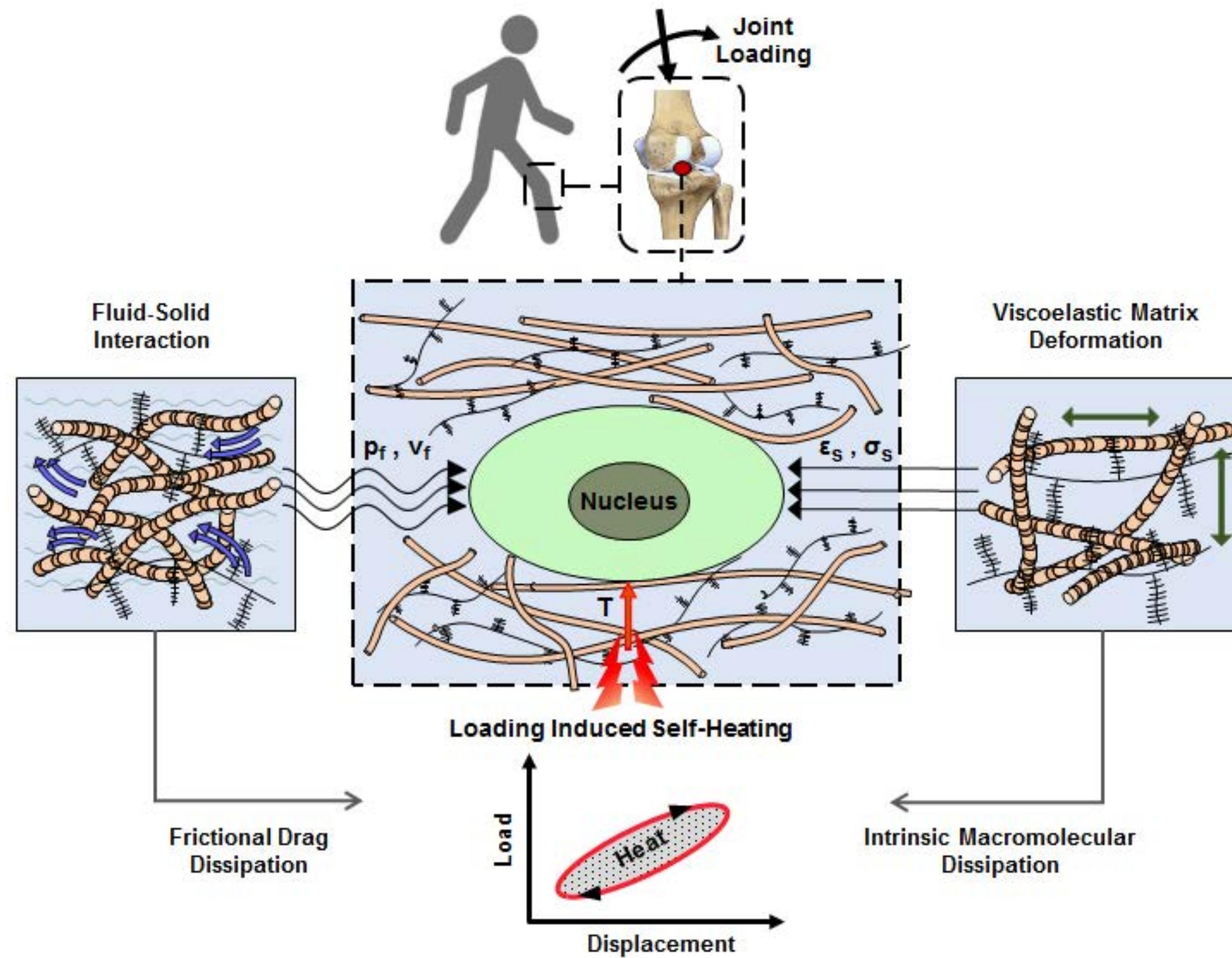
Mechanical stimulation:
400 steps up and down



Proton Resonance Frequency Shift
(PRFS)-based MR thermometry

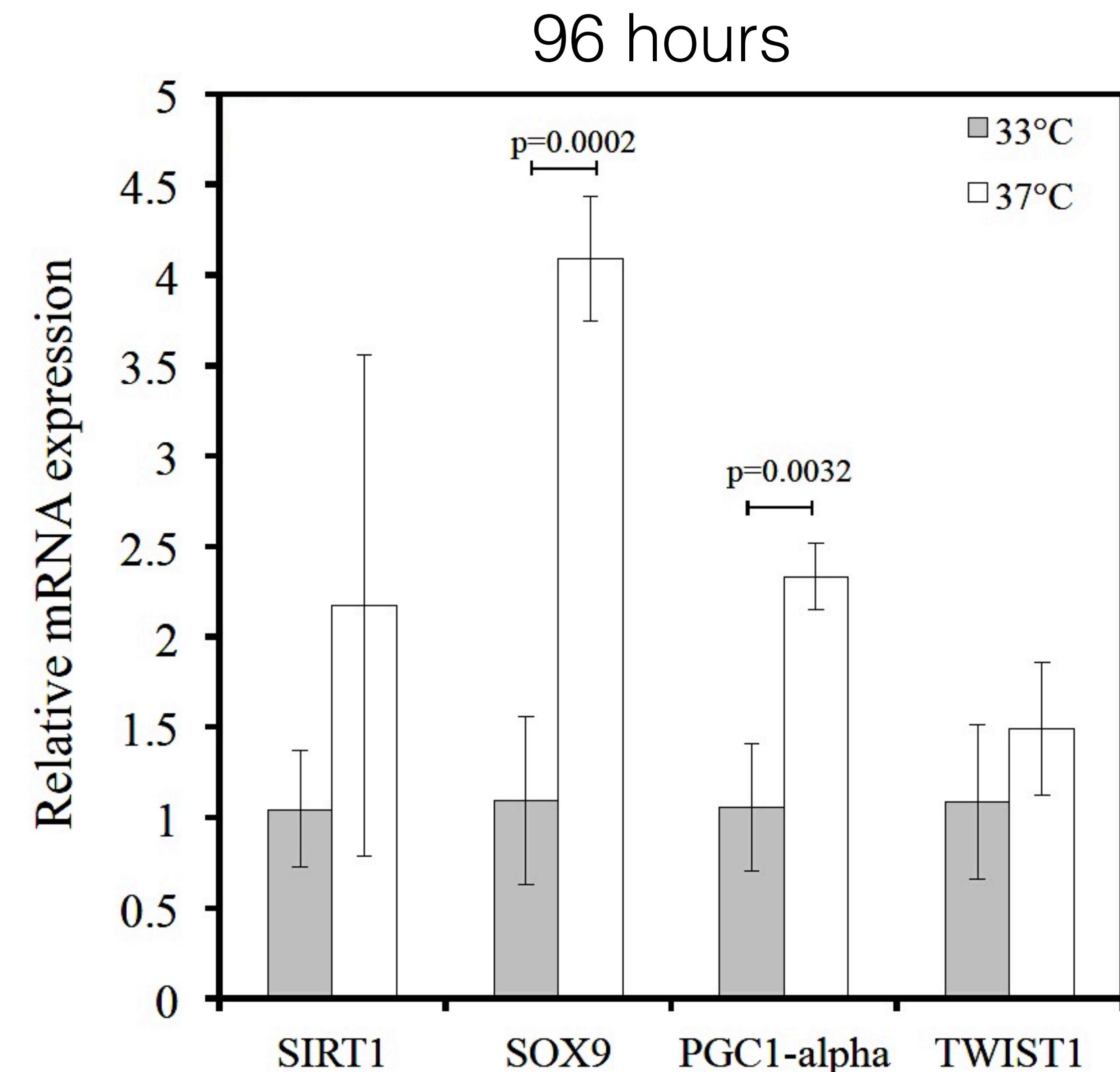
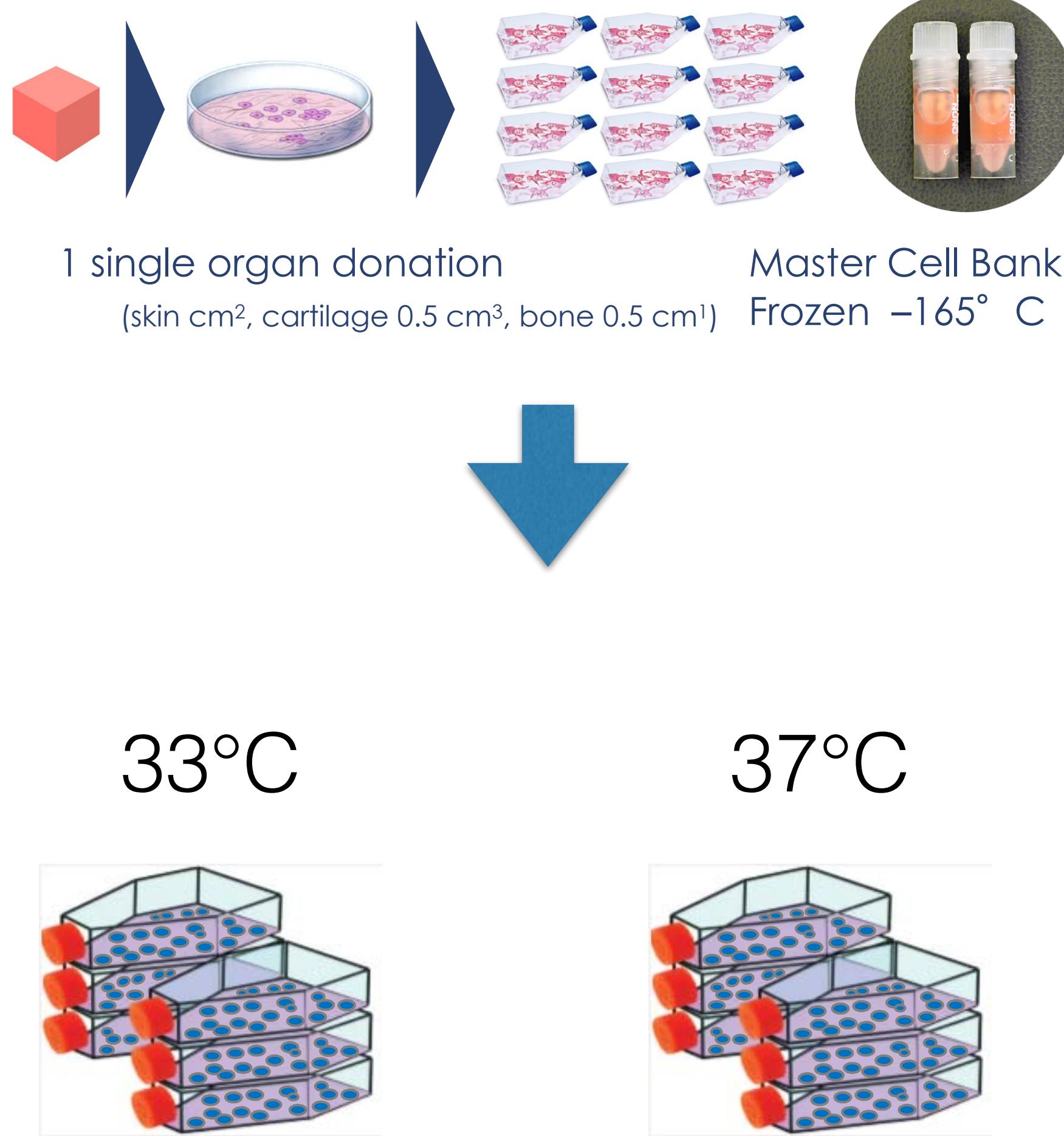


ECM dissipation \rightarrow cartilage tissue

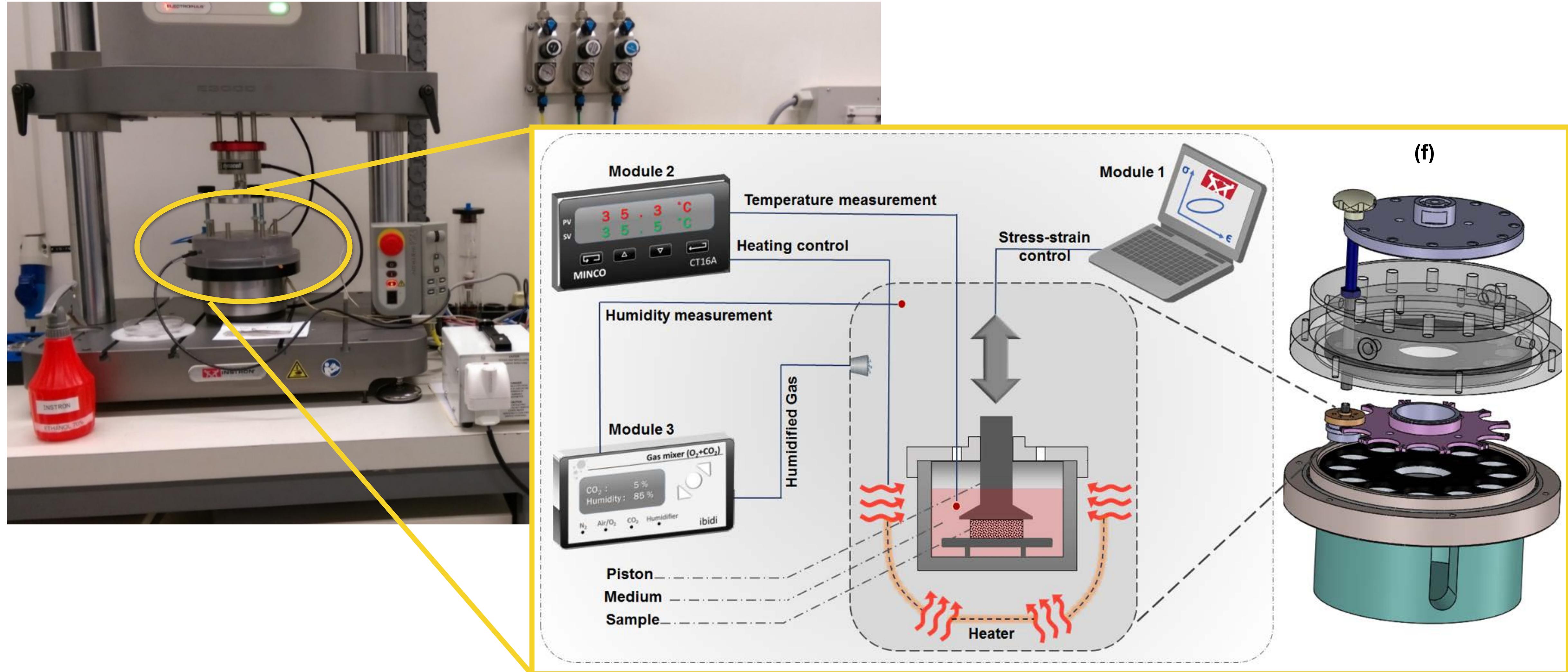


Temperature effect on chondrocytes behaviour

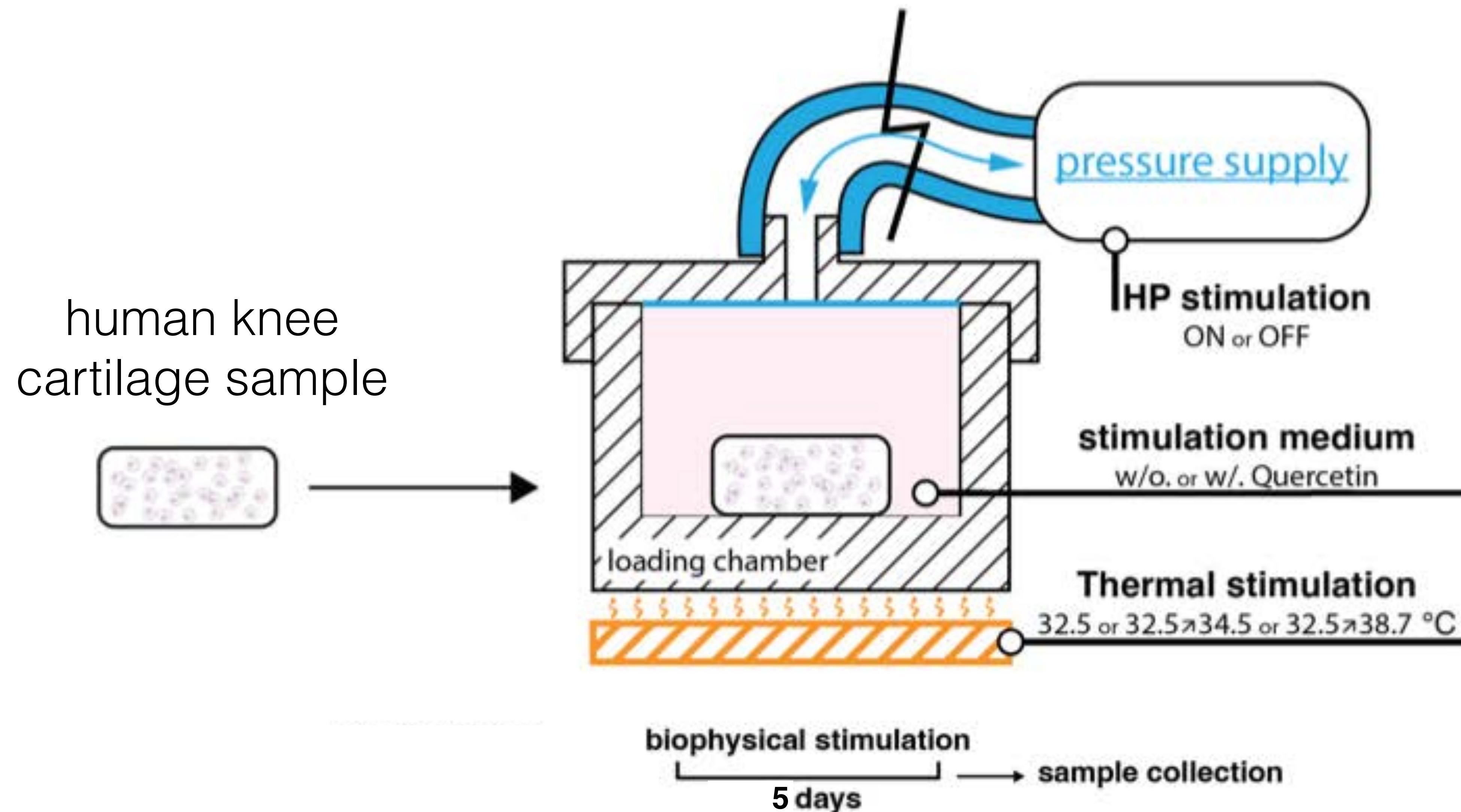
Human epiphyseal chondro-progenitor cells



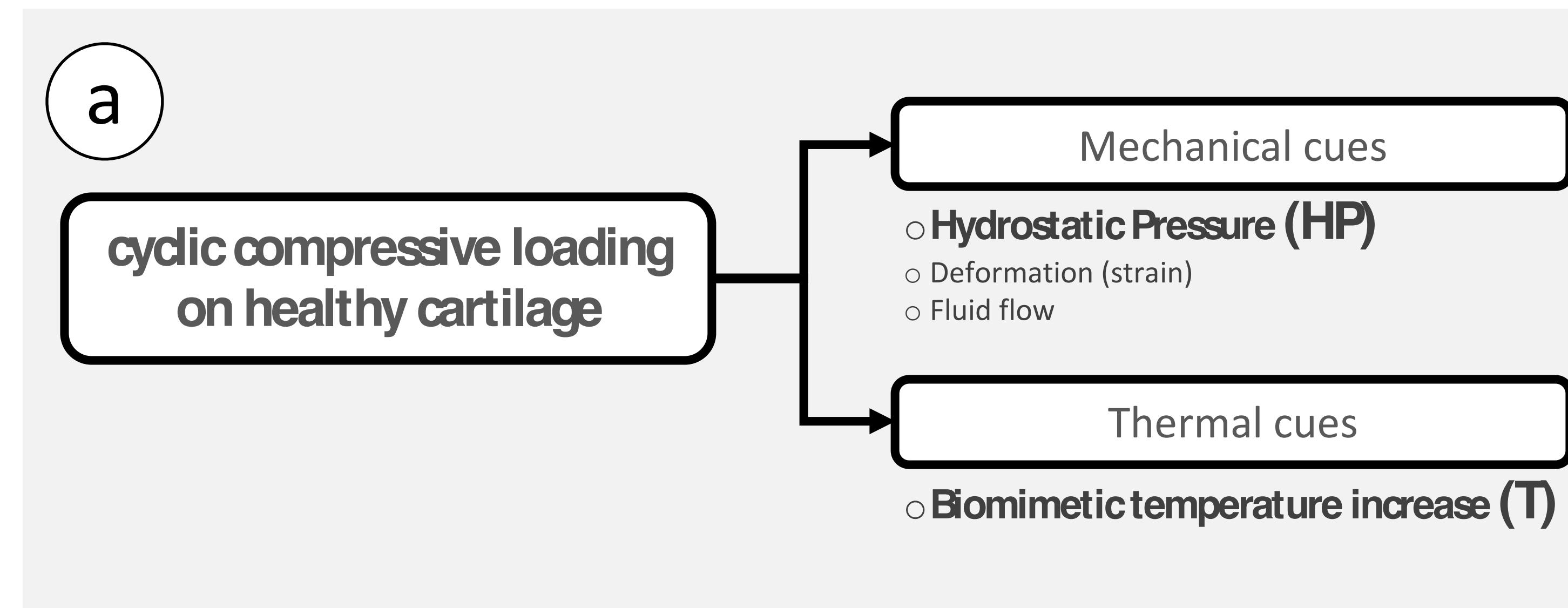
Temperature effect on bloodocyte behaviour



What's about thermomechanical stimulation at the tissue level?



Research context — from 3 critical points to research questions



Research context — from 3 critical points to research questions

a

Healthy cartilage
--- HP+T cues are coupled

b

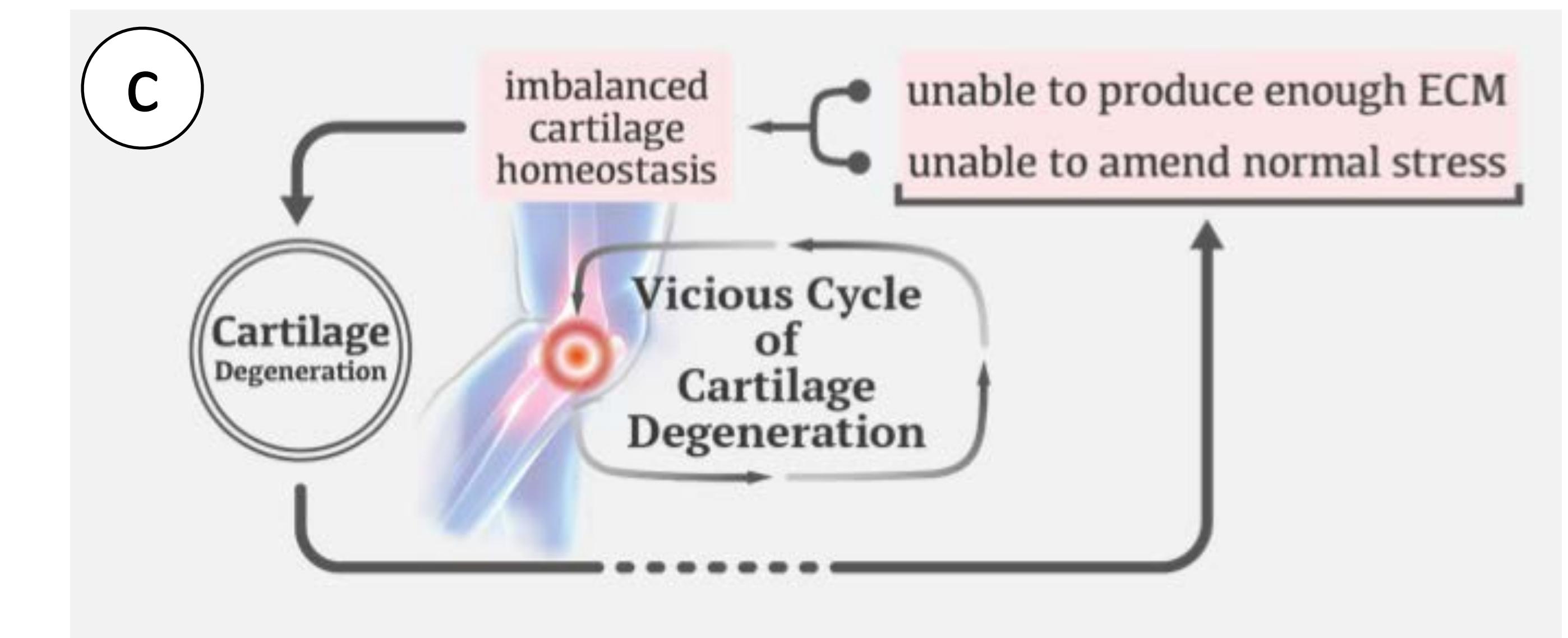
in degenerated cartilage

porosity↑ : HP ↓

dissipative property↓ : T_{Max}↓

Research context — from 3 critical points to research questions

- a**
Healthy cartilage
--- HP+T cues are coupled
- b**
Degenerated cartilage
--- HP+T cues are decreased



Research context — from 3 critical points to research questions

a

Healthy cartilage

--- HP+T cues are coupled

b

Degenerated cartilage

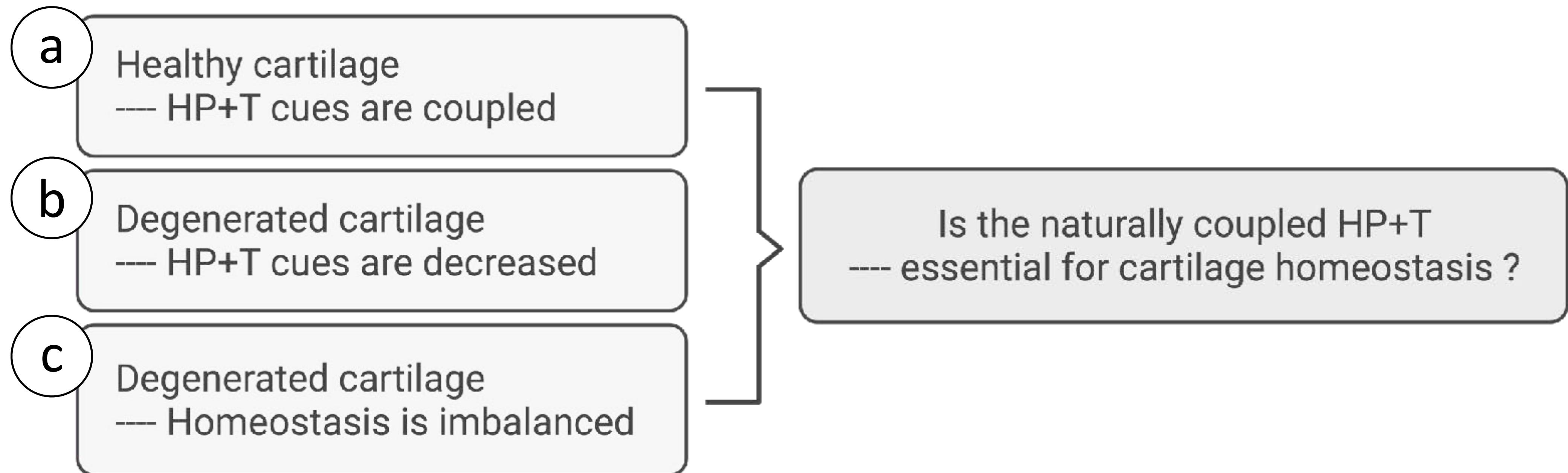
--- HP+T cues are decreased

c

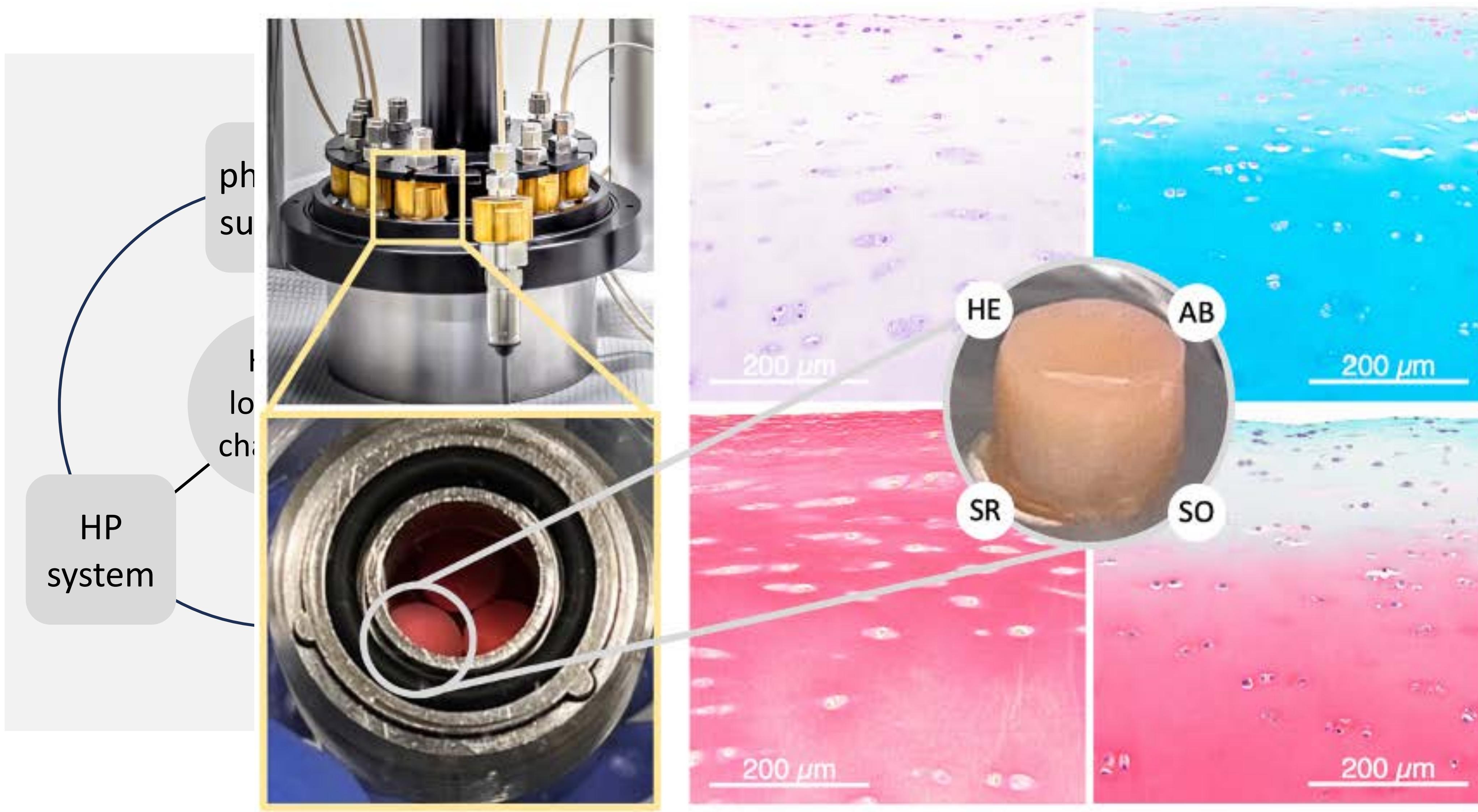
Degenerated cartilage

--- Homeostasis is imbalanced

Research context — from 3 critical points to research questions

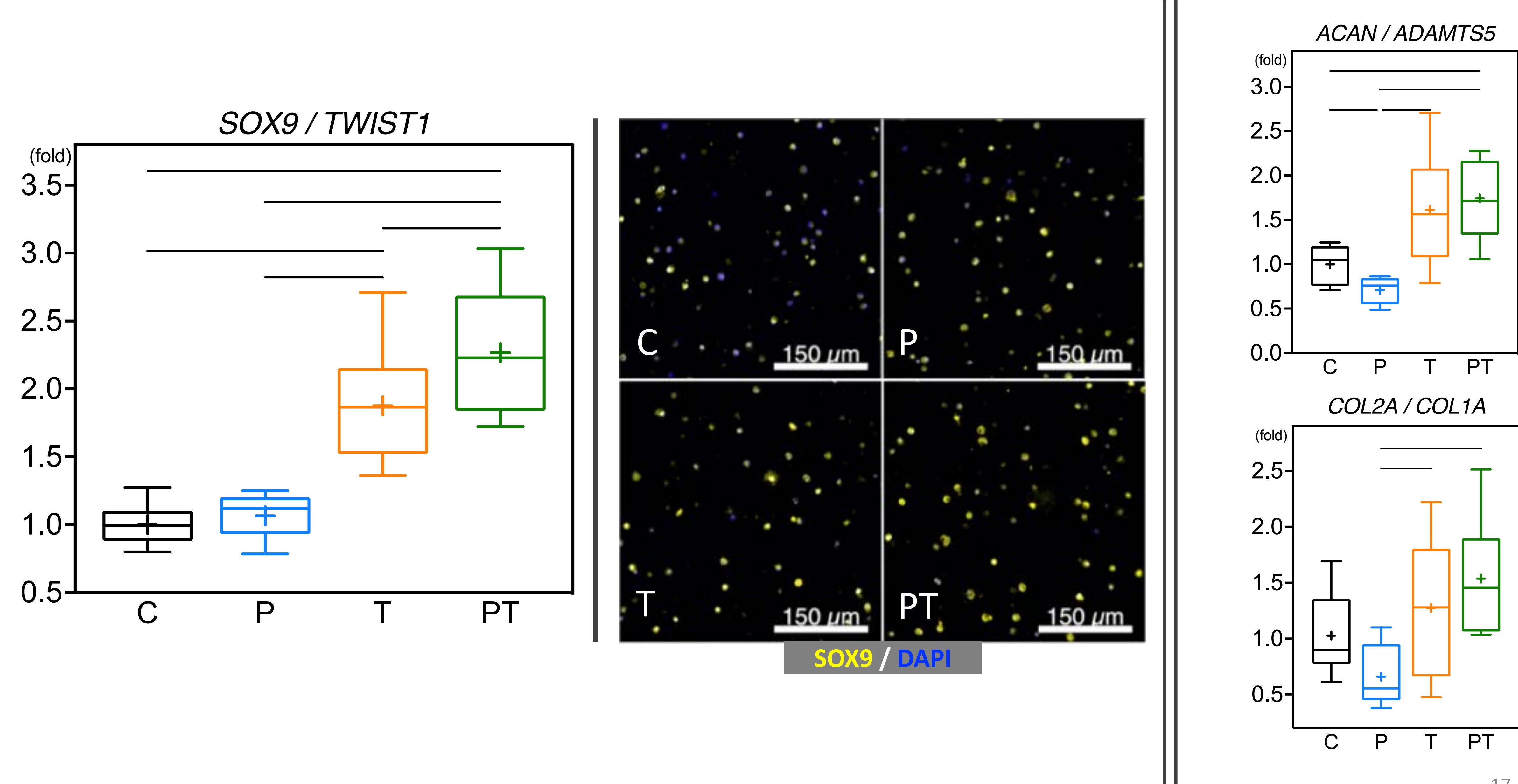


Development of in vitro HP-T platform

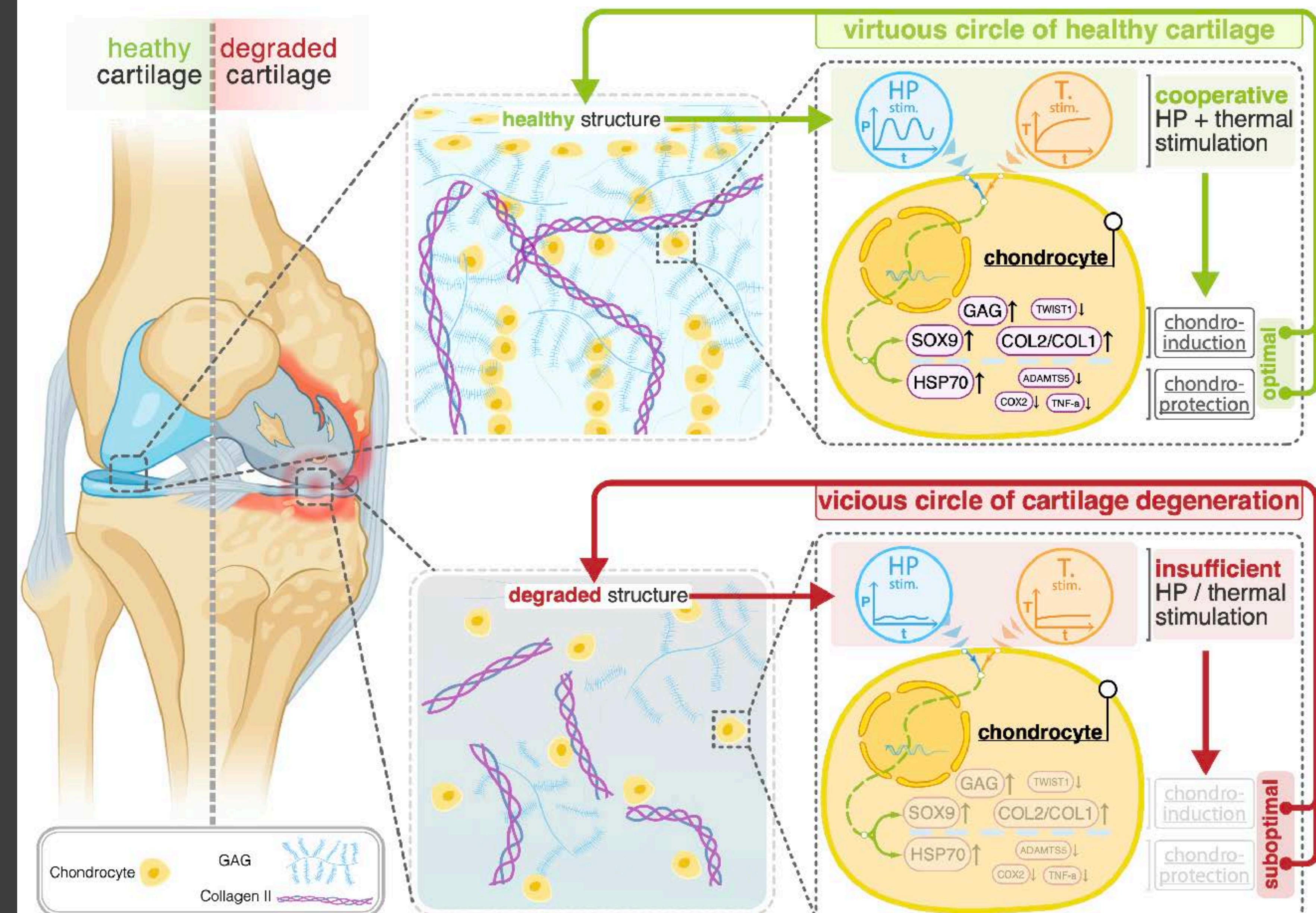


able to apply
isolated & combined
of HP, T stimuli
to samples

Result 1: Combined HP-T is necessary for maximum chondroinduction

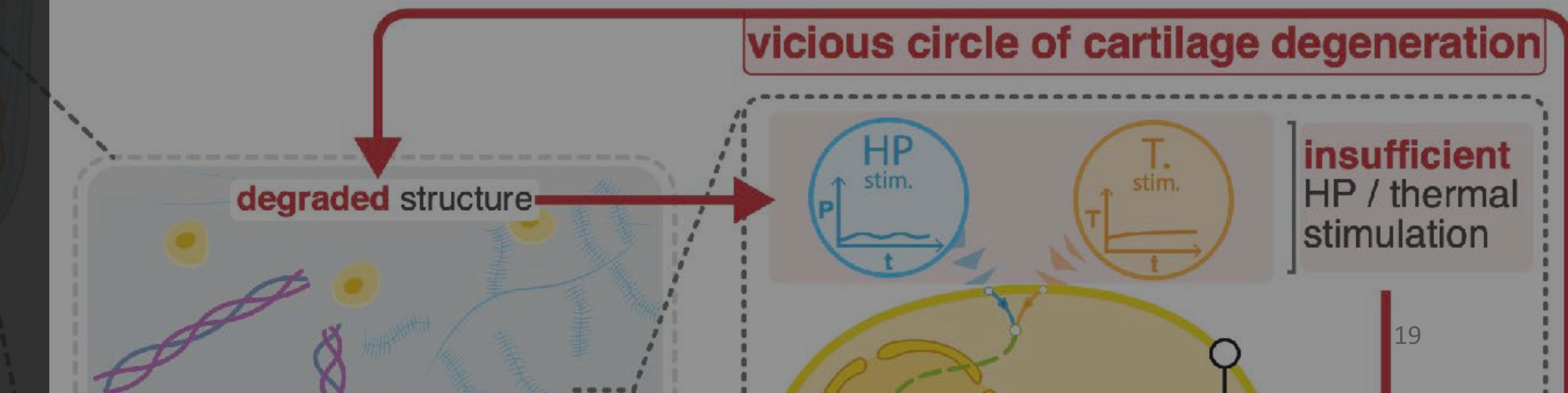
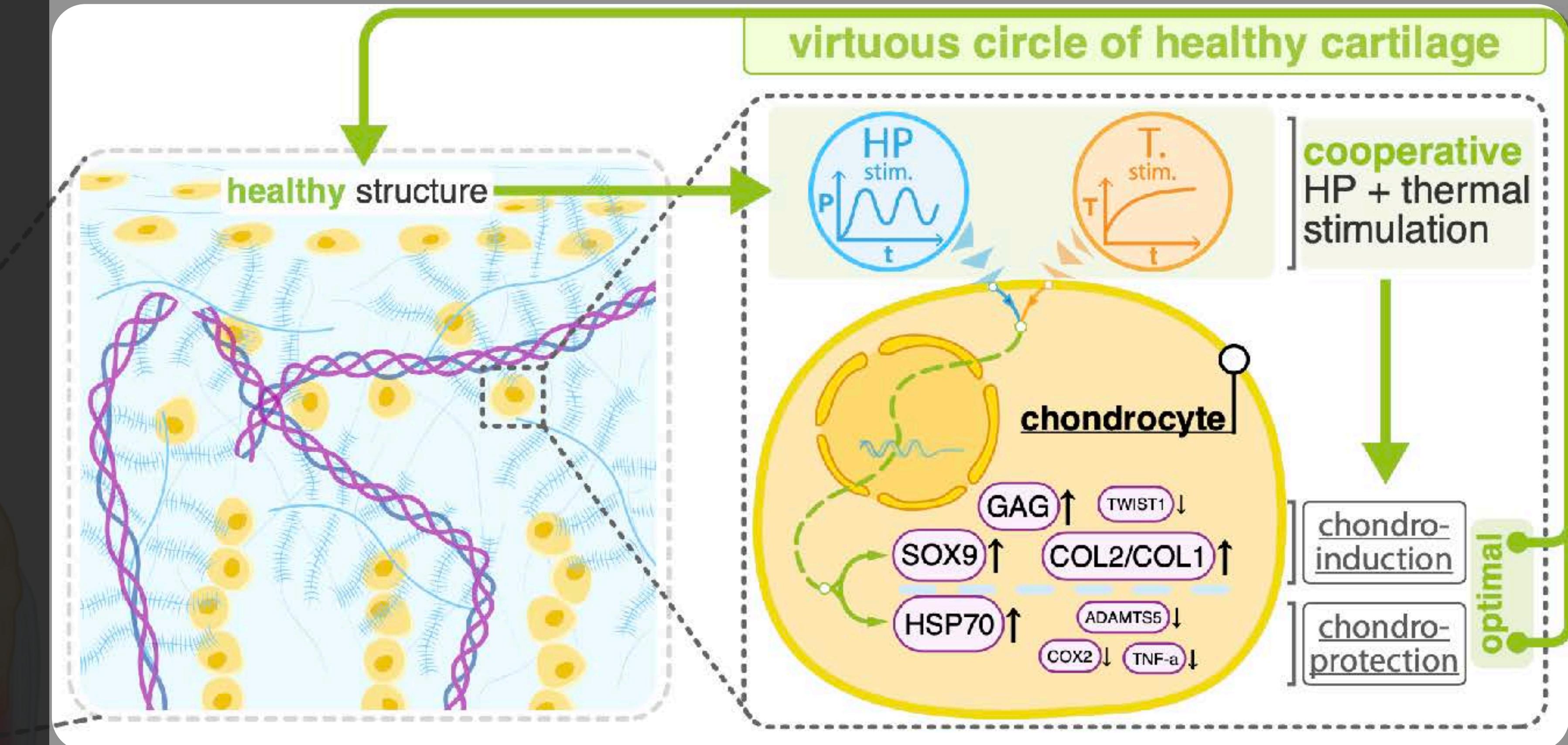


Proposed mechanism of cartilage homeostasis (focusing on HP-T)

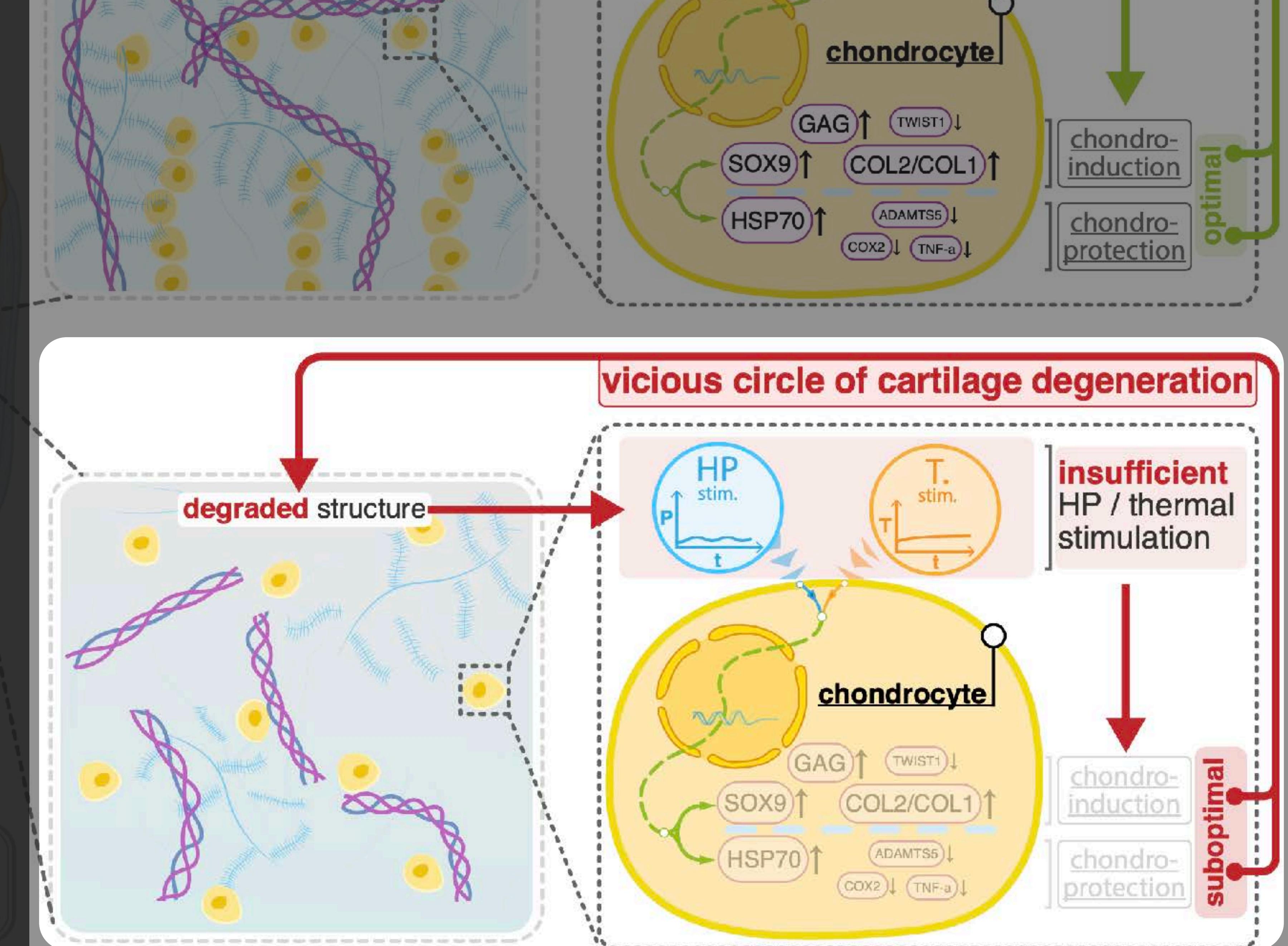
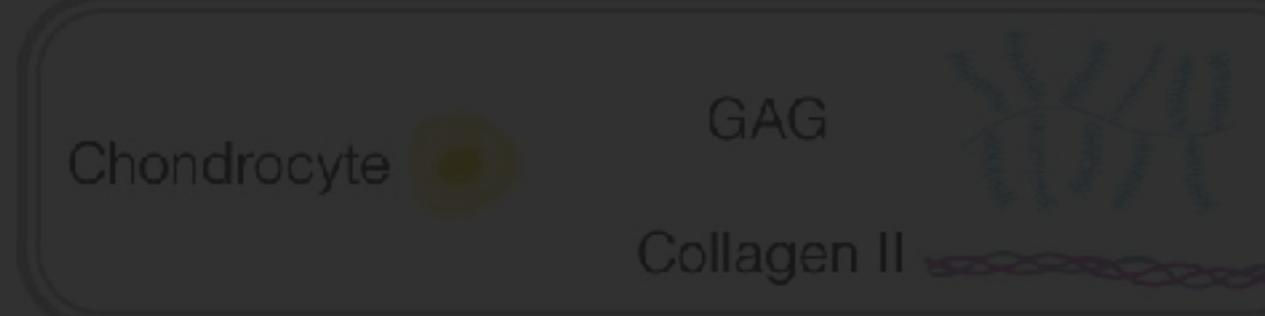


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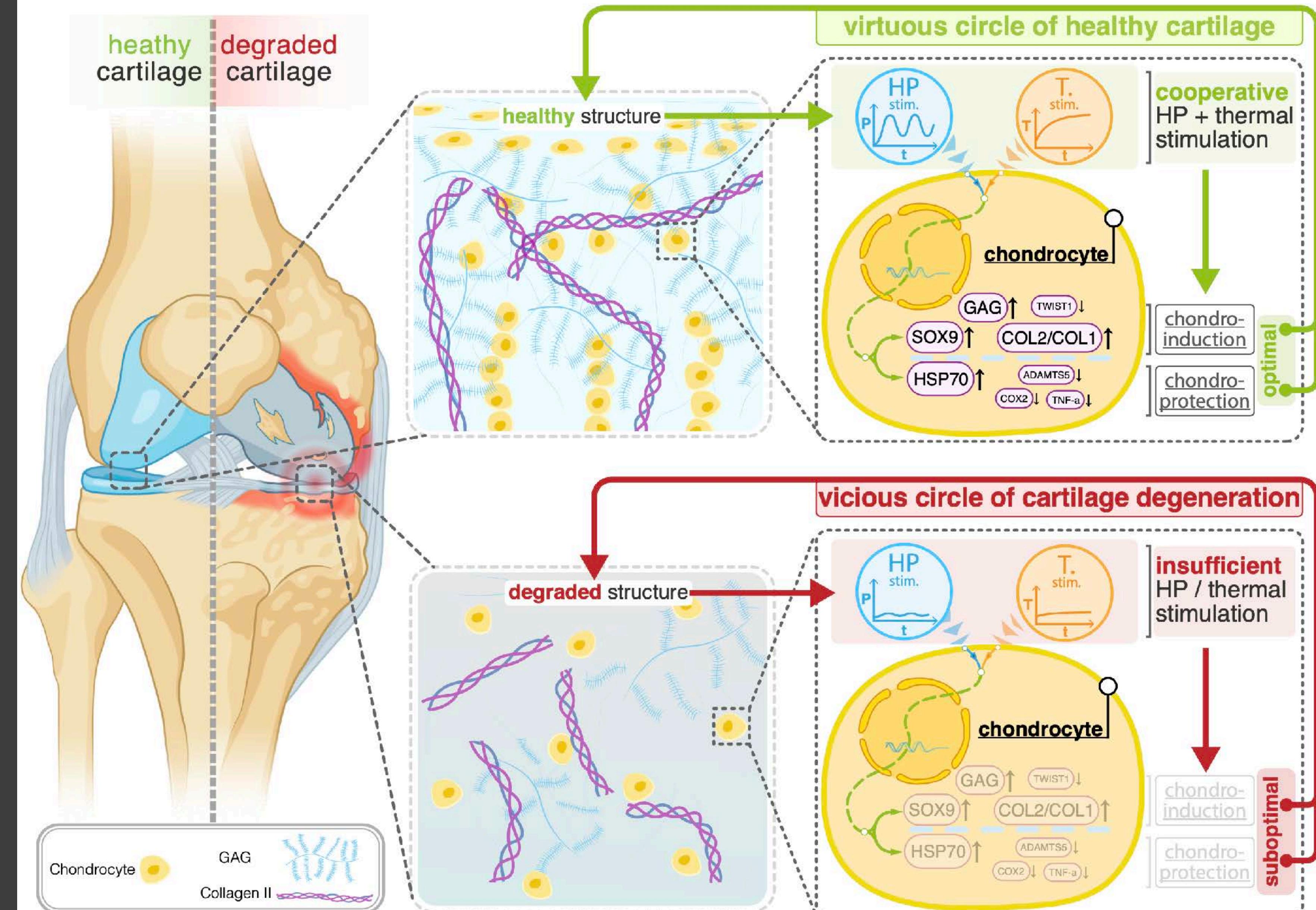
healthy cartilage
degraded cartilage



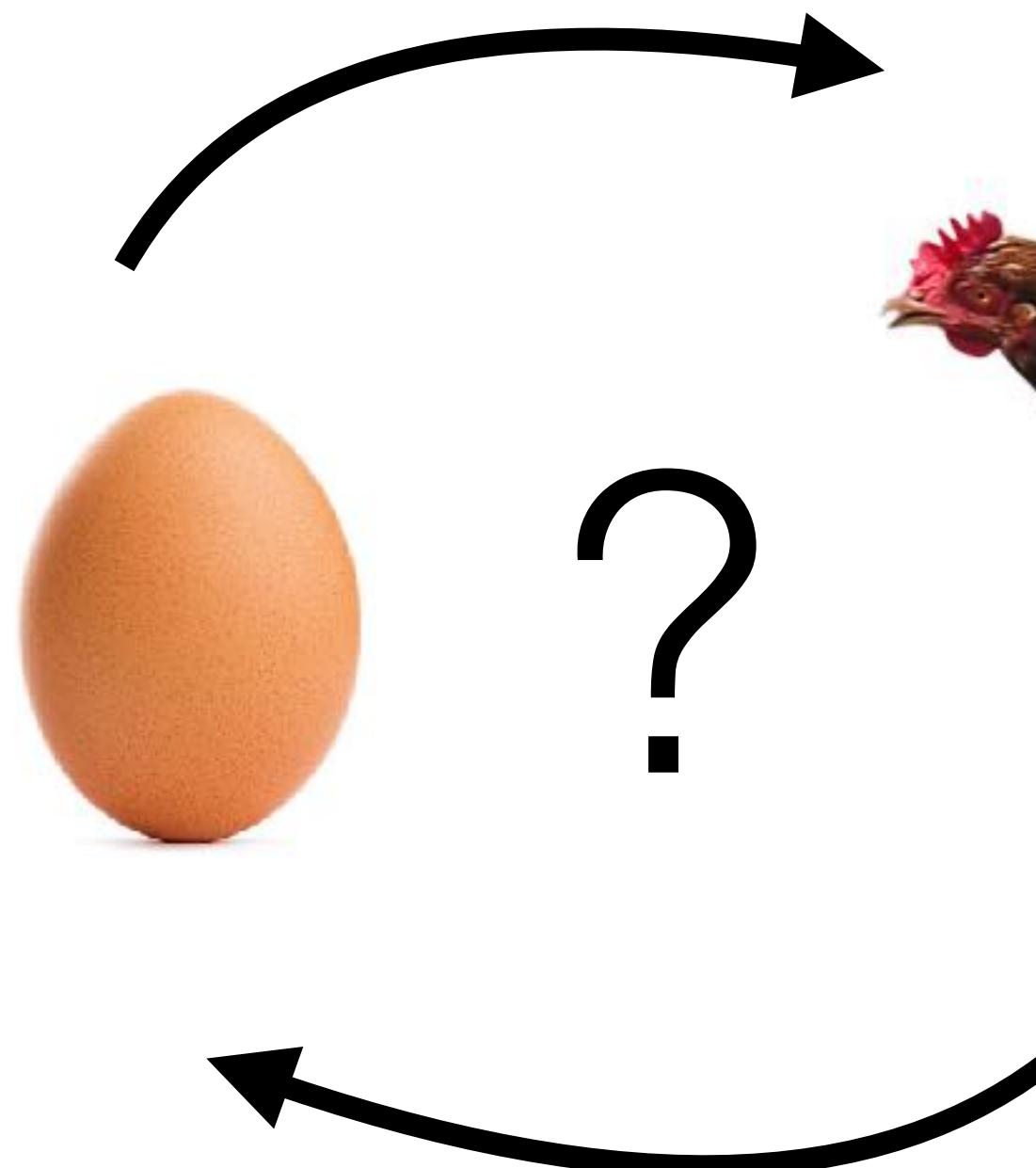
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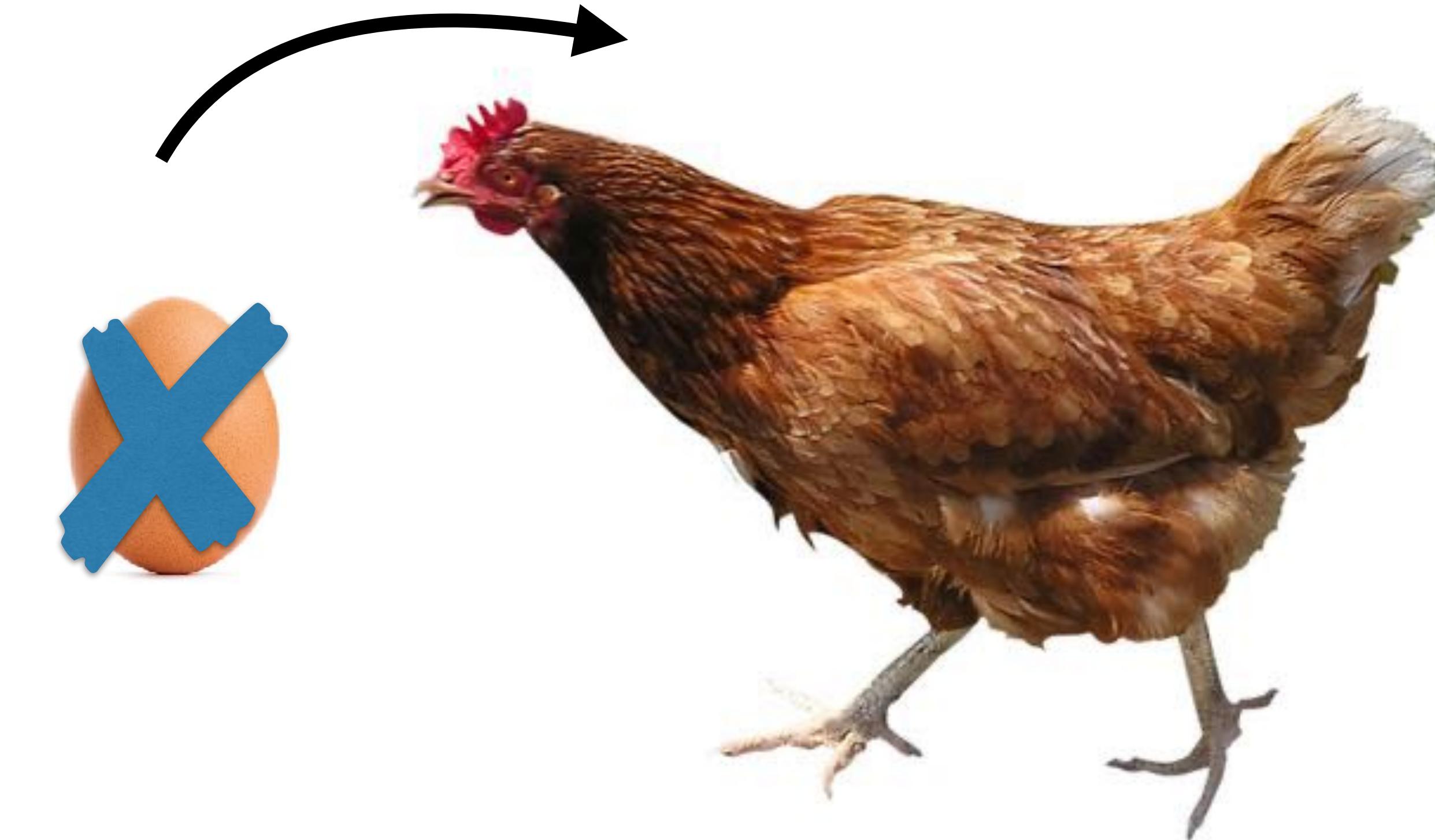


Egg and chicken problem



Absence of
HP-T stimuli

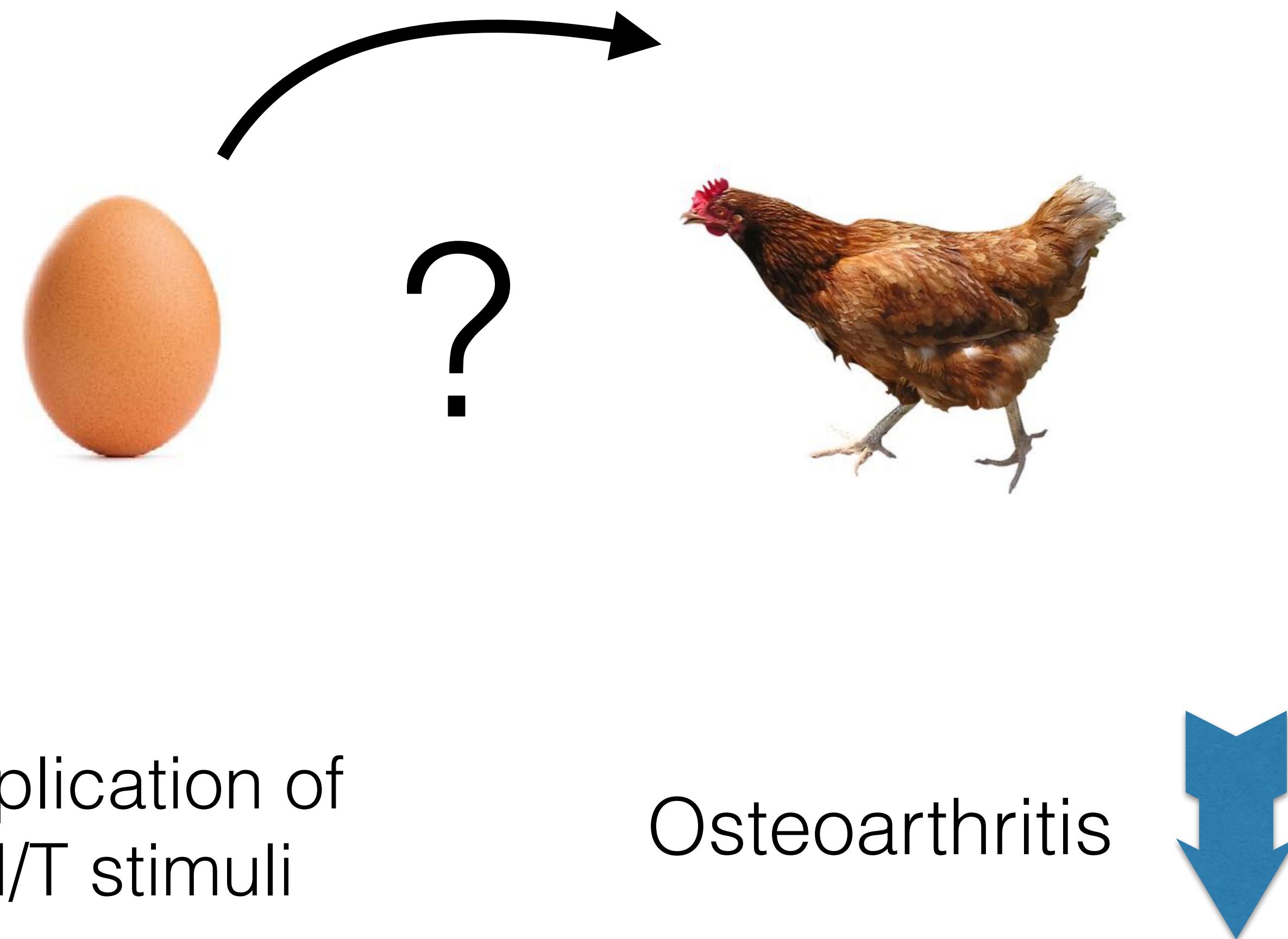
Osteoarthritis



Absence of
HP/T stimuli

Osteoarthritis

Egg and chicken problem



Effect of heat and exercise to relieve OA pain

Original Article

Egyptian Journal of Health Care, 2020 EJHC Vol. 11. No.3

Effect of physical Exercise and Heat Application on Pain and Morning Stiffness in Osteoarthritis Patients

Shereen Abd El Moniem Ahmed⁽¹⁾, Wafaa Ismaiel Shereif⁽²⁾, Shereen Reda Hassan⁽³⁾, Nagwa Mohamed Helmy⁽⁴⁾

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(2) Professor of Medical-Surgical Nursing, Faculty of Nursing, Mansoura University
(3) BScN, Zagazig University, Master student, Faculty of Nursing, Suez Canal University
(4) Lecturer of Medical-Surgical Nursing, Faculty of Nursing, Suez Canal University



Clinical Biomechanics
Volume 57, August 2018, Pages 107-113



Archives of Gerontology and Geriatrics
Volume 57, Issue 3, November–December 2013, Pages 352-359



Effectiveness of exercise with or without thermal therapy for community-dwelling elderly Japanese women with non-specific knee pain: A randomized controlled trial

Hunkyoung Kim^a   , Takao Suzuki^b, Kyoko Saito^a, Miji Kim^a, Narumi Kojima^a,
Tatsuro Ishizaki^a, Yukari Yamashiro^a, Erika Hosoi^a, Hideyo Yoshida^a

INTERNATIONAL JOURNAL
of NURSING PRACTICE

ORIGINAL RESEARCH PAPER |  Full Access

Application of heat and a home exercise program for pain and function levels in patients with knee osteoarthritis: A randomized controlled trial

Songul Karadağ RN, PhD  , Sultan Taşçı RN, PhD, Nurhan Doğan RN, Huseyin Demir PhD, MD, Züleyha Kılıç RN

First published: 22 August 2019 | <https://doi.org/10.1111/jnp.12772> | Citations: 6

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Is Therapeutic Exercise Clinically Effective in Reducing Pain Intensity in Patients With Knee Osteoarthritis? A Systematic Review

Beydağı, Muharrem Gökhan PT; Bazancır, Zilan PT; Bozgeyik, Sibel PT; Ulge, Ozlem PhD, PT
Author Information 

Topics in Geriatric Rehabilitation 37(2):p 89-103, April/June 2021. | DOI: 10.1097/TGR.0000000000000309

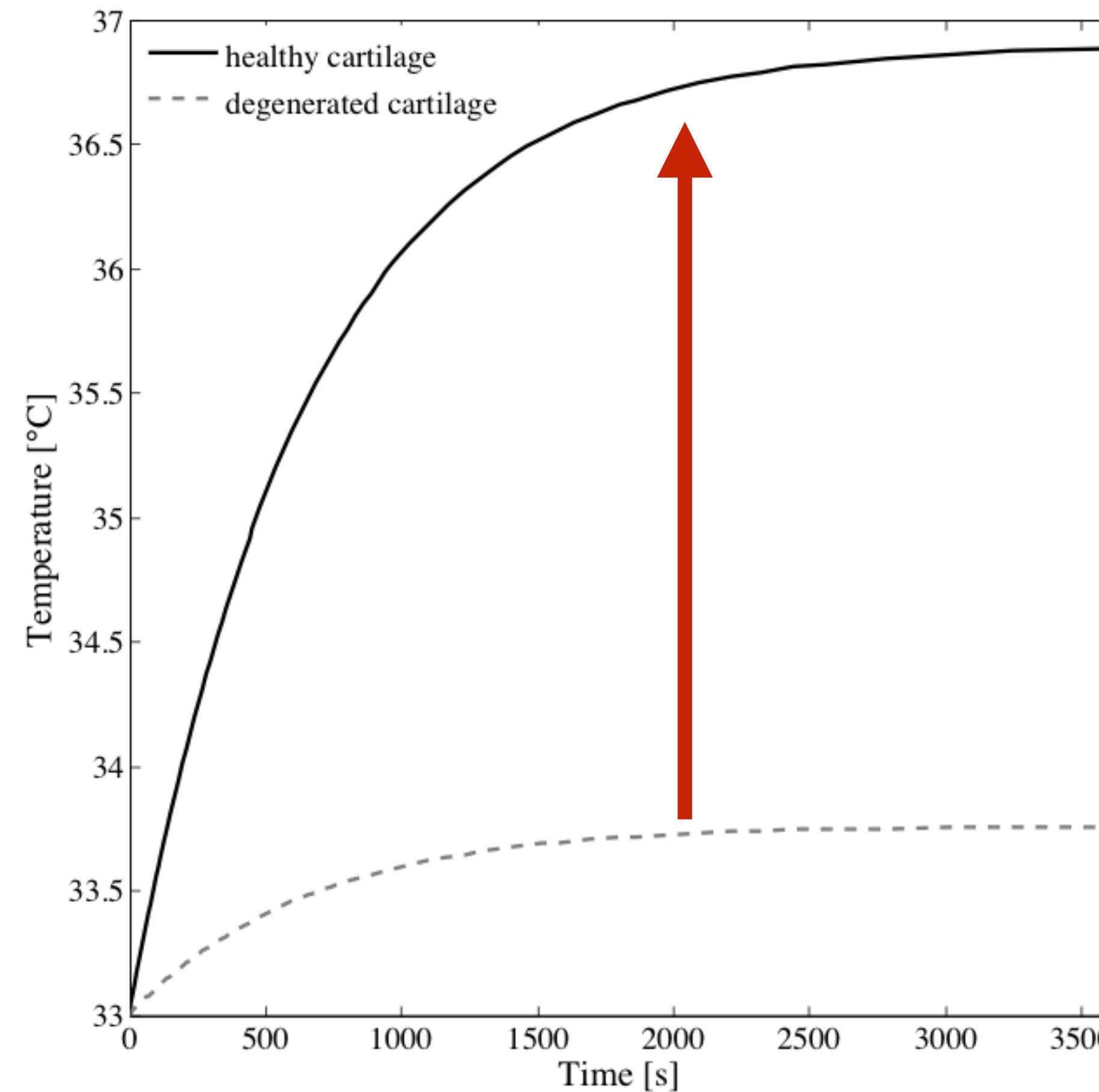


Can we use thermomechanical stimulation to compensate for the loss of dissipative cartilage abilities?

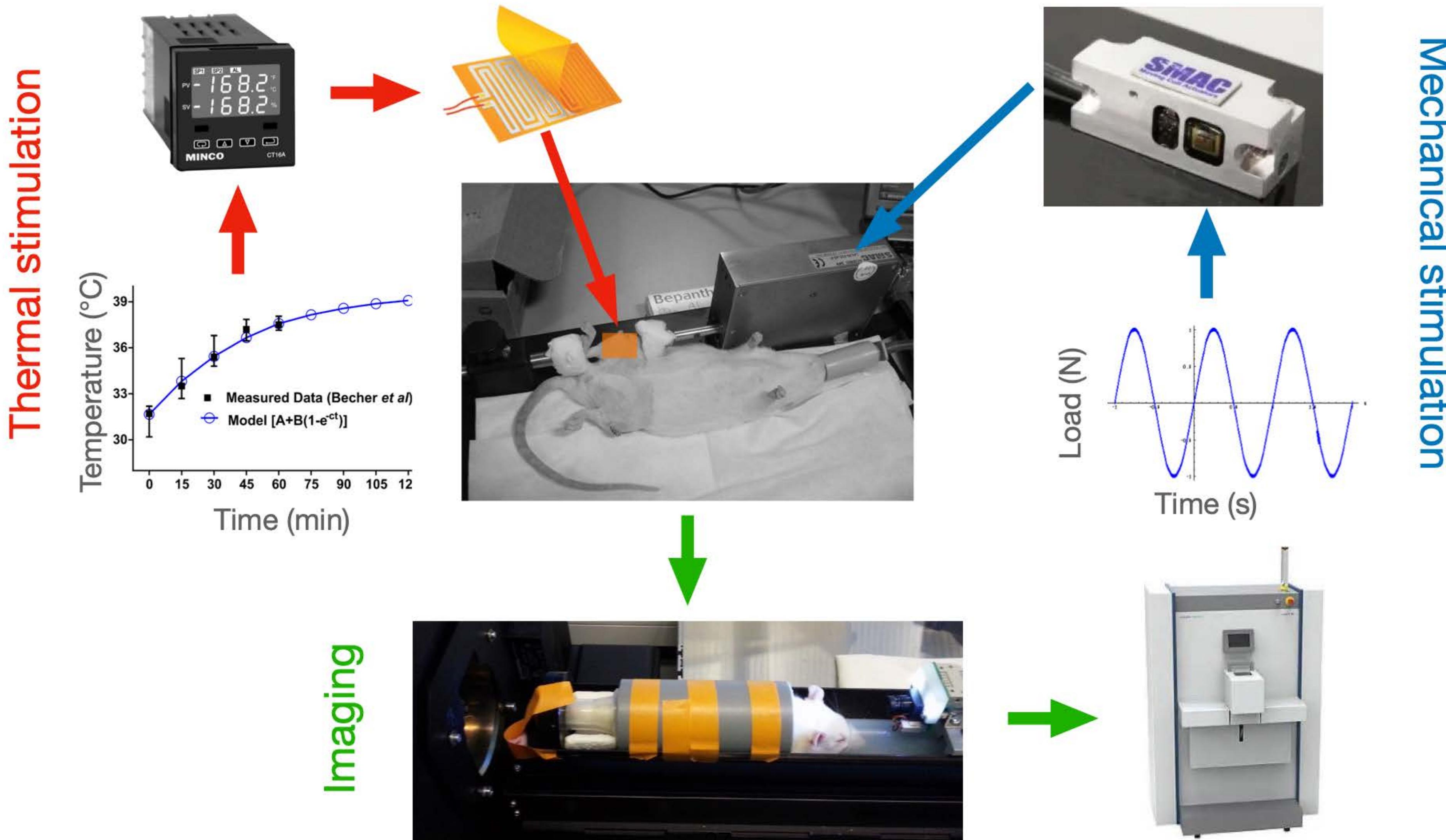


Onsen is undoubtedly bringing some health benefits, but it is not enough:
It is a thermal but not a thermomechanical stimulus

Can we use thermomechanical stimulation to compensate for the loss of dissipative cartilage abilities?



In other words, could thermomechanical stimulations revert osteoarthritis?



Thermomechanobiology: the next frontier for treating osteoarthritis



Yanheng Guo

EPFL

Theofanis Stampoultzis