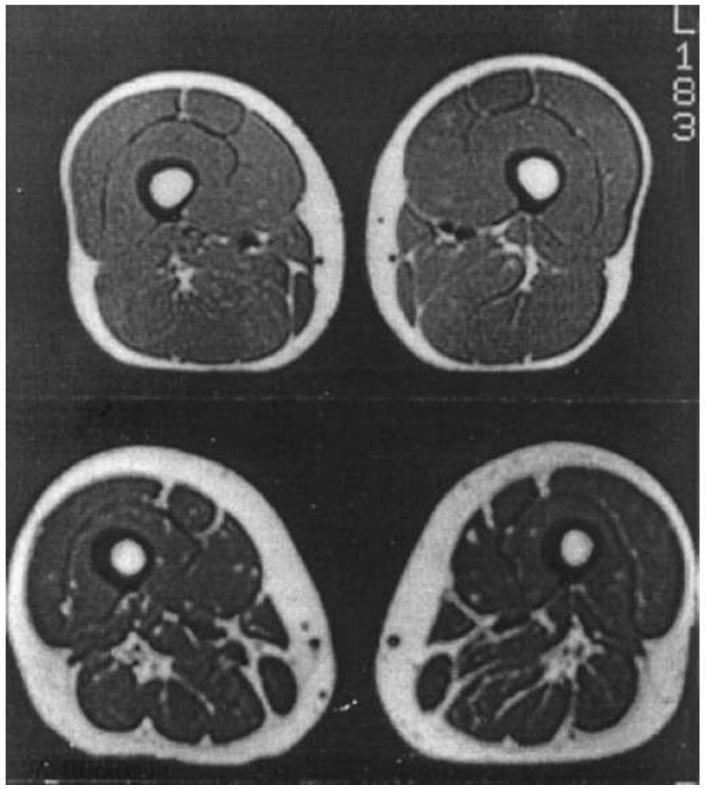


31 yr male

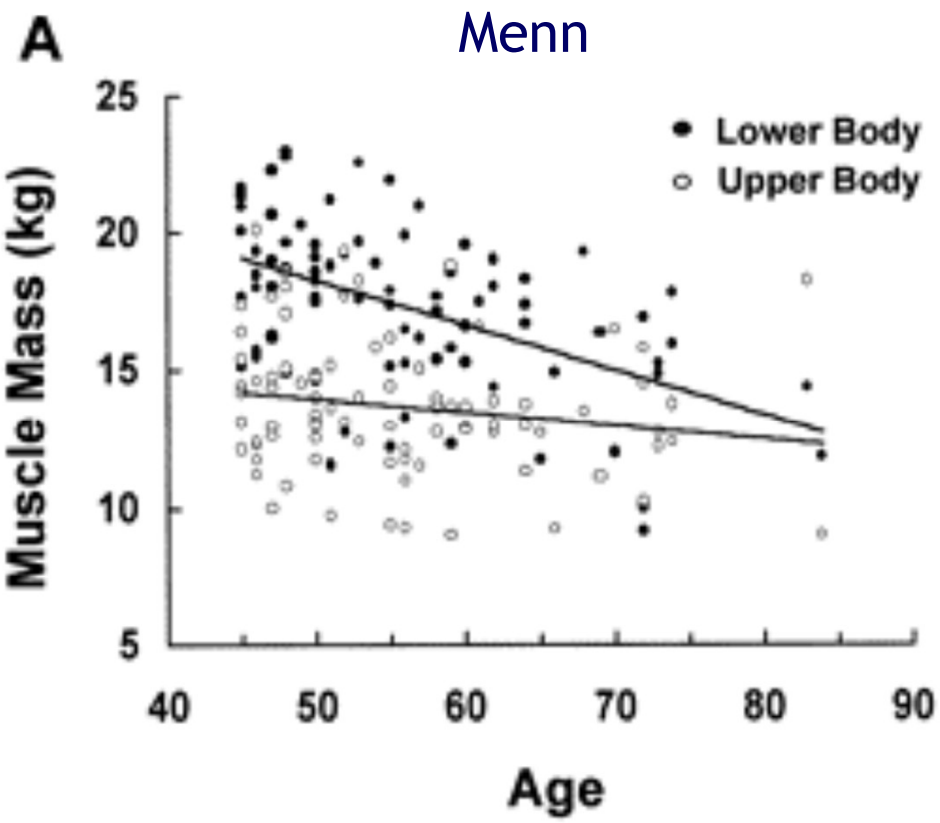
66 yr male

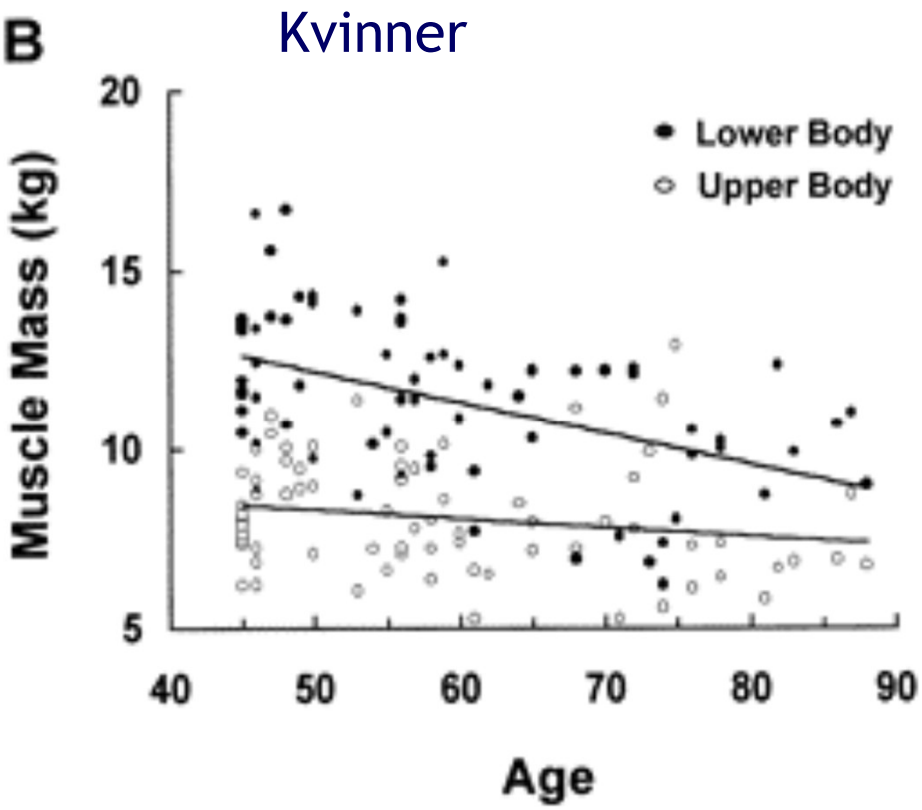
Hva skjer med musklene våre når vi eldes og hva er mekanismene bak sarkopeni?

NIH Institutt for fysisk prestasjonsevne
NORGES IDRETTSHØGSKOLE

Muskelmasse og alder

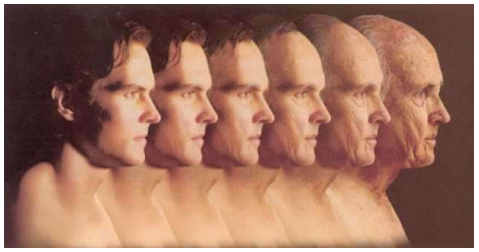
- 5-15% reduksjon/10-år etter fylte 50 år





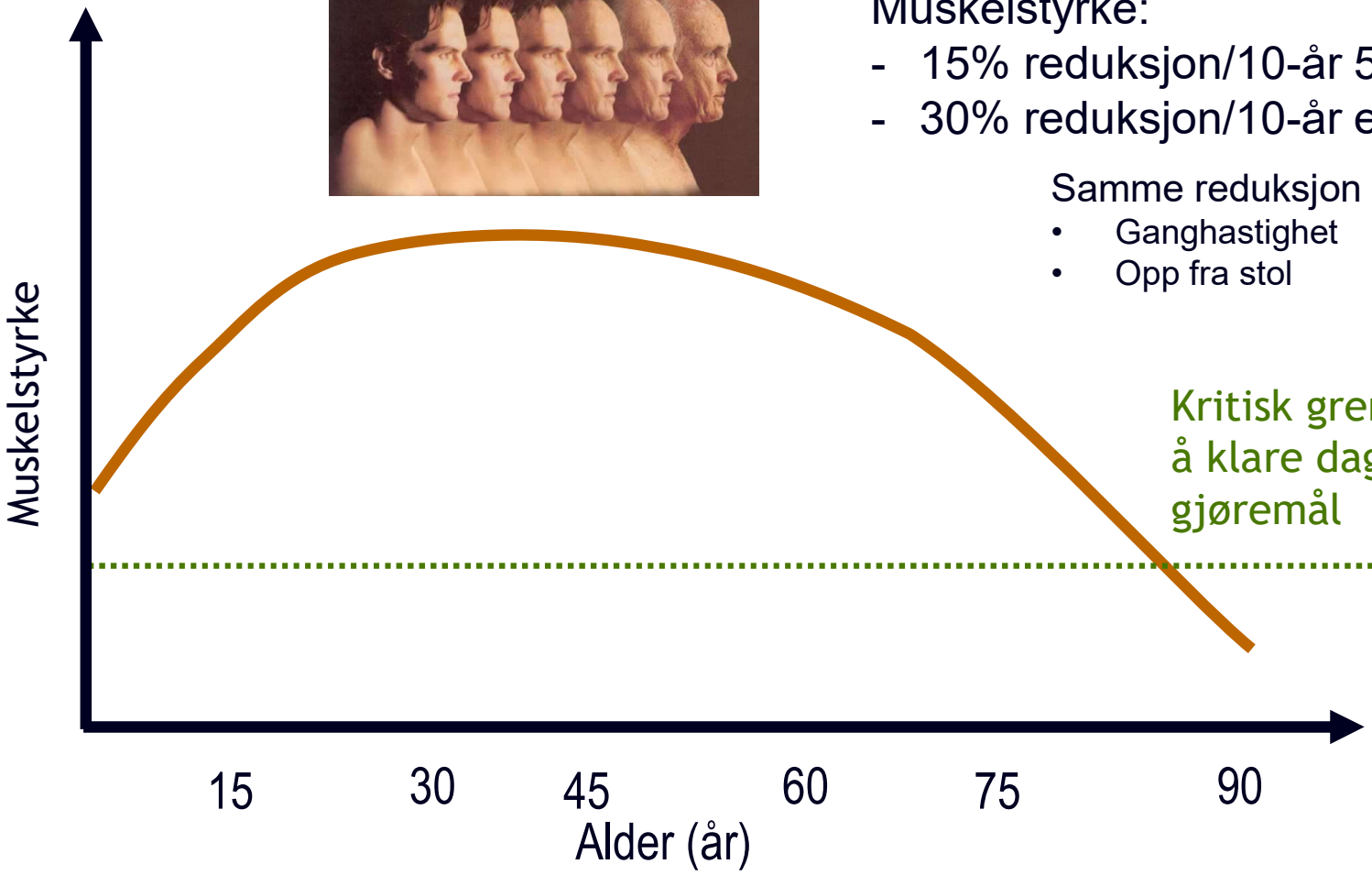
(Janssen et al 2000)

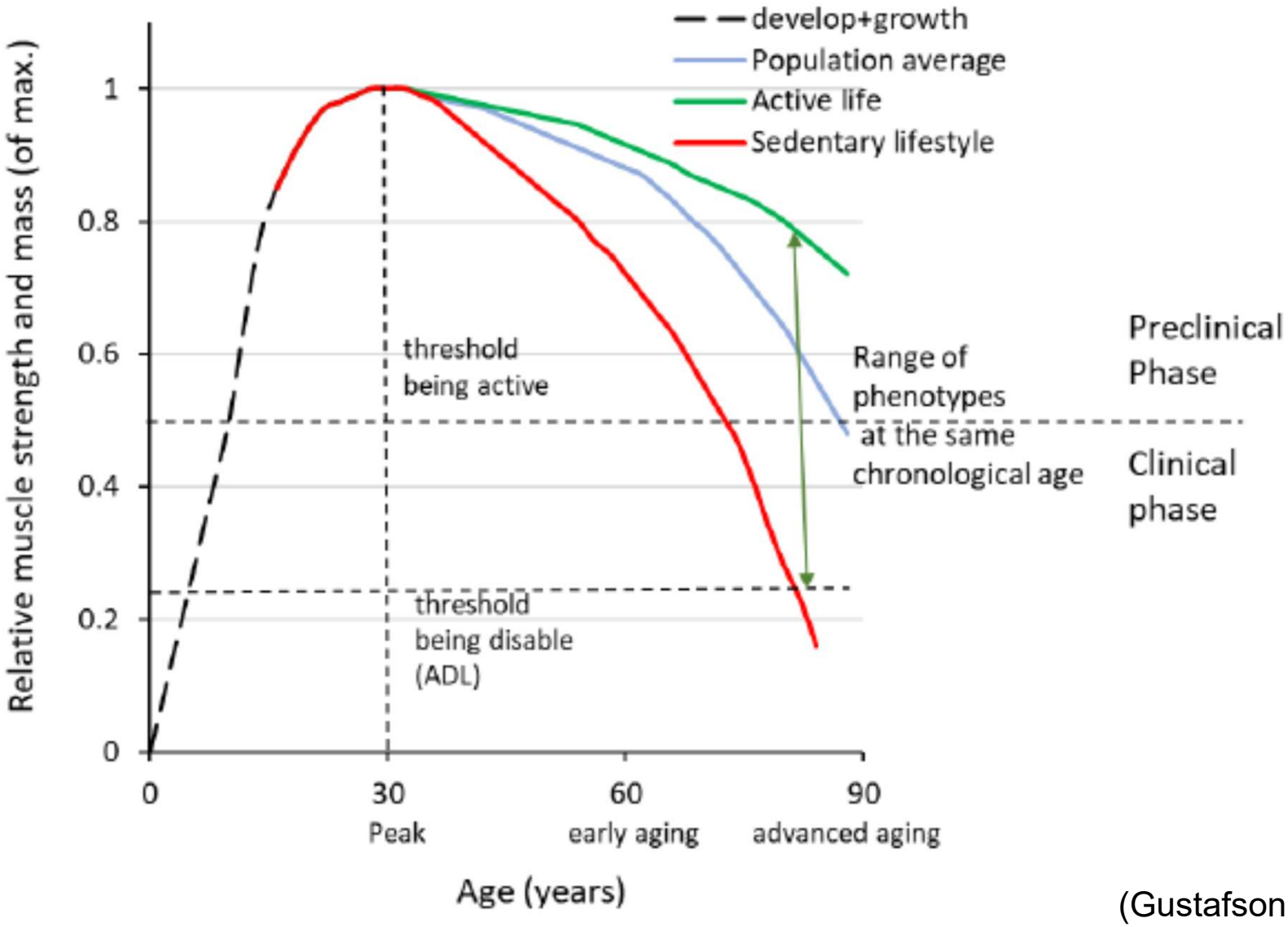
Styrke og alder



Muskelstyrke:
- 15% reduksjon/10-år 50-70 år
- 30% reduksjon/10-år etter fylte 70 år

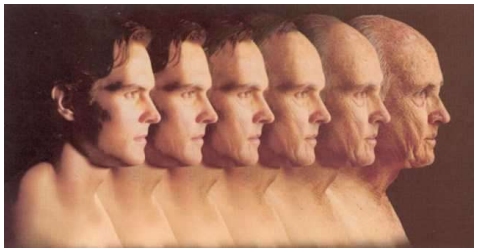
Samme reduksjon i funksjon:
- Ganghastighet
- Opp fra stol



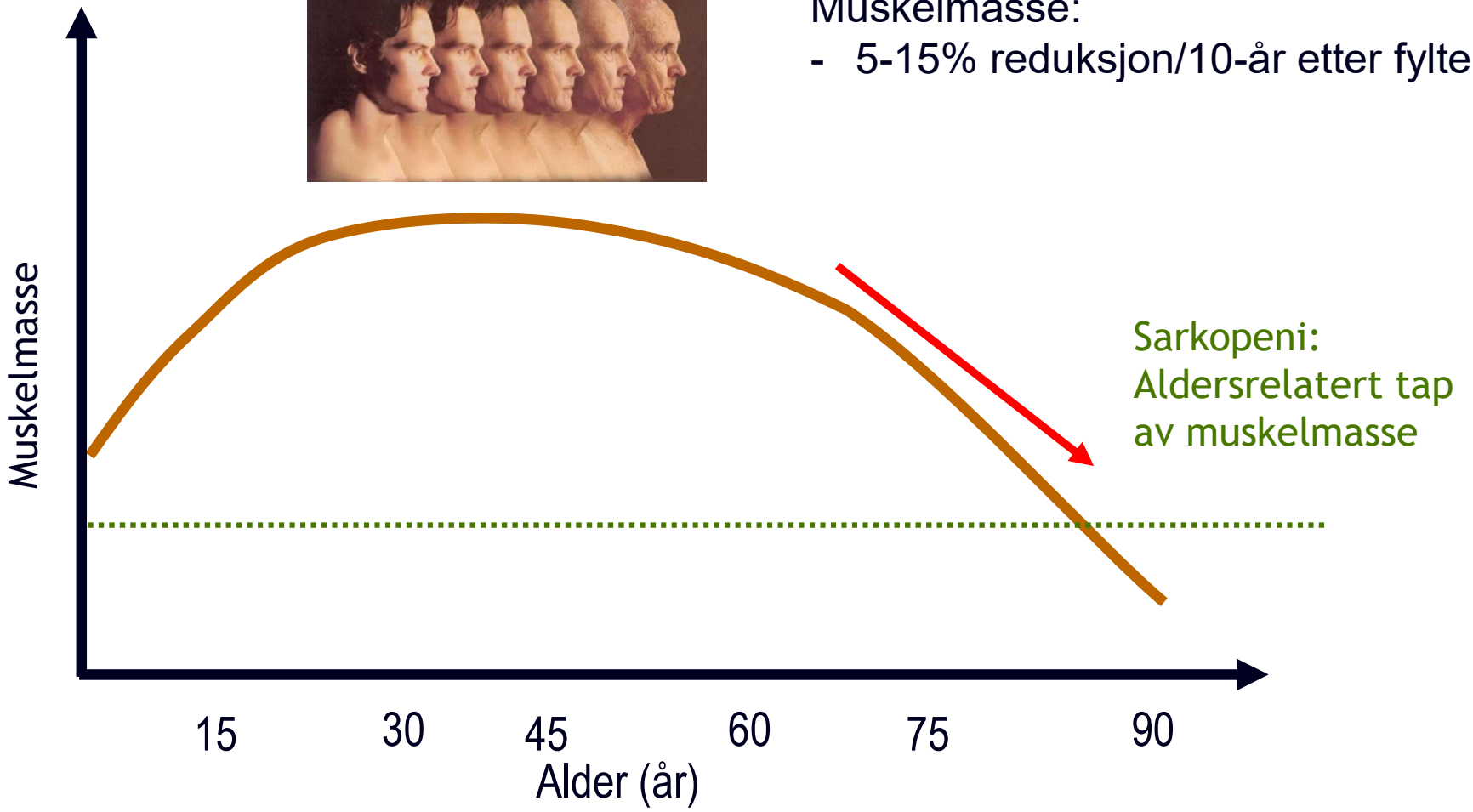


(Gustafson og Ulfhake 2024)

Muskelmasse og alder



Muskelmasse:
- 5-15% reduksjon/10-år etter fylte 50 år



Sarkopeni - diagnose
- *Aldersrelatert muskelsvakhet*

- lav muskelmasse (i forhold til egen kroppsvekt), lav muskelstyrke og lavt funksjonsnivå
  - Pre-sarkopeni
  - Sarkopeni
  - Alvorlig sarkopeni
- Rammer 20-50 % mellom 70-80 år
- Økt forekomst > 80 år

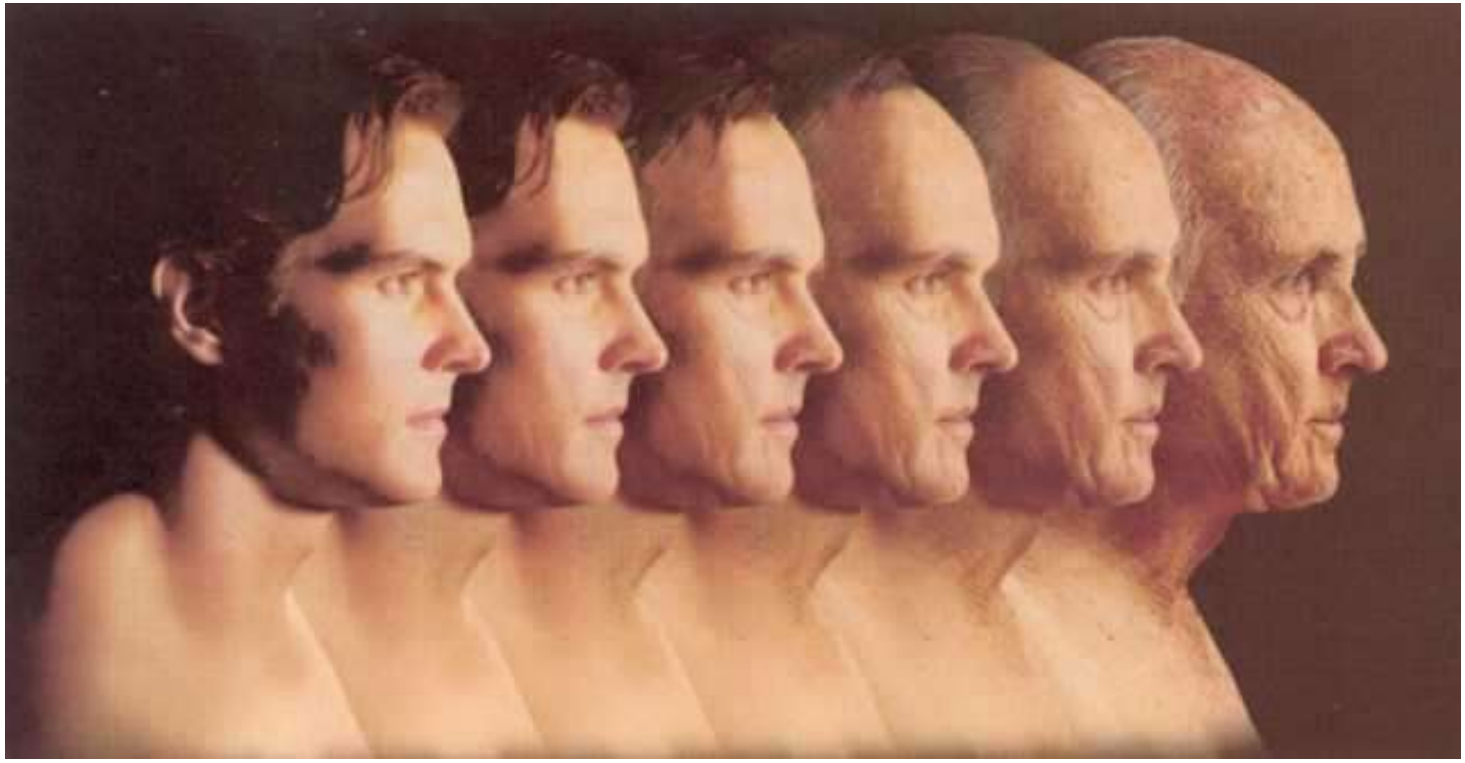
European Working Group on Sarcopenia in Older People (EWGSOP)

Forskjellige grader og ulike former

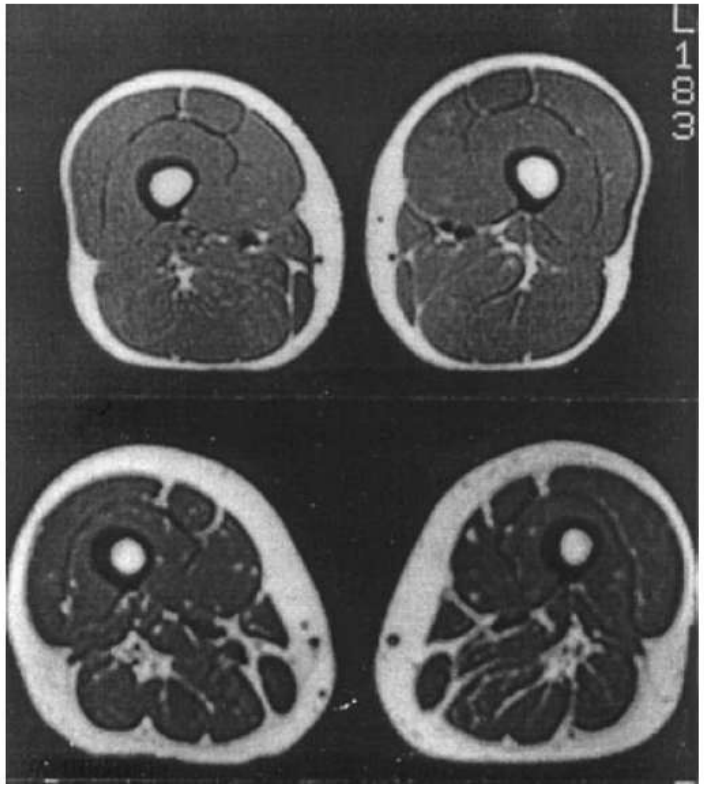
- Pre-sarkopeni:
  - Relativt godt fungerende
    - Tynne – Normalvektige - Overvektige
- Sarkopeni:
  - Dårligere funksjon, går saktere
    - Tynne – Normalvektige - Overvektige

Sarcopenic obesity
«Double metabolic burden»

Aldersrelaterte endringer i muskulatur



Muskelmasse og kvalitet, MR av lår



Mann
31 år

Mann
66 år

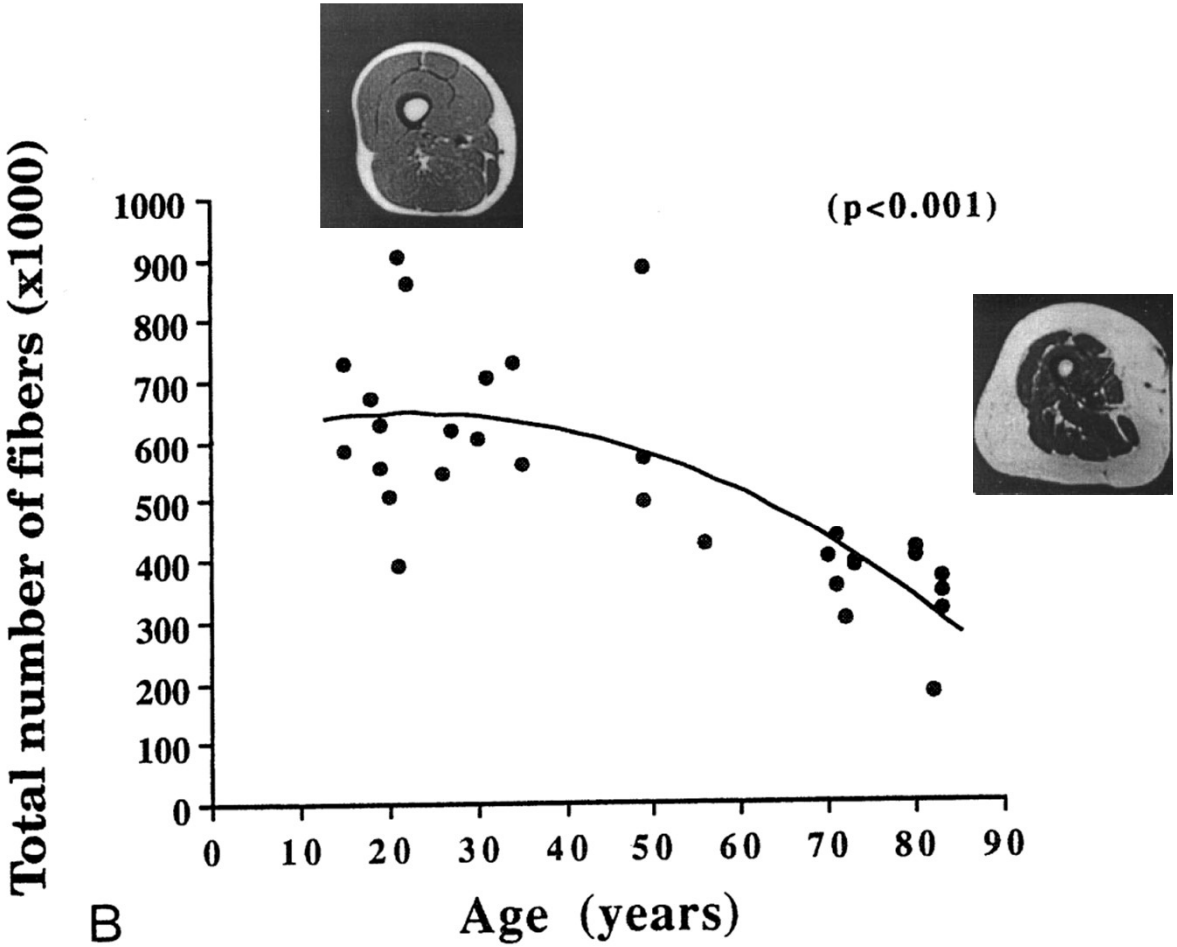
Kvinne
73 år

Kvinne
85 år

Redusert muskelkvalitet!

(Parise & Yarasheski, 2000)

Muskeltverrsnitt og antall fibre

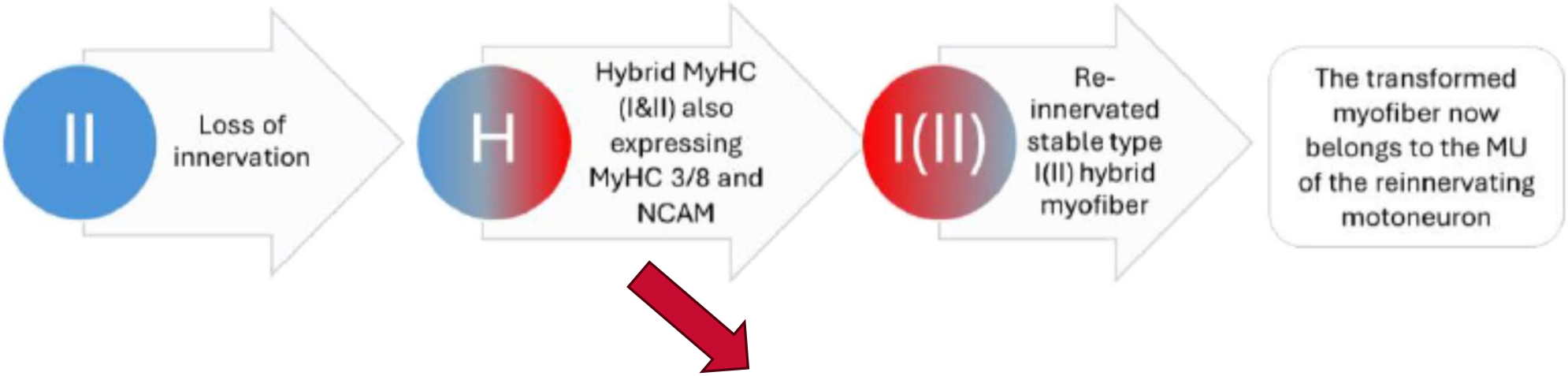


50% færre muskelfibre i *m. vastus lateralis* hos 80-åringer sammenlignet med 20-åringer

Irreversibel prosess

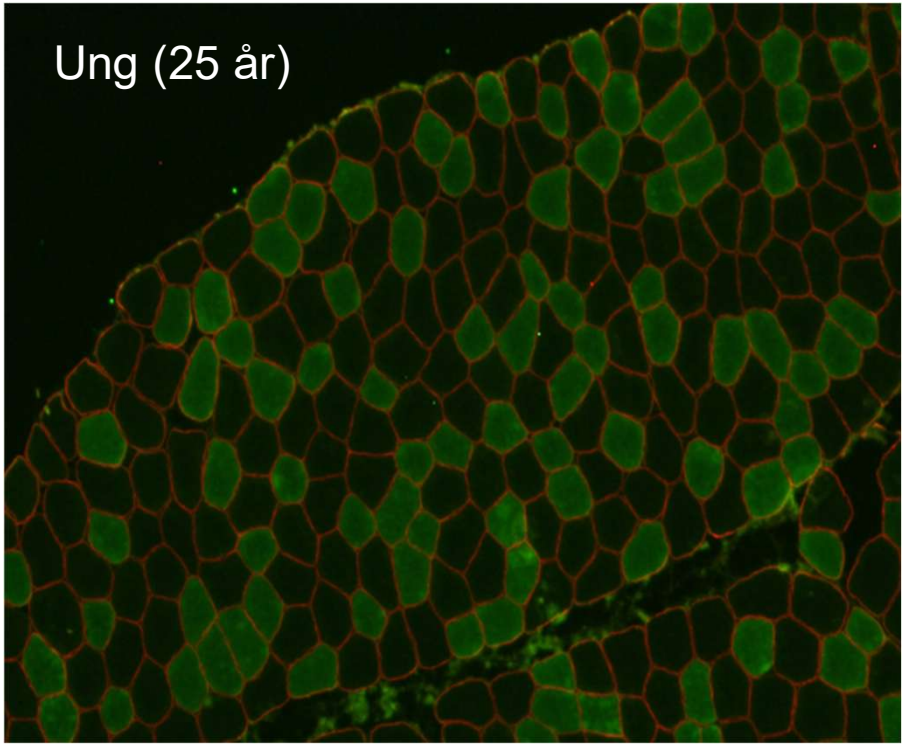
Lexell et al. 1988

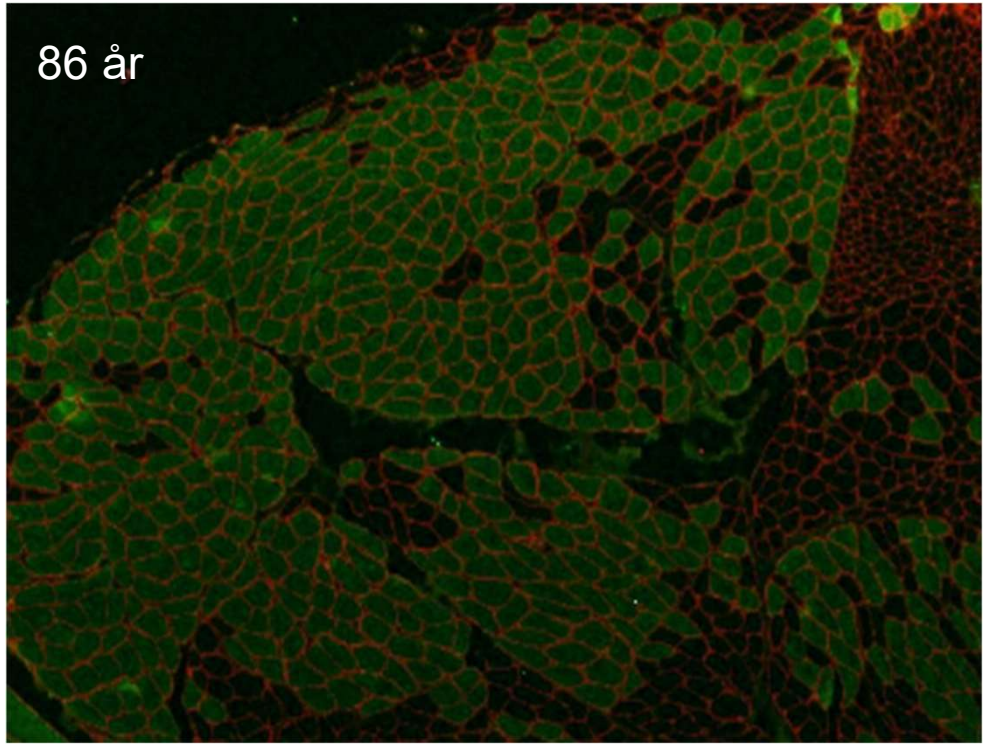
Denervasjon – reinnervasjon
-> fibertype gruppering!



Noen muskelfibre dør – tap av muskelfibre

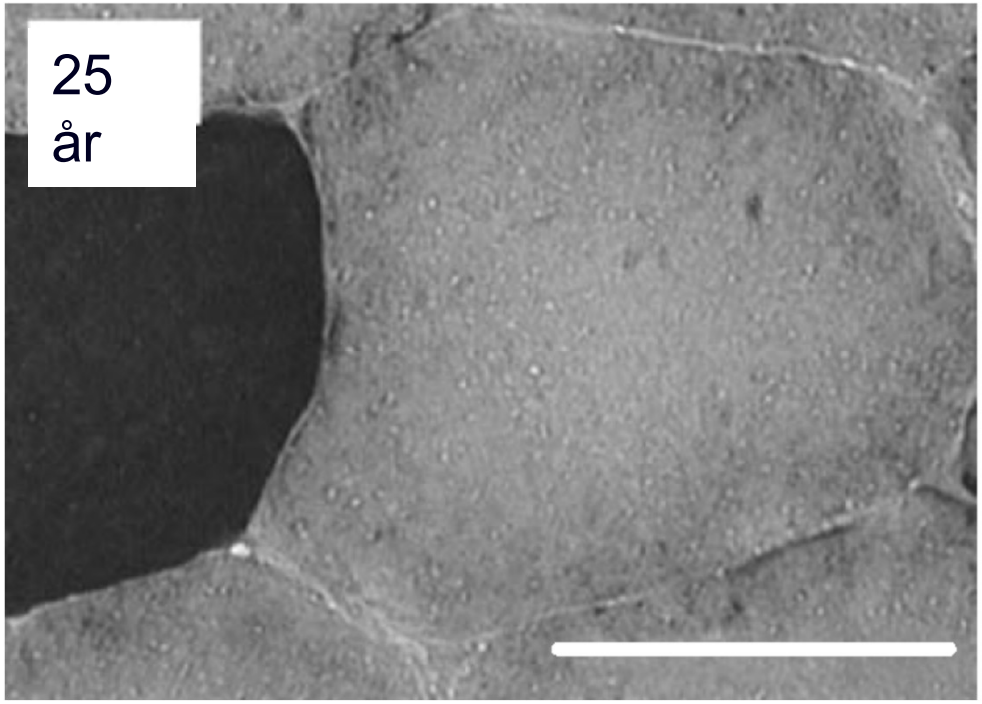
Mindre muskelfibre og “gruppering” av fibre hos enkelte

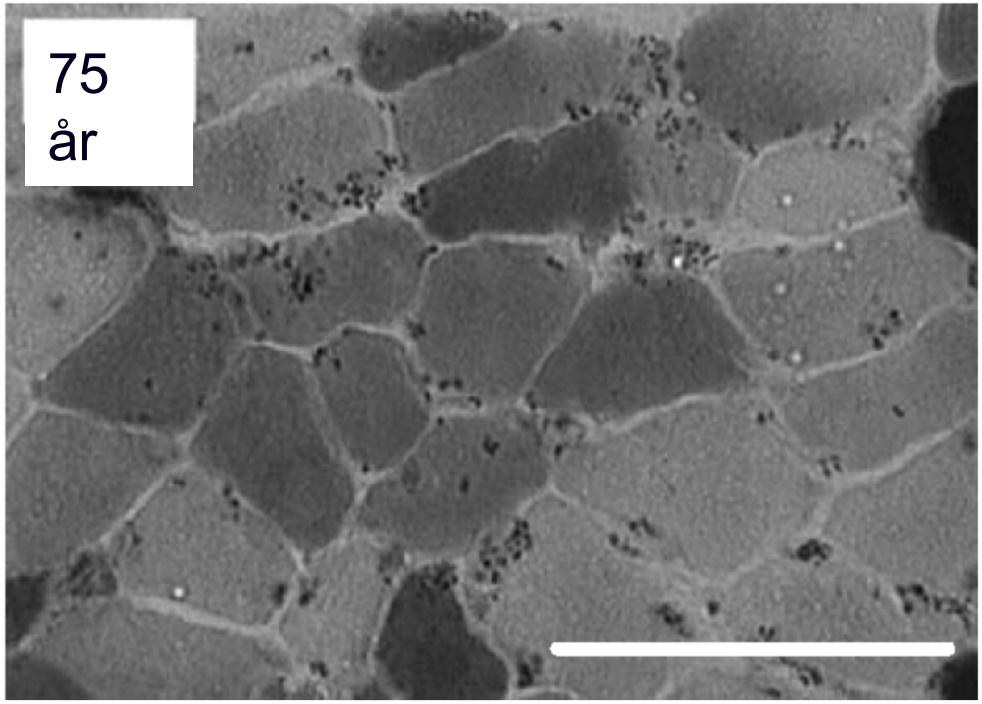




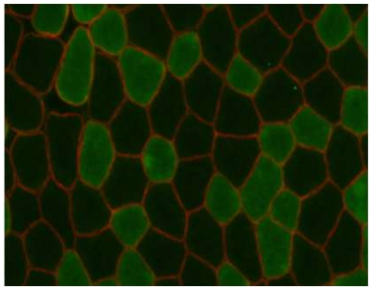
(Karsrud 2017)

Fiberareal – mindre muskelfibre hos eldre – spesielt de hurtige type II fibrene



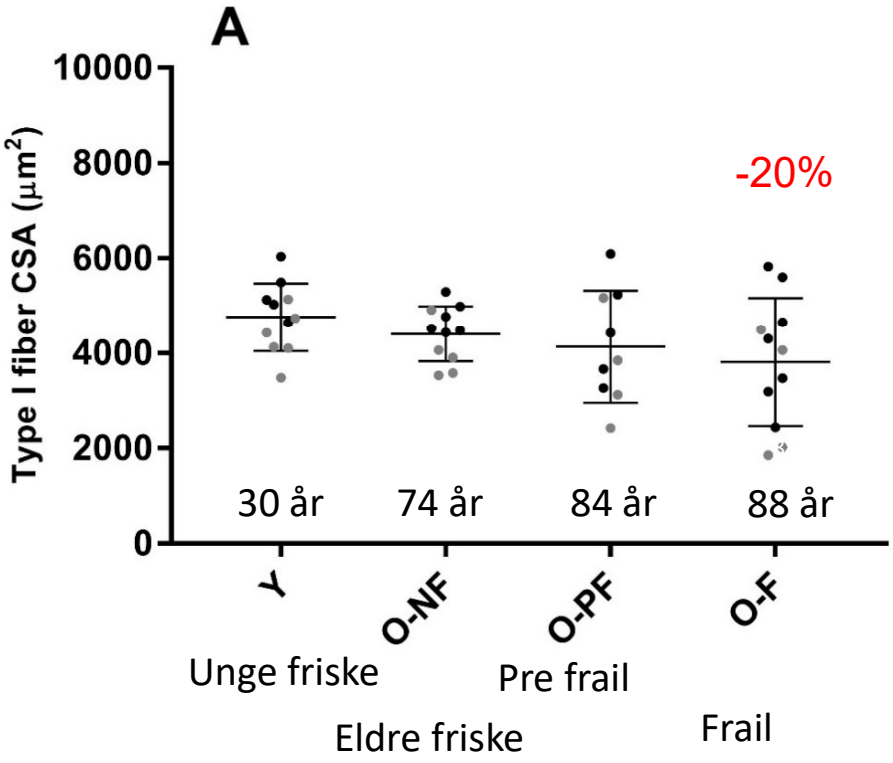


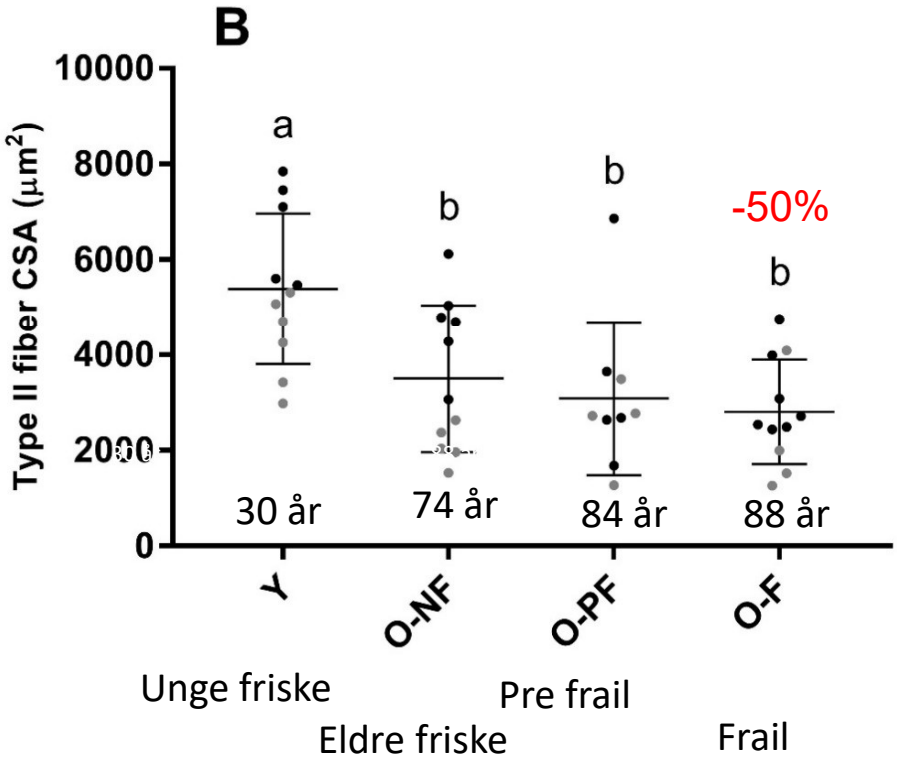
(Andersen 2003)



Forskjeller mellom gammel og ung muskel

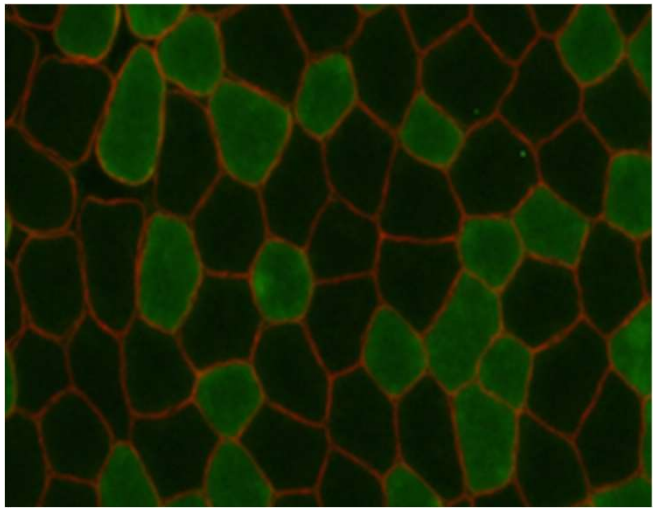
- Fiberstørrelse, mindre type II fibre





(Aas et al, 2019)

Fiberareal

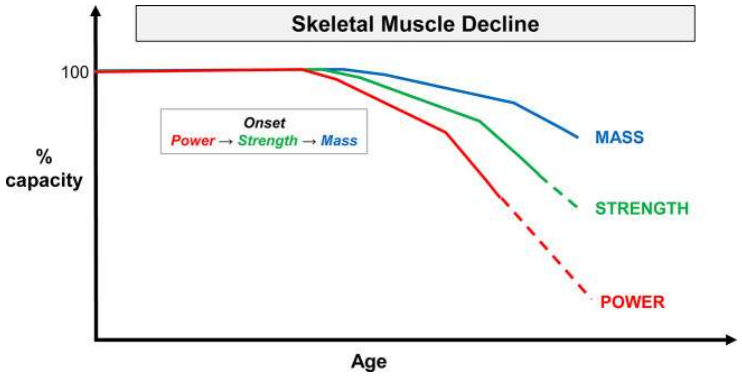


- Eldre har mindre muskelfibre enn yngre
- Størst reduksjon i type II fibre ved aldring
  - Type I 20-30 % mindre hos eldre (80 år) enn yngre
  - Type II 40-70 % mindre hos eldre (70-90 år)
- Enkelte områder av muskelen som blir påvirket

Reversibel prosess!

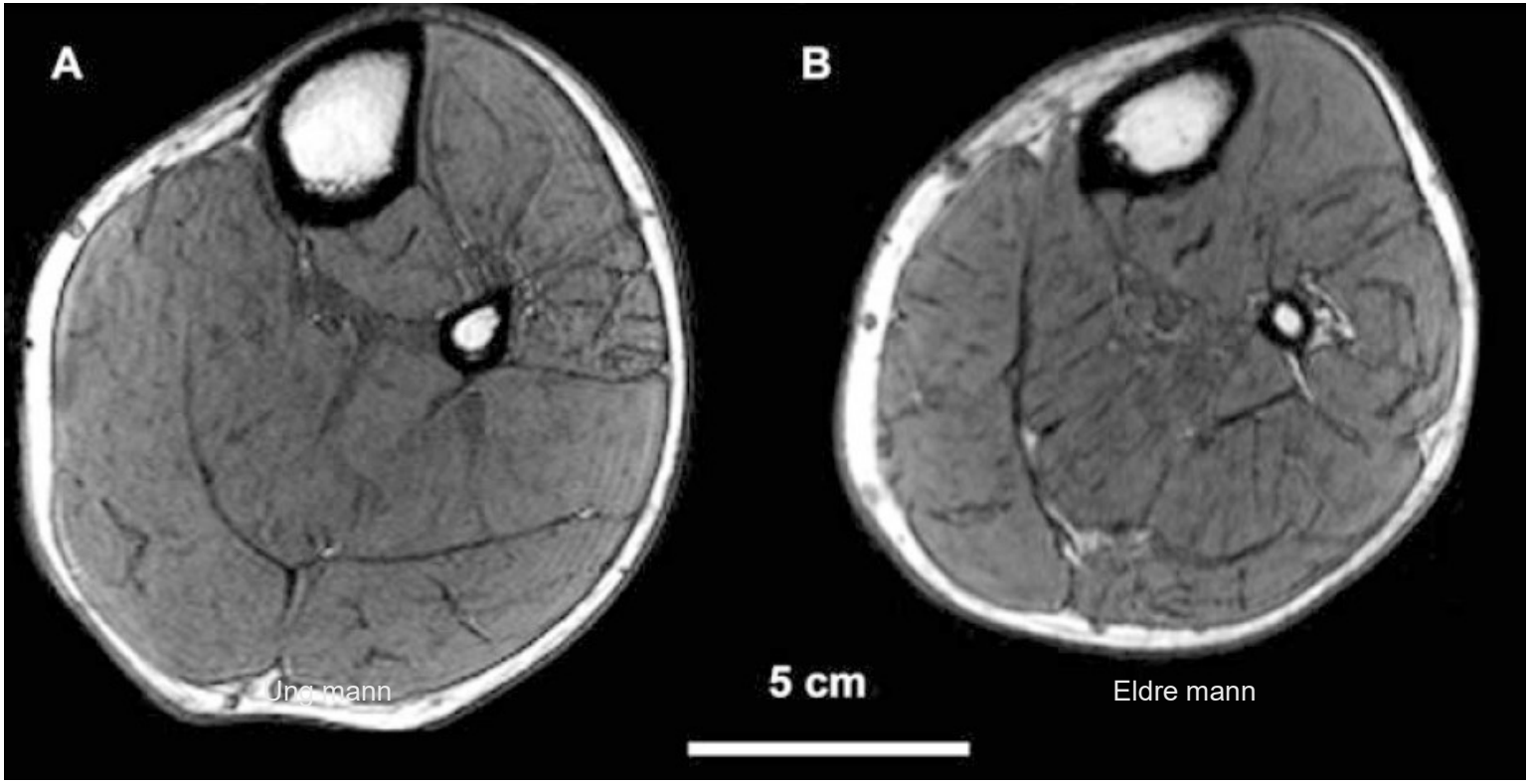
Eksplosiv styrke mer redusert enn maksimal styrke

Powerpenia



Muskelkvalitet
- økt fettinnhold, 30% lavere N/cm²

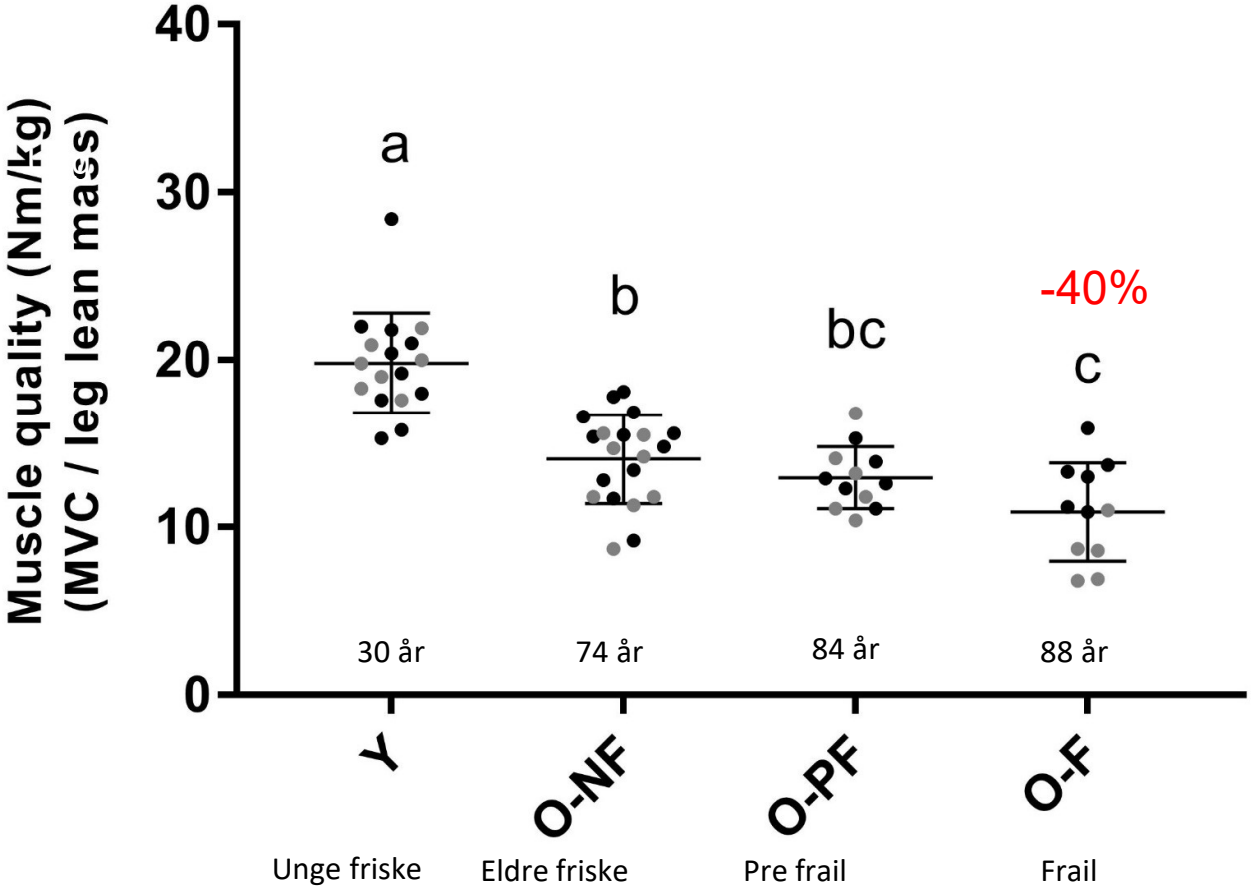
Ung voksen mann (25 år) Eldre mann (75 år)

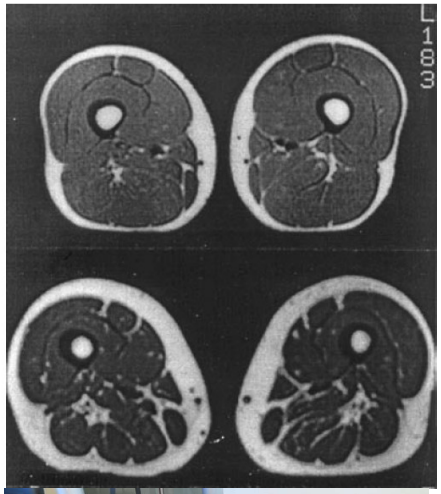


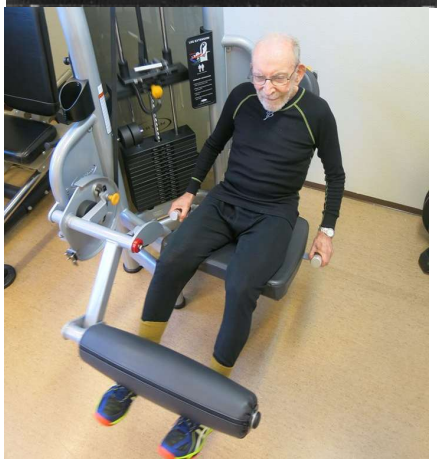
Morse et al. 2004

Forskjeller mellom gammel og ung muskel

- Muskelkvalitet - knestrekkerne

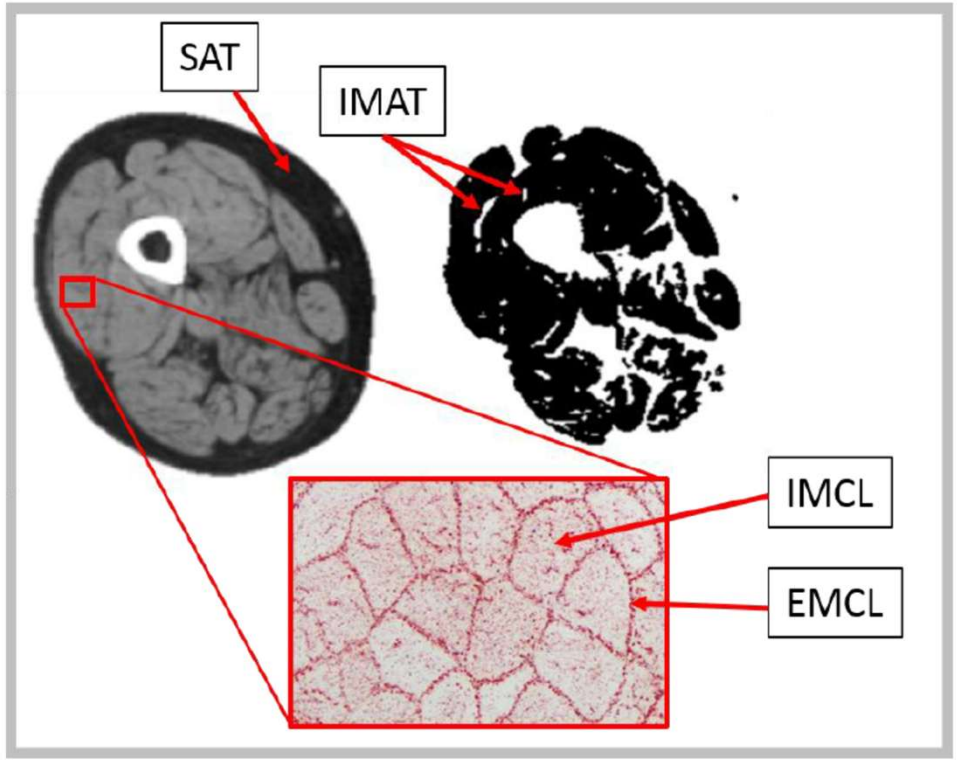






(Aas et al,. 2019)

Fettinfiltrasjon i muskelvev



SAT: Subcutaneous adipose tissue

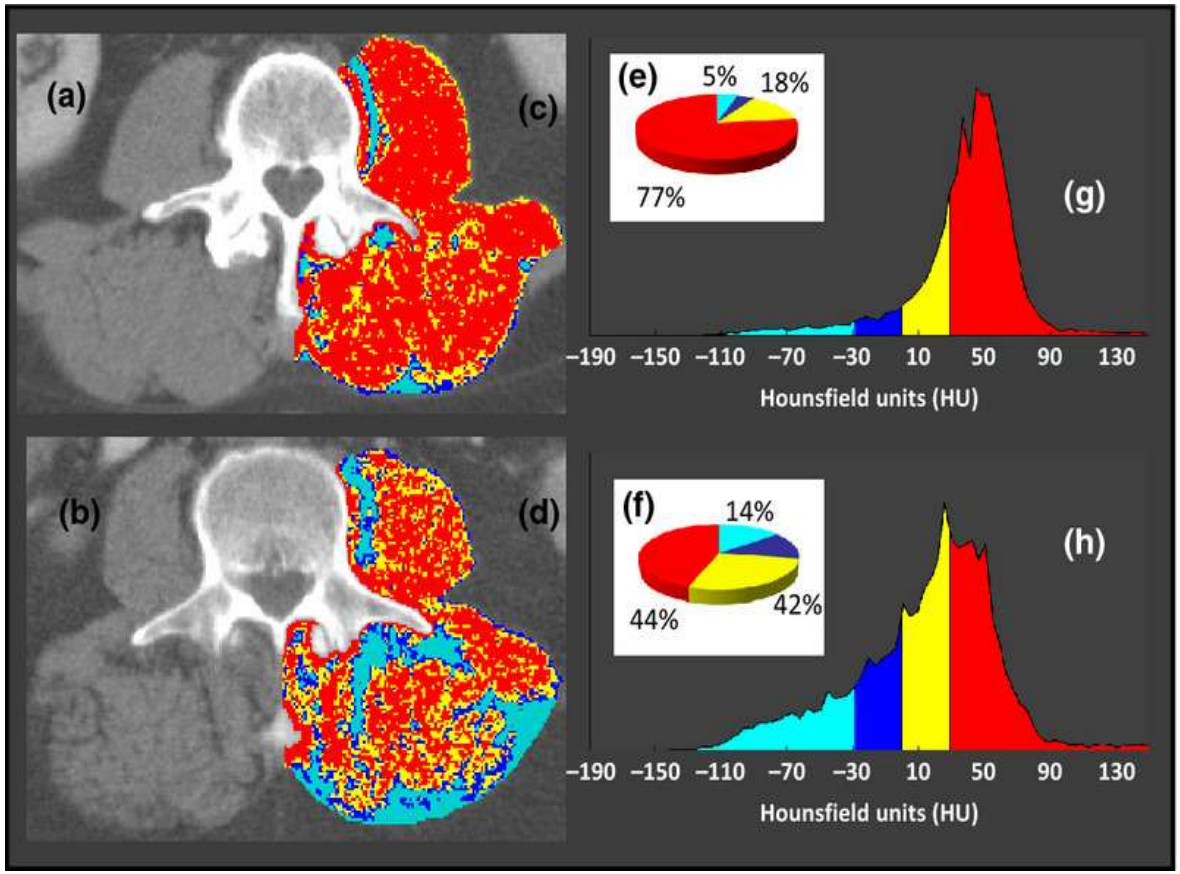
IMAT: Intermuscular adipose tissue

IMCL: Intramyocellular lipids

EMCL: extramyocellular lipids

Måling av vevstetthet ved røntgenståler (CT scan)

Eldre - frisk



Eldre - skrøpelig

CT scans

Fett: <-30 HU

Muskel: 0 – 150 HU

Normal tetthet muskel: 31-100 HU

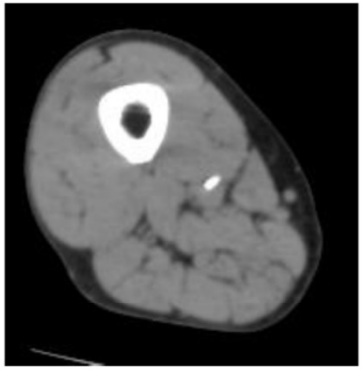
Lav-tetthet muskel:0-30 HU

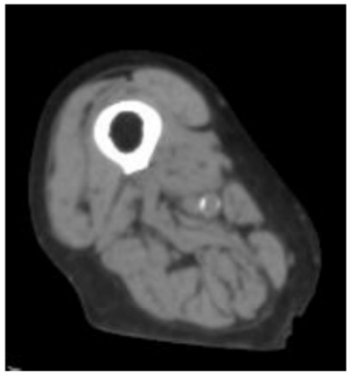
Økt mengde intermuskulært fett (IMAT) med aldring – også hos de som går ned fettmasse!

12% reduksjon i spesifikk styrke

Prospective study following participants over 5 years

- 3075 well-functioning men and women
- between the ages of 70 and 79 y at baseline





	Men (n = 813)		Women (n = 865)	
	Change	Percentage change	Change	Percentage change
Total thigh muscle area (cm^2)	−6.8 ± 10.0	−4.9 ± 7.4	−3.2 ± 7.6	−3.2 ± 7.9
Average maximal muscle torque (N-m)	−24.5 ± 28.1	−16.1 ± 20.6	−12.7 ± 17.5	−13.4 ± 23.0
Muscle quality (N-m/cm^2)[3]	−0.32 ± 0.41	−13.1 ± 20.4	−0.26 ± 0.37	−11.1 ± 23.8
Subcutaneous fat (cm^2)	−0.8 ± 9.1	−1.5 ± 19.8	−3.2 ± 16.6	−2.1 ± 16.9
Intermuscular fat (cm^2)	3.1 ± 3.1	48.5 ± 59.6	1.7 ± 3.0	29.0 ± 43.6

Delmonico et al., 2009. Am J Clin Nutr.

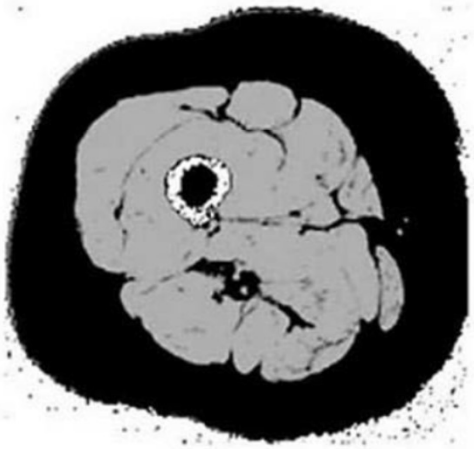
Muskelkvalitet (kraft per volum)

- større potensial for treningspåvirkning hos eldre?

	Timed up and go (s)	Stair up (s)	Stair down (s)	Lower extremity power (W)	Knee extension strength (N)
Subject 07	8.4	6.6	7.0	88.2	194.8
Subject 44	6.5	4.9	4.4	139.5	248.3
Difference	25%	29%	45%	45%	24%

80 år
Reversibelt?

Subject 07
Lean: 99.5 cm^2
IMAT: 18.8 cm^2



Subject 44
Lean: 100.7 cm^2
IMAT: 9.8 cm^2

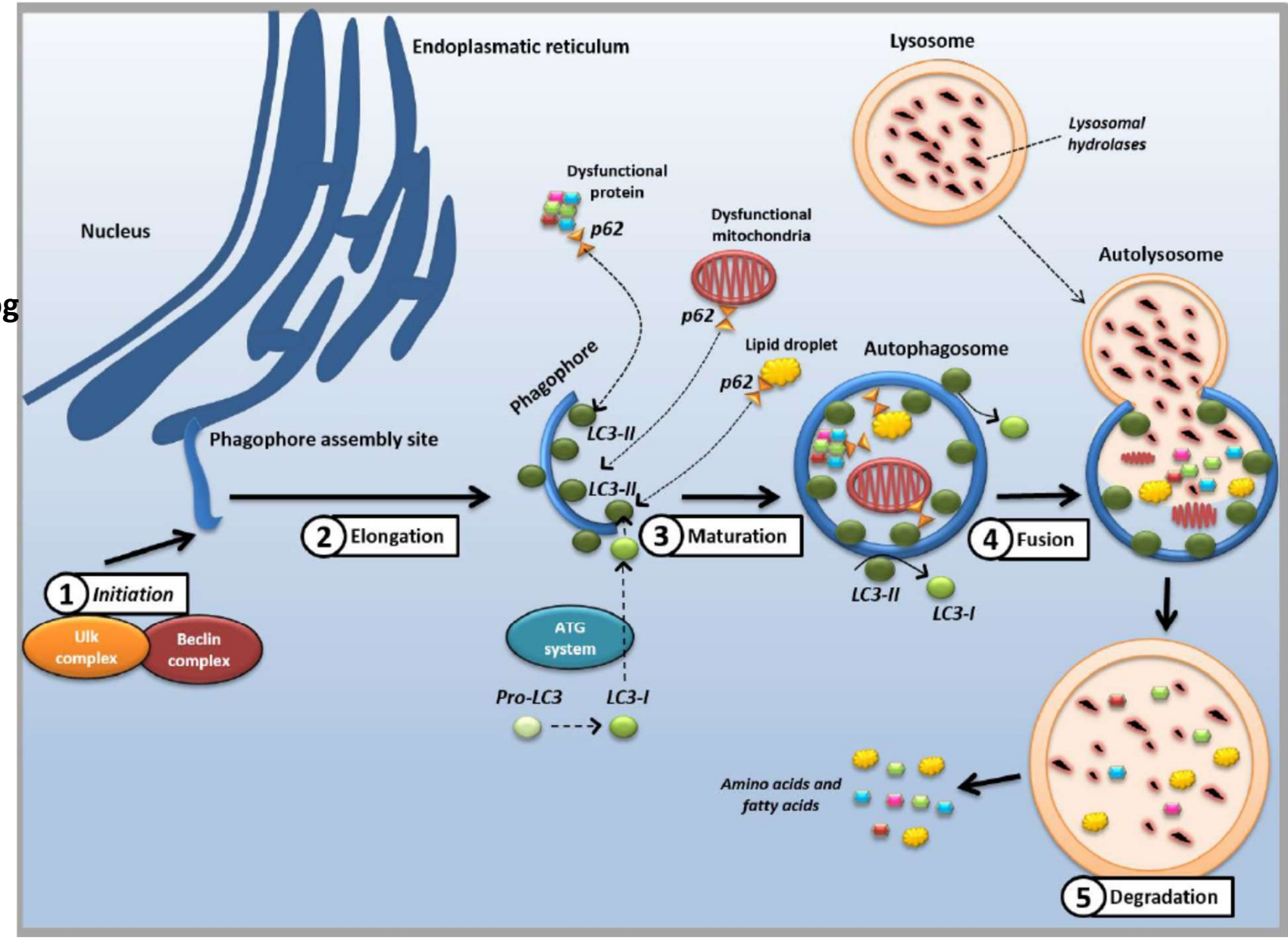
Kvinner – samme alder
Samme muskelmasse
- 24% forskjell i muskelstyrke
- 25-45% forskjell i funksjon!

IMAT: Intra Muscular Adipose Tissue

Addison et al. (2014).

Redusert kapasitet for å fjerne ødelagte proteiner og organeller?

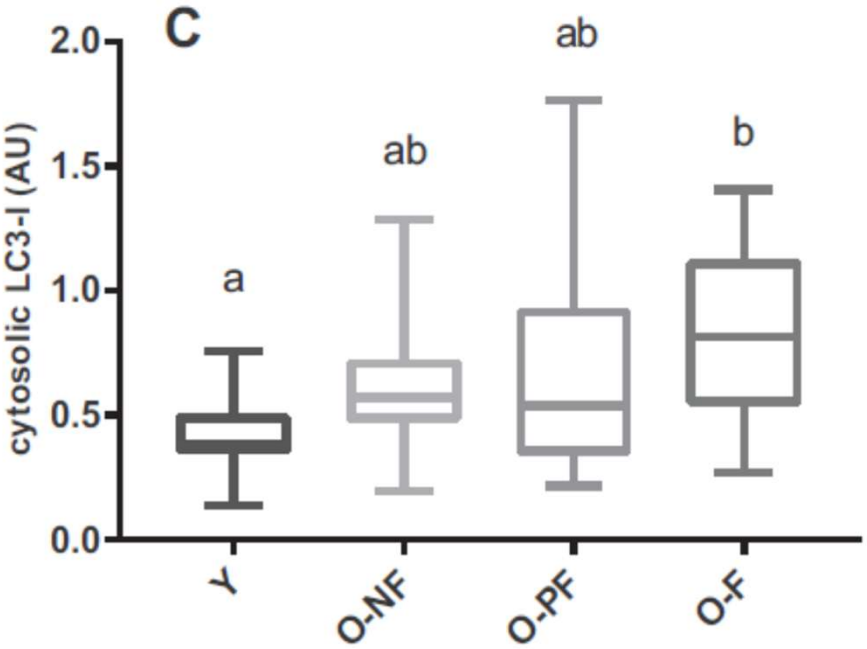
- **Redusert autofagi**
- *Akkumulering av dysfunksjonelle proteiner?*
- **Redusert mitofagi**
- *Dårlig mitokondriefunksjon*



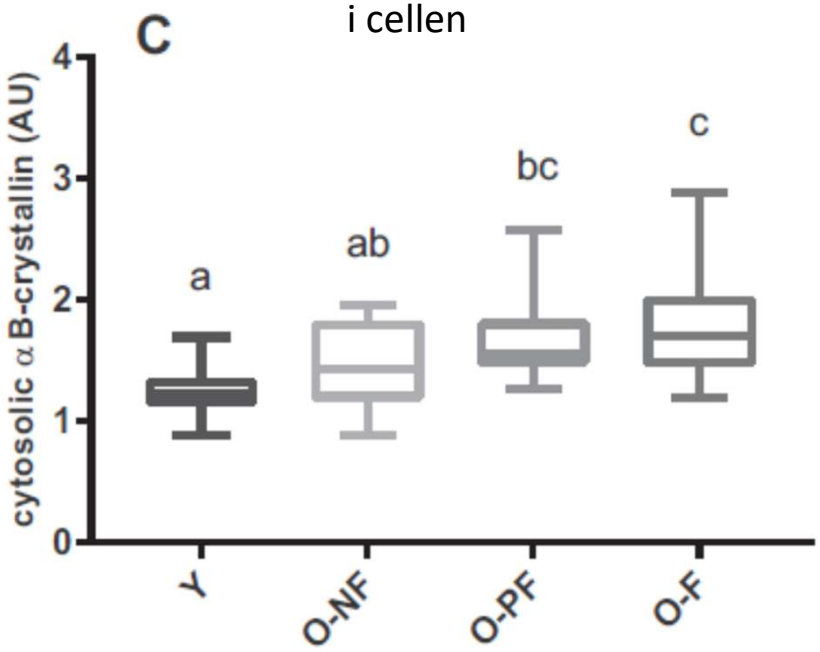
Sigve Nyvik Aas

Kan redusert autofagi øke stress i muskelceller og dermed redusere muskelkvalitet?

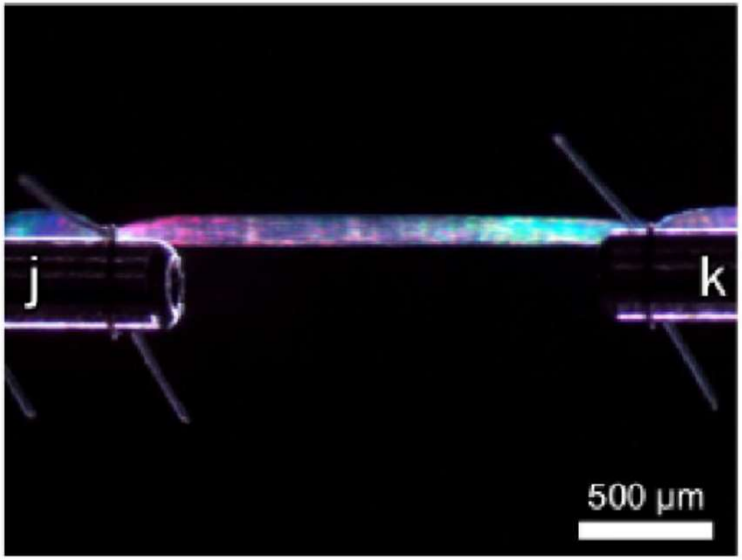
Markør for autofagi; økte nivåer indikerer redusert aktivitet!

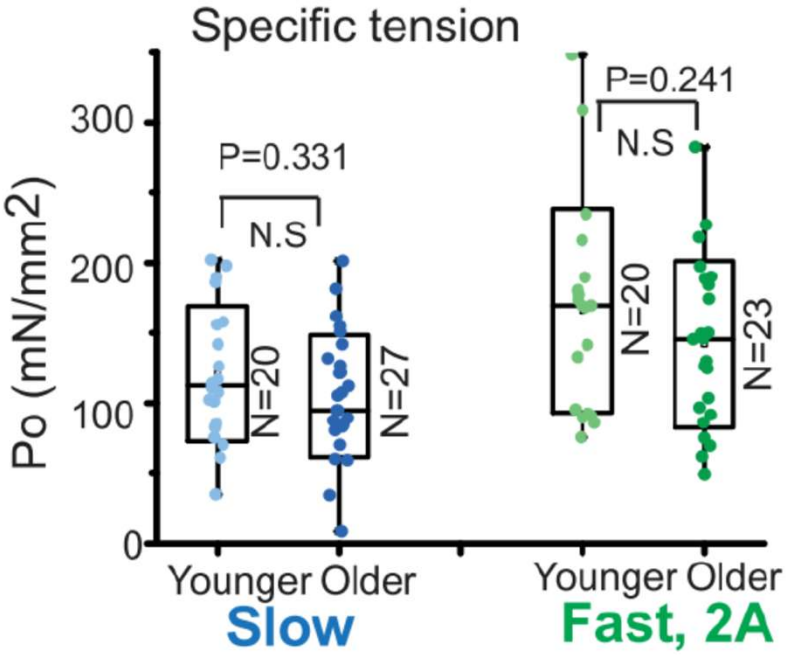


Stress protein; økte nivåer -> Økt stress i cellen



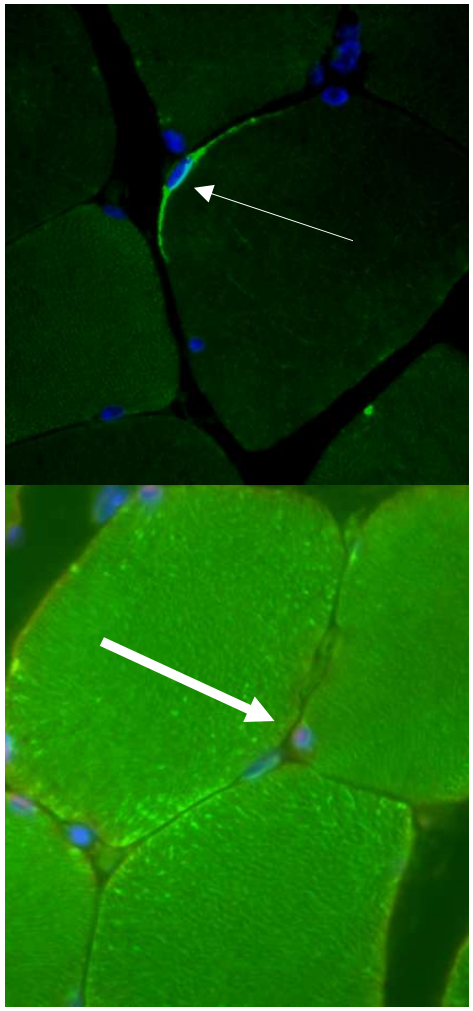
Redusert spesifikk kraft på fibernivå med aldring?

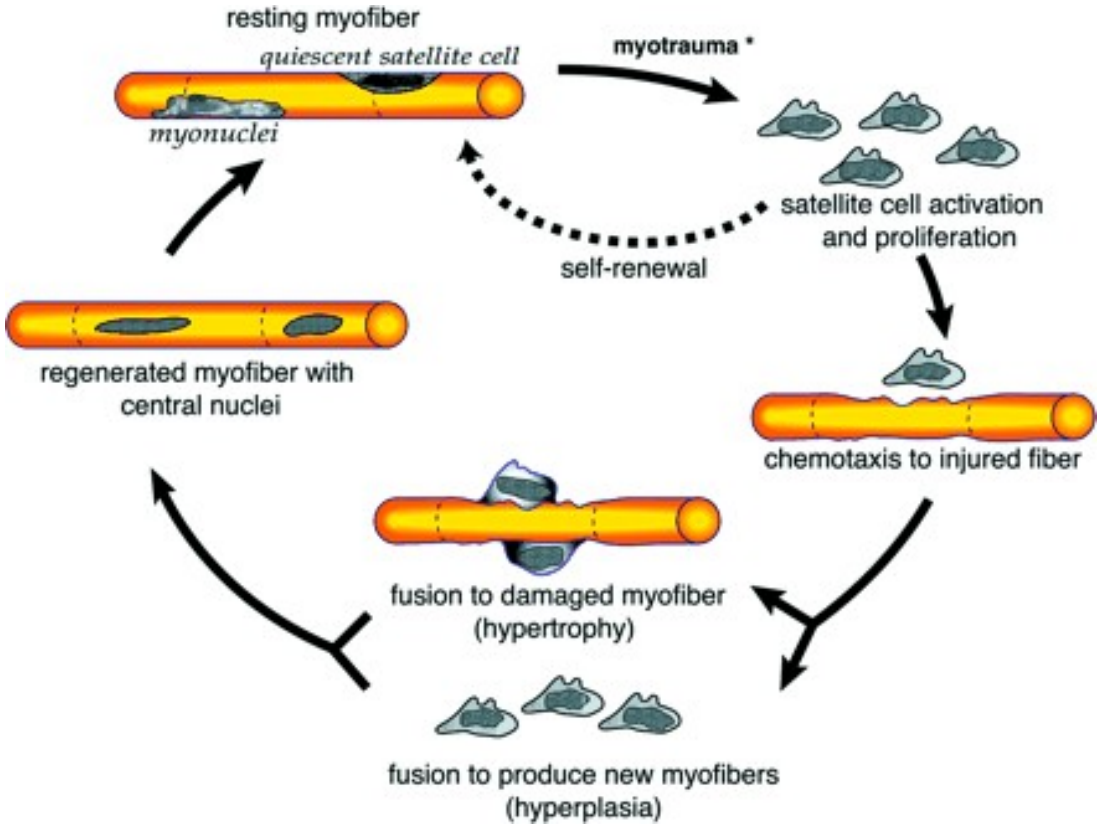




Murgia et al., 2017. Cell Rep

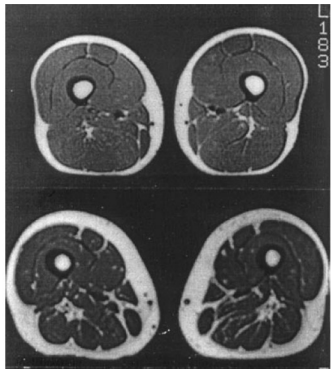
Satellittceller – redusert antall og funksjon hos eldre

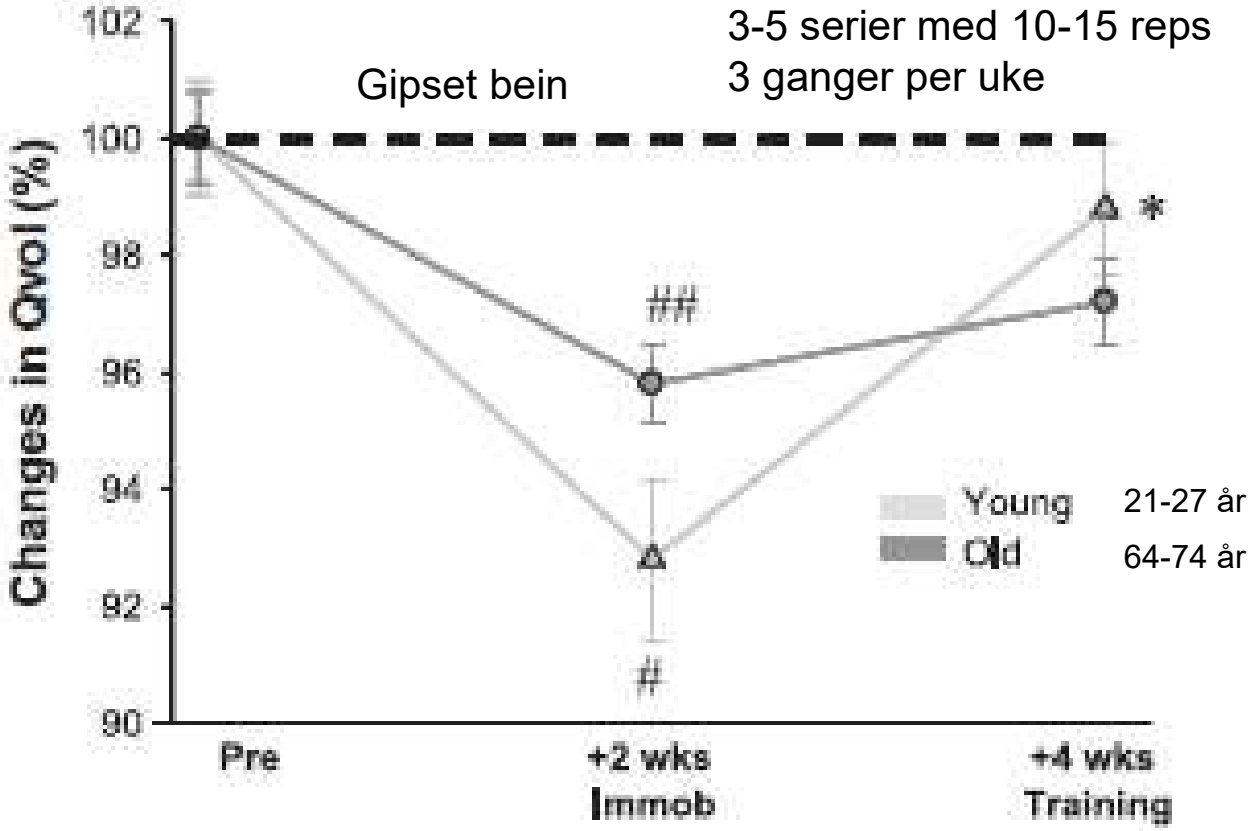


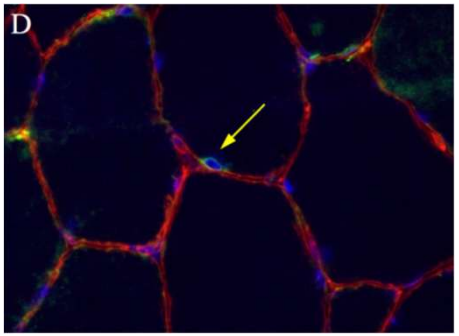


Langsommere opptrening hos eldre?

- pga. færre satellittceller?







(Suetta et al 2009)

Ageing Research Reviews 65 (2021) 101200

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Review

Sarcopenia – Molecular mechanisms and open questions

Petra Wiedmer [a], Tobias Jung [a], José Pedro Castro [a,1], Laura C.D. Pomatto [b,2], Patrick Y. Sun [b], Kelvin J.A. Davies [b,c,d], Tilman Grune [a,e,f,g,h,*]

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[h] NutriAct-Competence Cluster Nutrition Research Berlin-Potsdam, Nuthetal, Germany

(Wiedmer et al 2021)

Characteristics of age-related muscle atrophy
Sarcopenia

muscle composition:

- Redistribution of muscle fibre types
- Adipocyte infiltration (sarcopenic obesity)

intracellular changes:

- Shift towards proteolysis
- Protein modifications
- ↑susceptibility to oxidative stress
- Impaired mitochondrial function

neuromuscular drive:

- ↓ number of motor units

satellite cells:

- ↓ number
- ↓ regenerative capacity

systemic effects:

- inflammaging/immuno-senescence
- ↓anabolic hormone levels

Accompanying influences

- Inactivity
- Malnutrition
- co-morbidities

DNA and histone modifications
Epigenetic modifications

- **↓ Muscle strength**
- **↓ Muscle quantity**
- **↓ Physical performance**

Regelmessig trening gjennom hele livet motvirker endringer i muskelmorfologi!

40-year-old triathlete 70-year-old sedentary. 70-year-old triathlete.

(Wroblewski et al 2011)

Takk for oppmekrsomheten!