Disclosures

Medical Advisory Boards:

Tanita Corp., Medifast, Regeneron, Lilly, Novo Nordisk

Adiposity

Age

Race

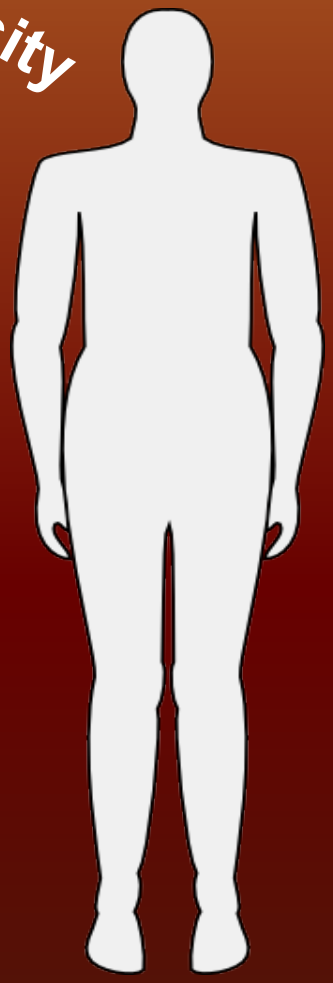
Genes

Diet

Activity

Hormones

Drugs



Strength

Endurance

Energy Expenditure

Metabolism

Clinical Endpoints

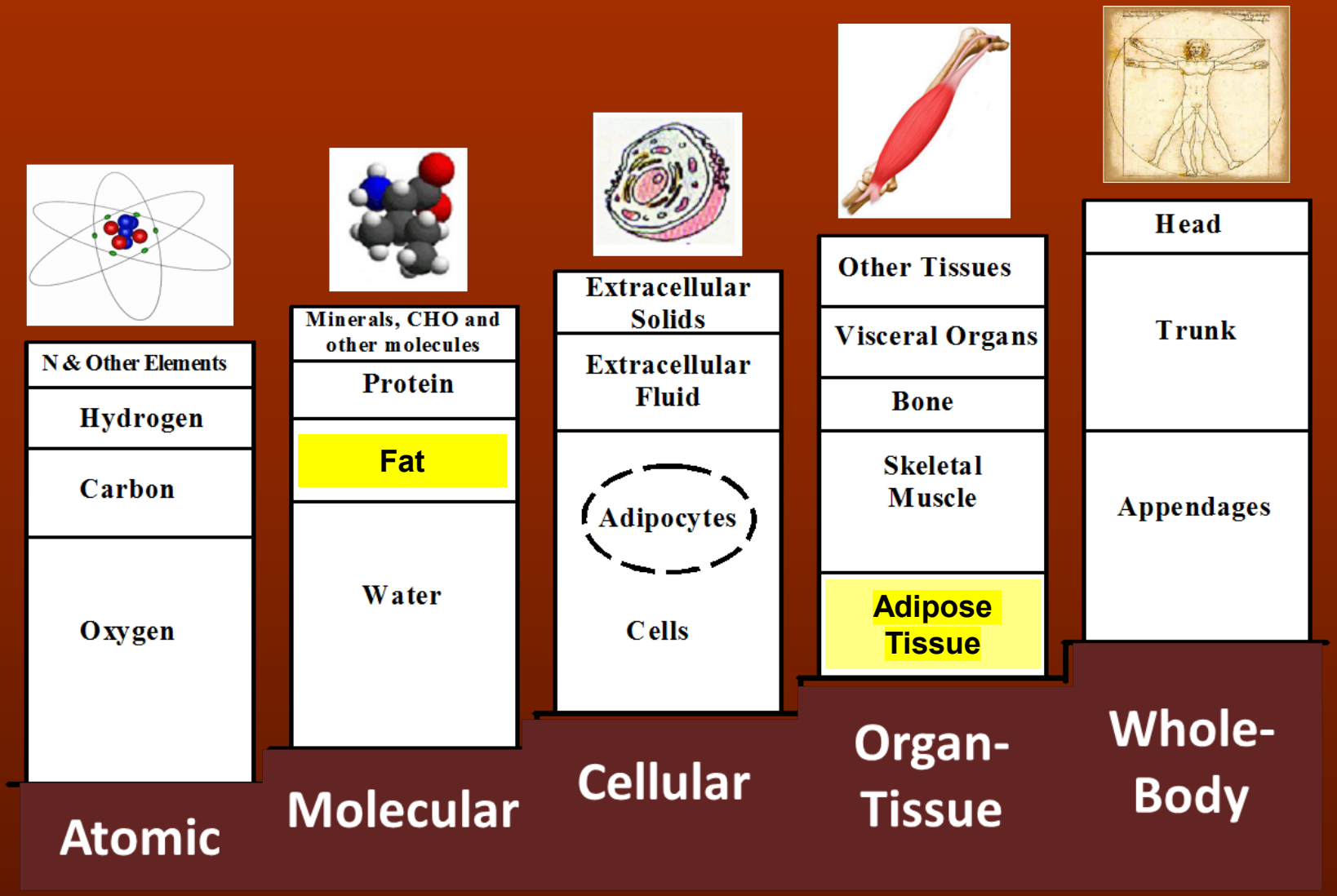
Form → Function → Outcome

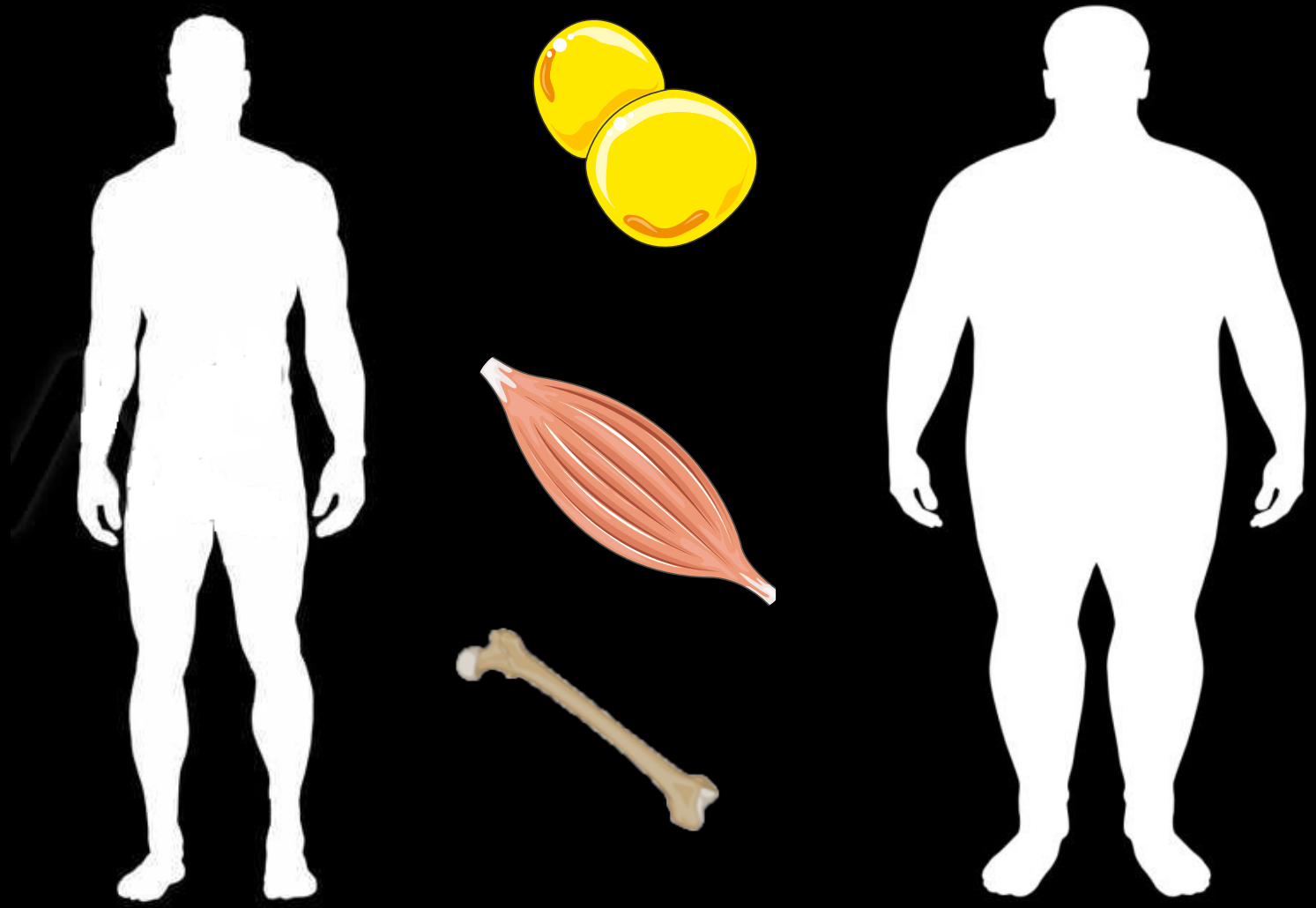
Steven Heymsfield

Body Composition Considerations Within the Context of Obesity

Pennington Biomedical Research Center
Baton Rouge, LA

Five-Level Model of Body Composition





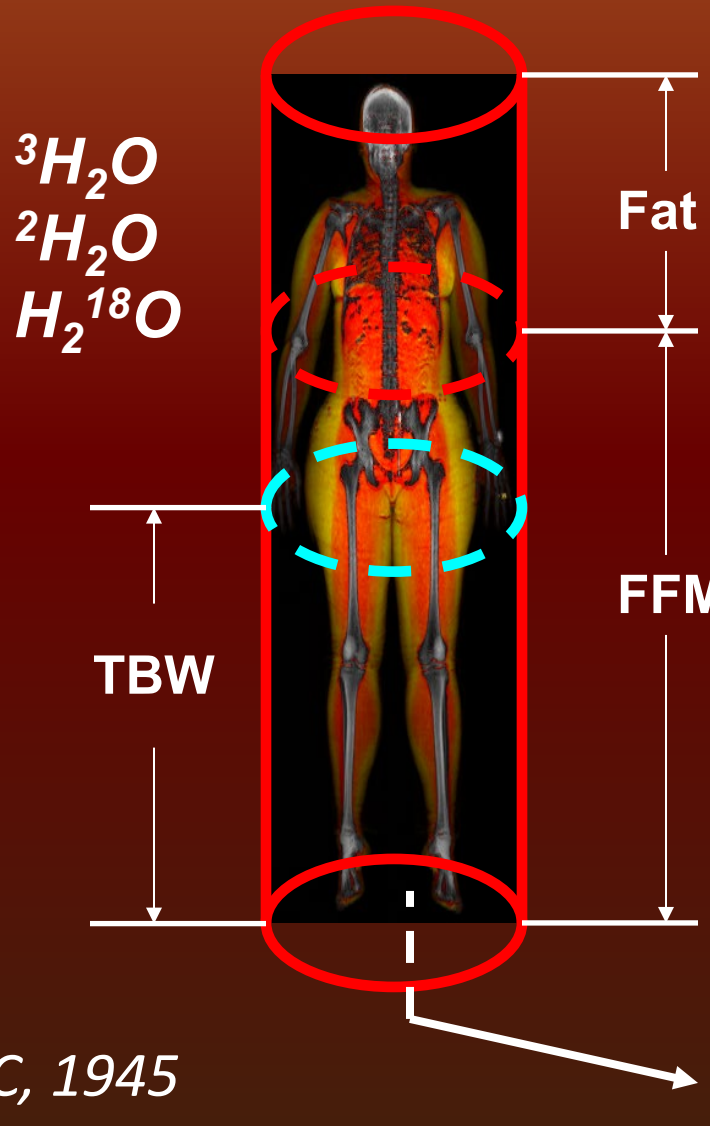
WW I
1914-1918

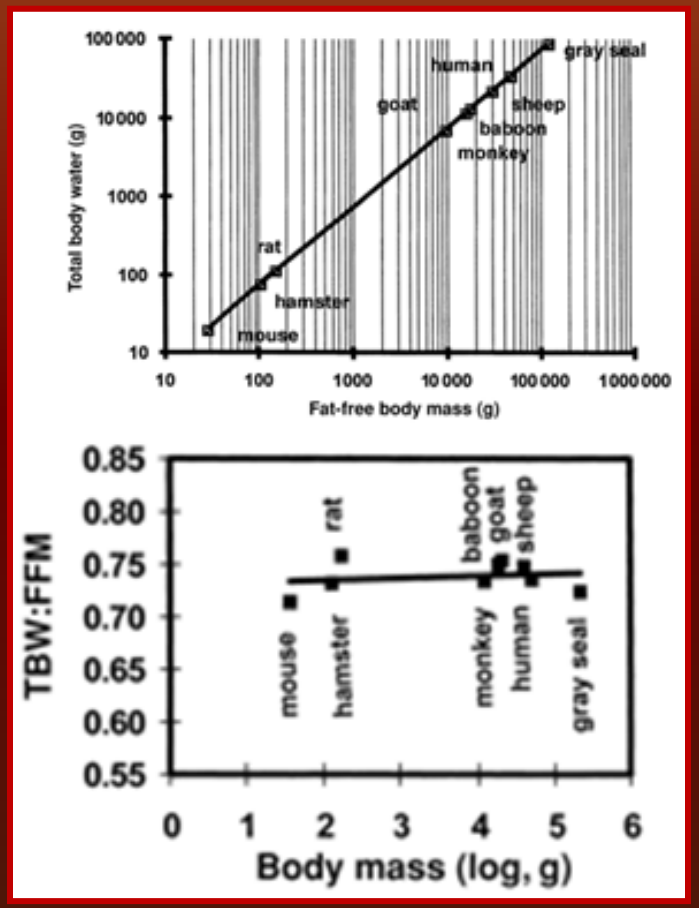
WW II
1939-1945

1945

Two Compartment Hydrometry Model:

Nello Pace & Edith Rathbun





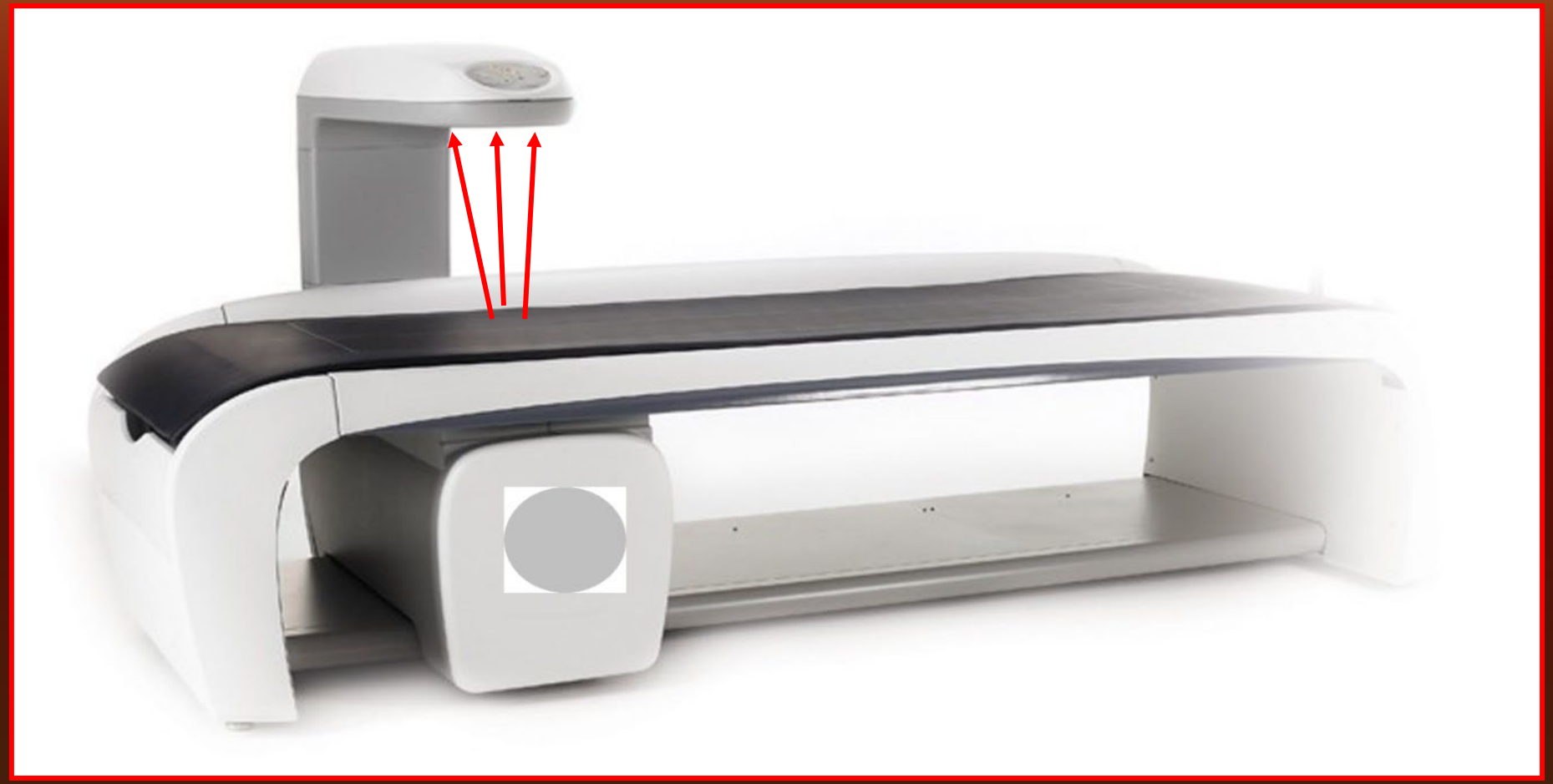
$M_T = M_F + M_{FFM}$

$M_{FFM} = M_{TBW} / 0.732$

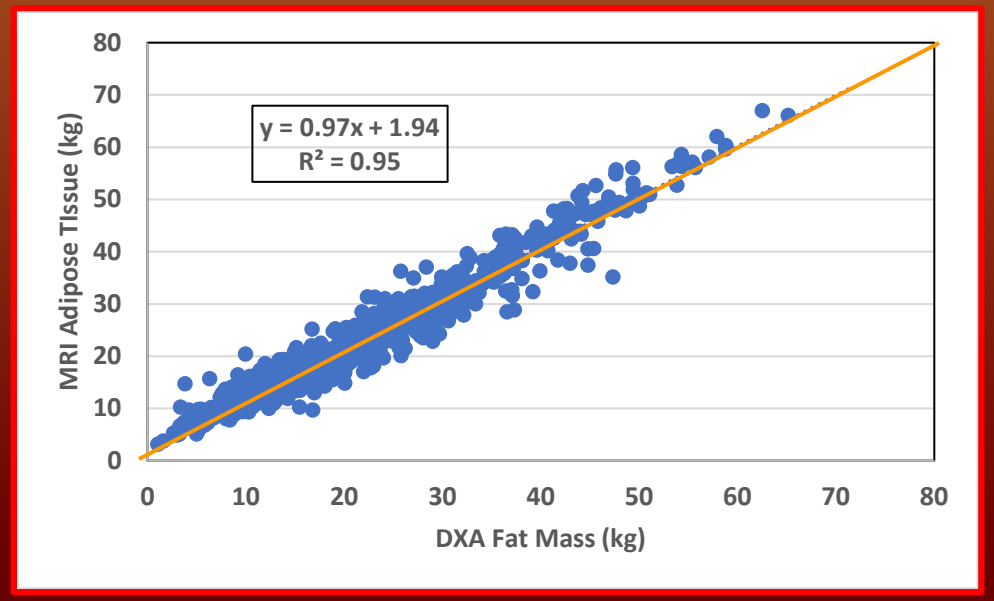
$M_{FAT} = M_T - M_{FFM}$

JBC, 1945

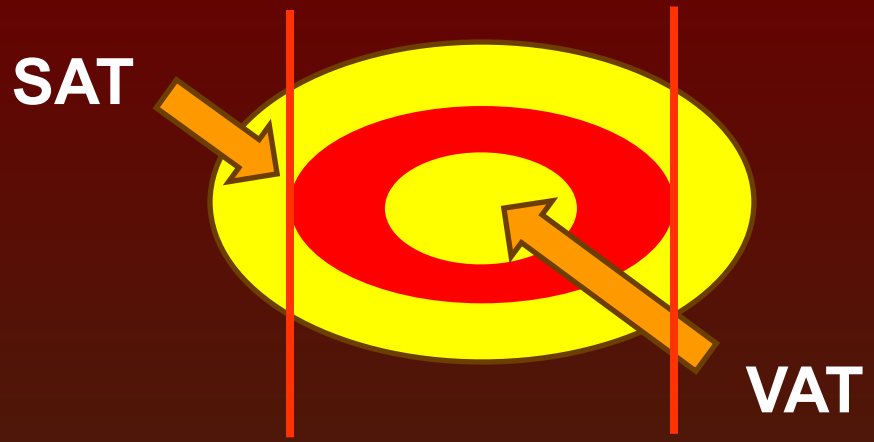
Dual-Energy X-ray Absorptiometry (DXA)



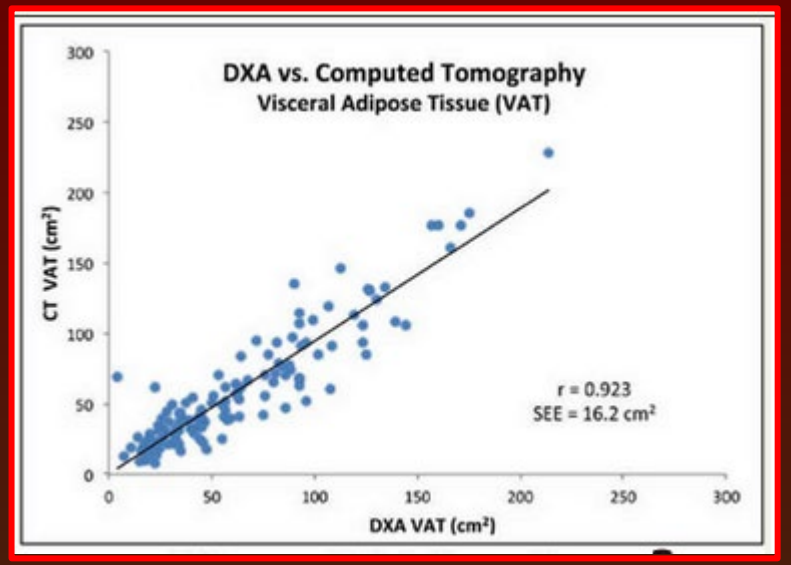
Validation of Adiposity by DXA



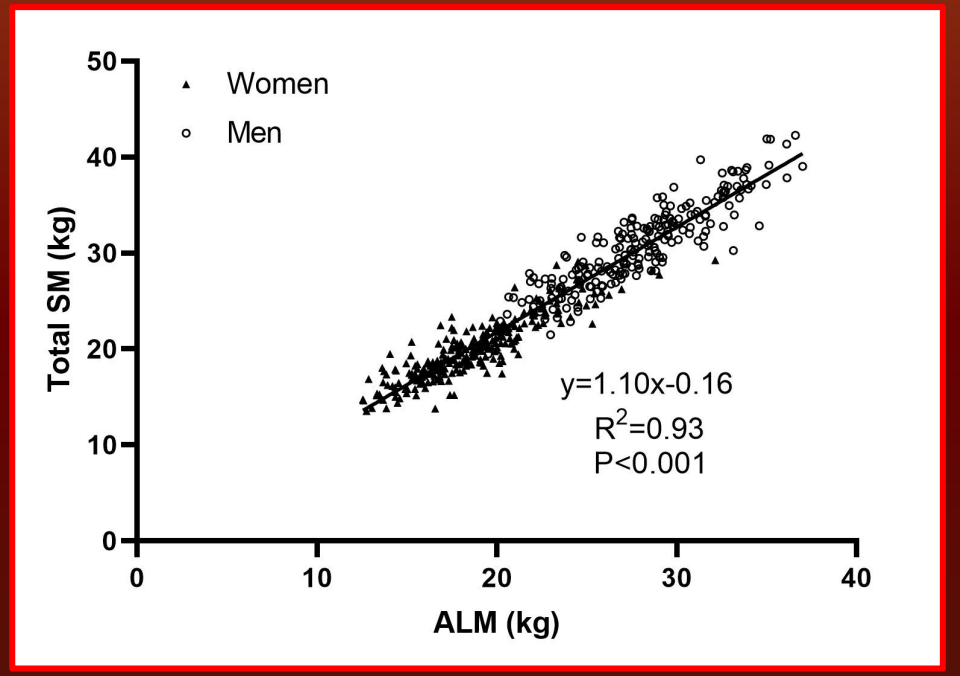
Visceral adipose Tissue
CT vs. DXA



Visceral Adipose Tissue (VAT)
Subcutaneous Adipose Tissue (SAT)



DXA Measurement of Skeletal Muscle Mass

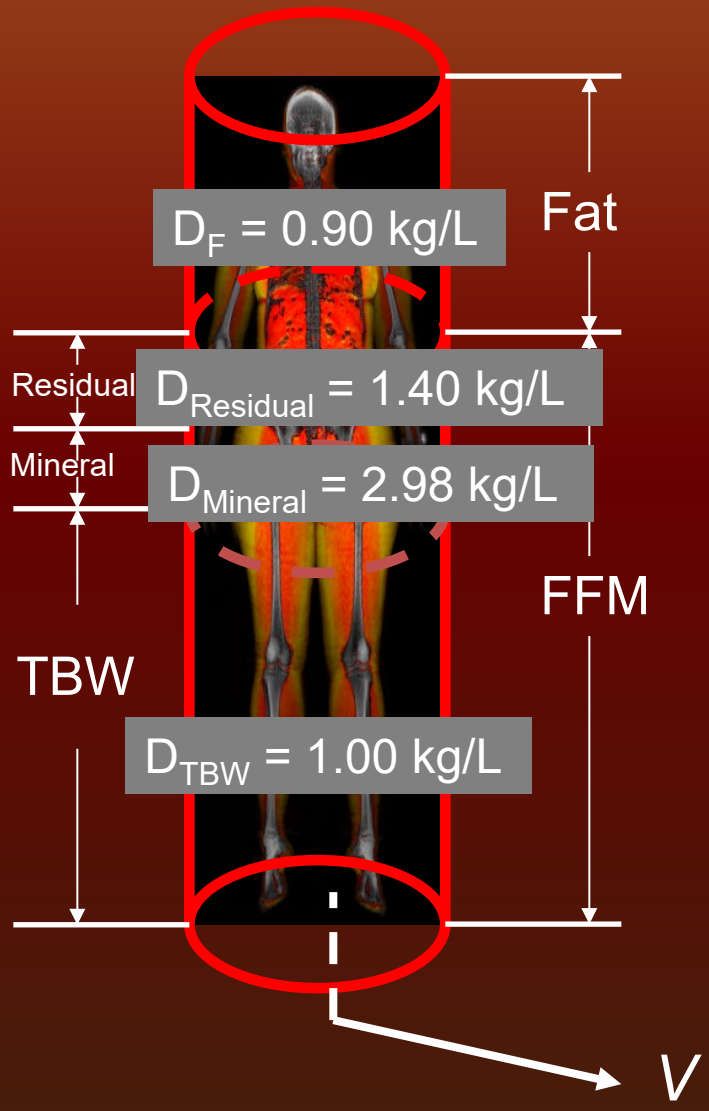


1990

4-Component Model

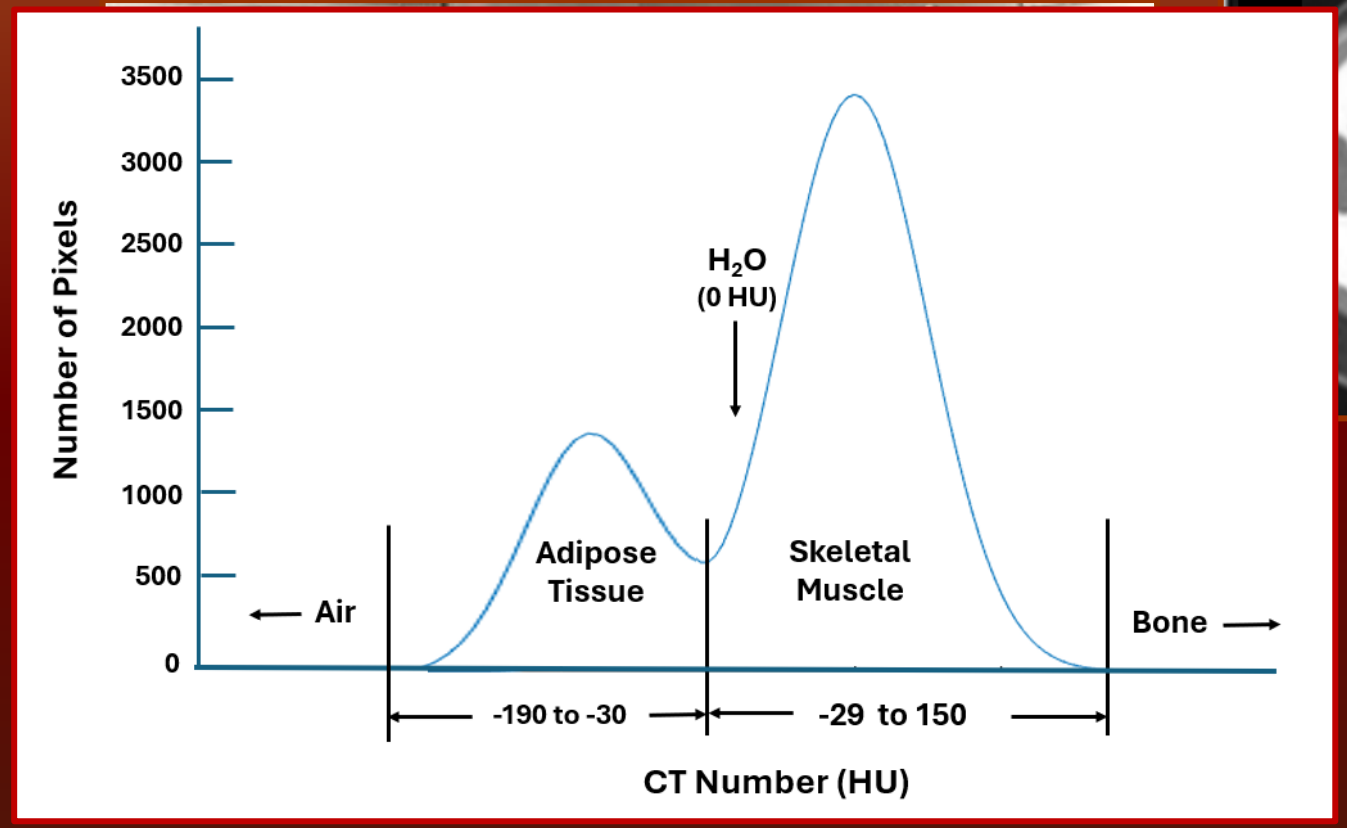
$$M_T = M_F + M_{TBW} + M_{Mineral} + M_{Protein}$$

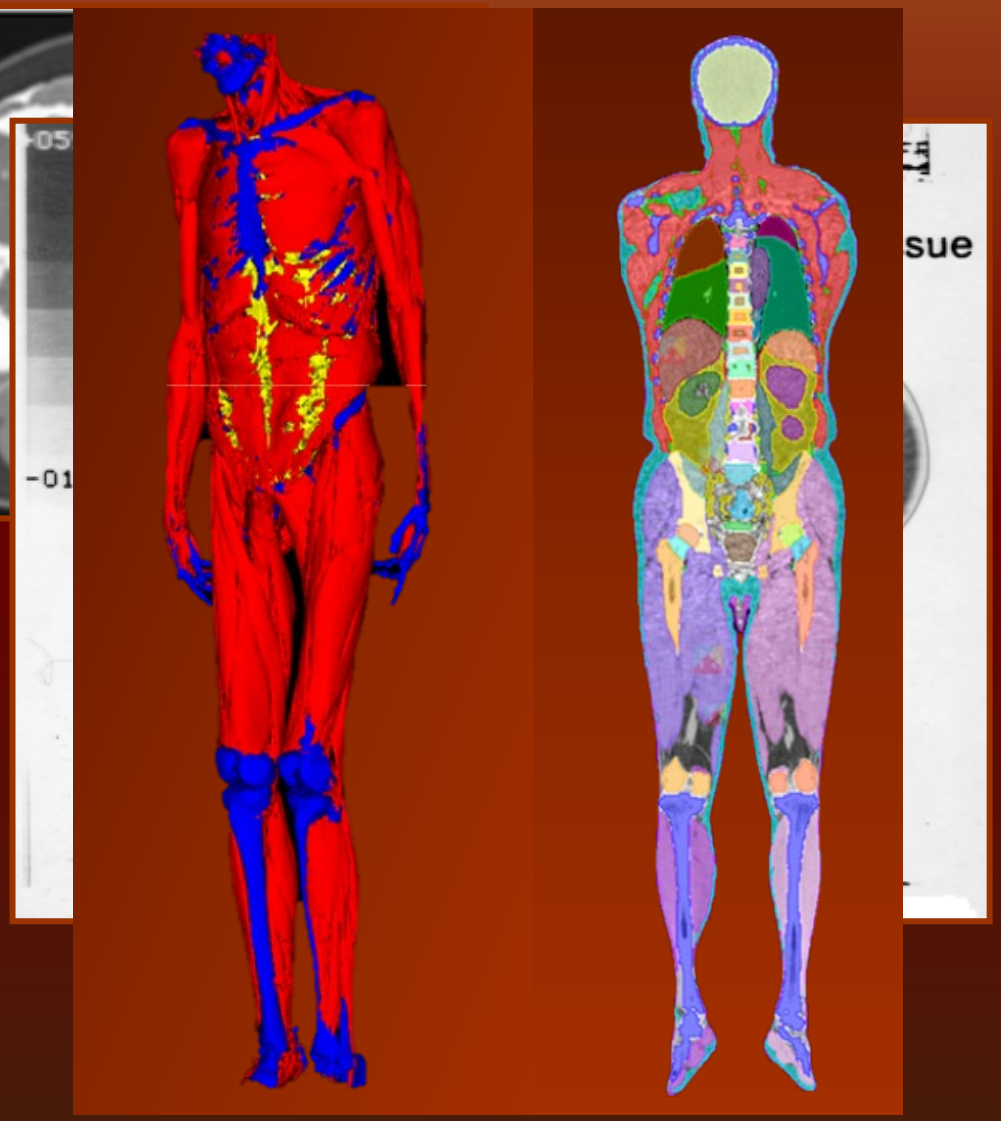
Combine body density, total body water, Bone Mineral Measurements



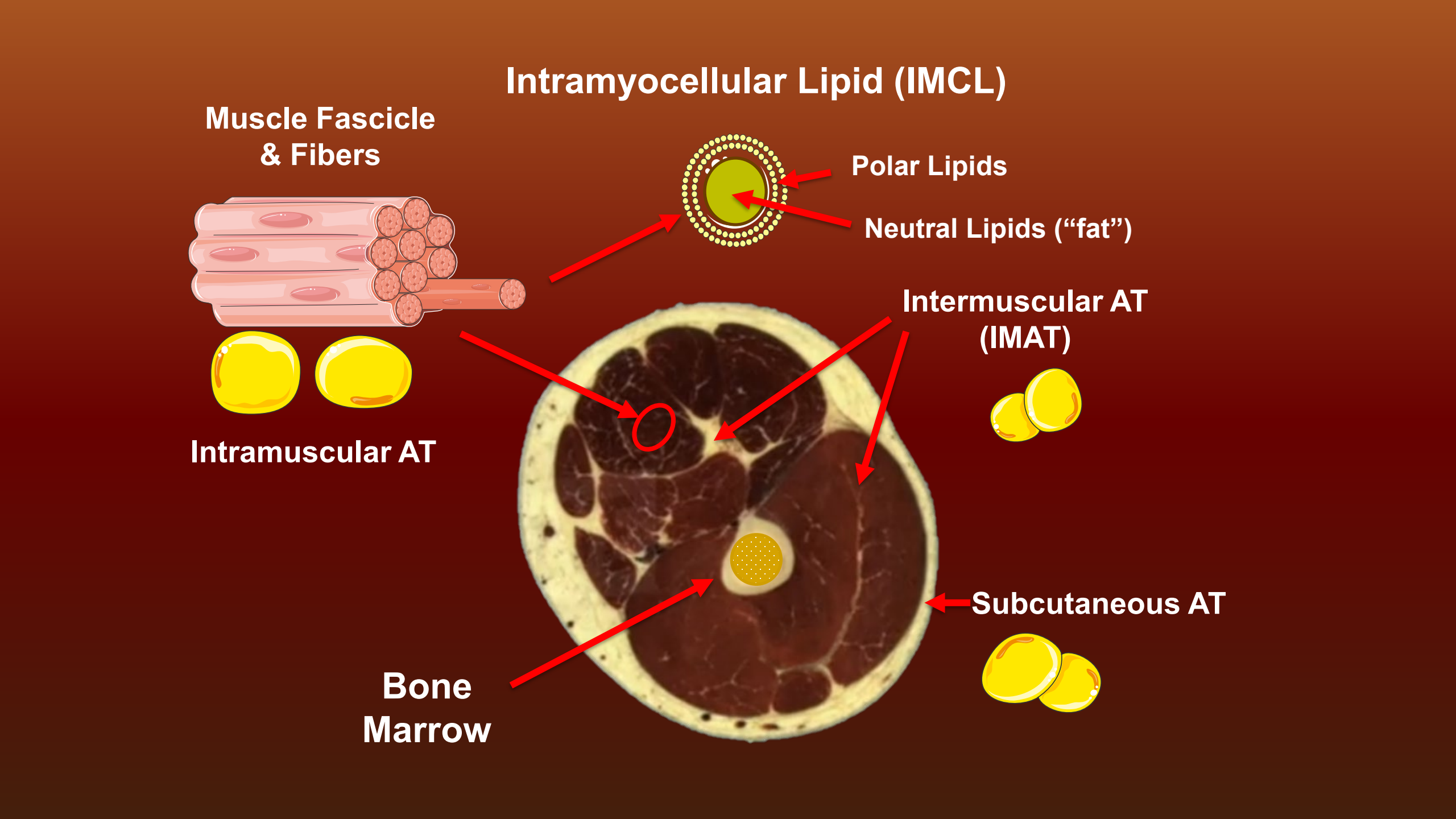
$$M_F = 2.51 \times V - 0.74 \times TBW + 0.95 \times Mo - 1.79 \times M_T$$

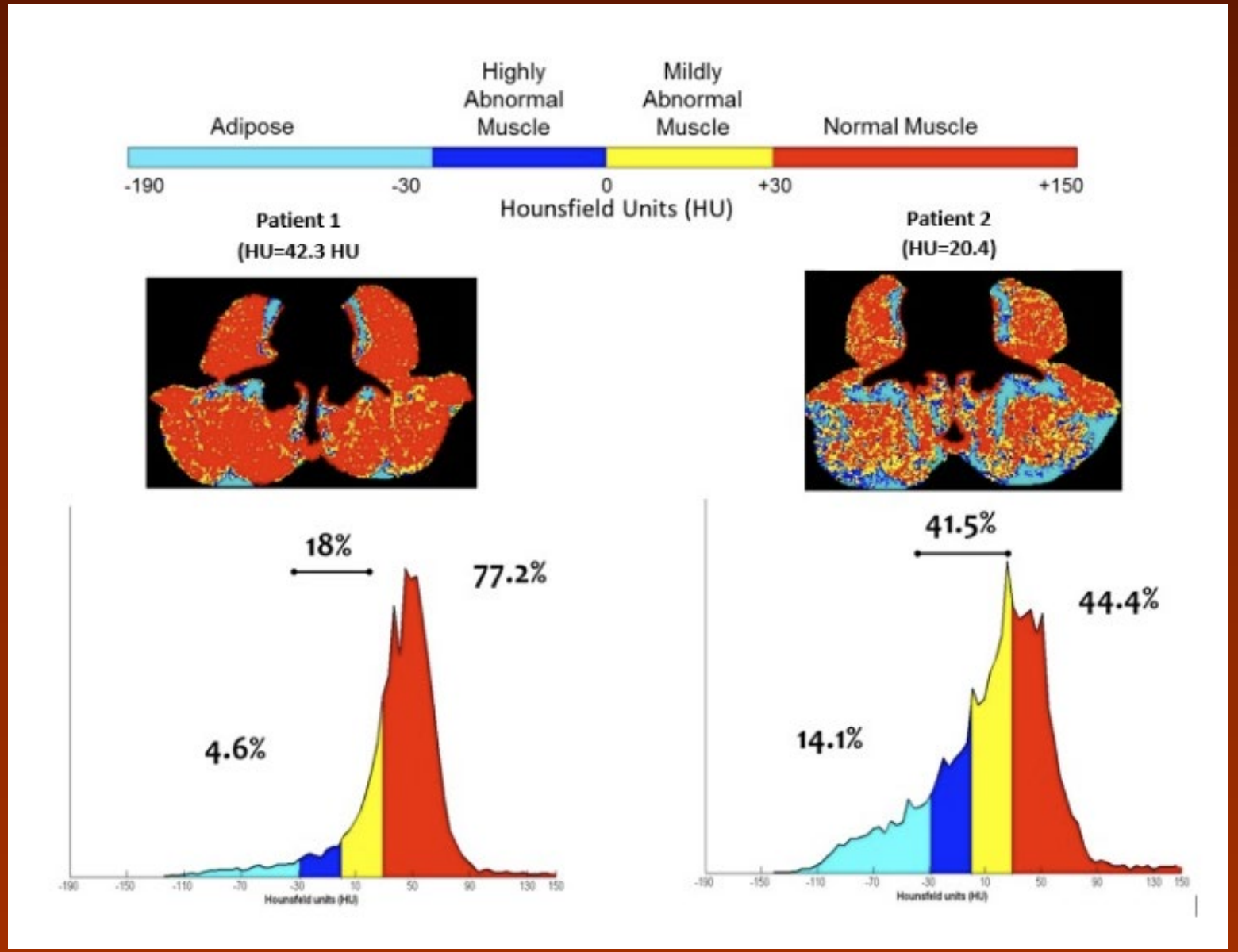
1973-5 Computerized Axial Tomography





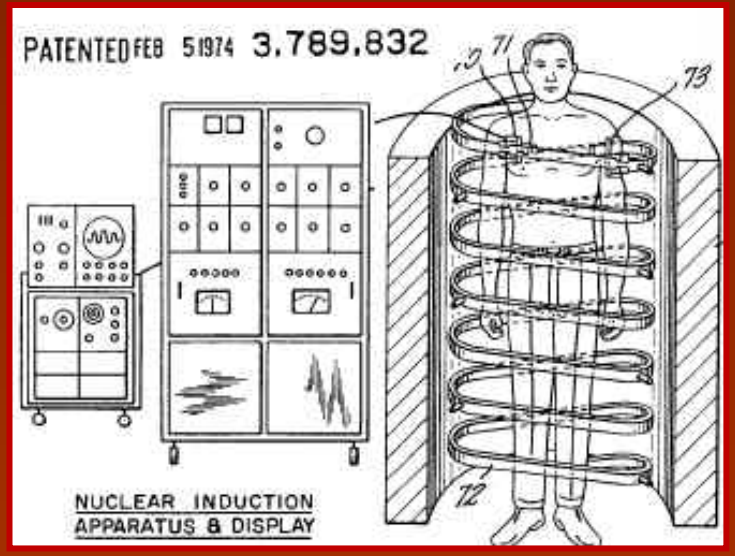
Geoffrey Hounsfield


Intramyocellular Lipid (IMCL)
Muscle Fascicle & Fibers
Polar Lipids
Neutral Lipids (“fat”)
Intermuscular AT (IMAT)
Intramuscular AT
Subcutaneous AT
Bone Marrow

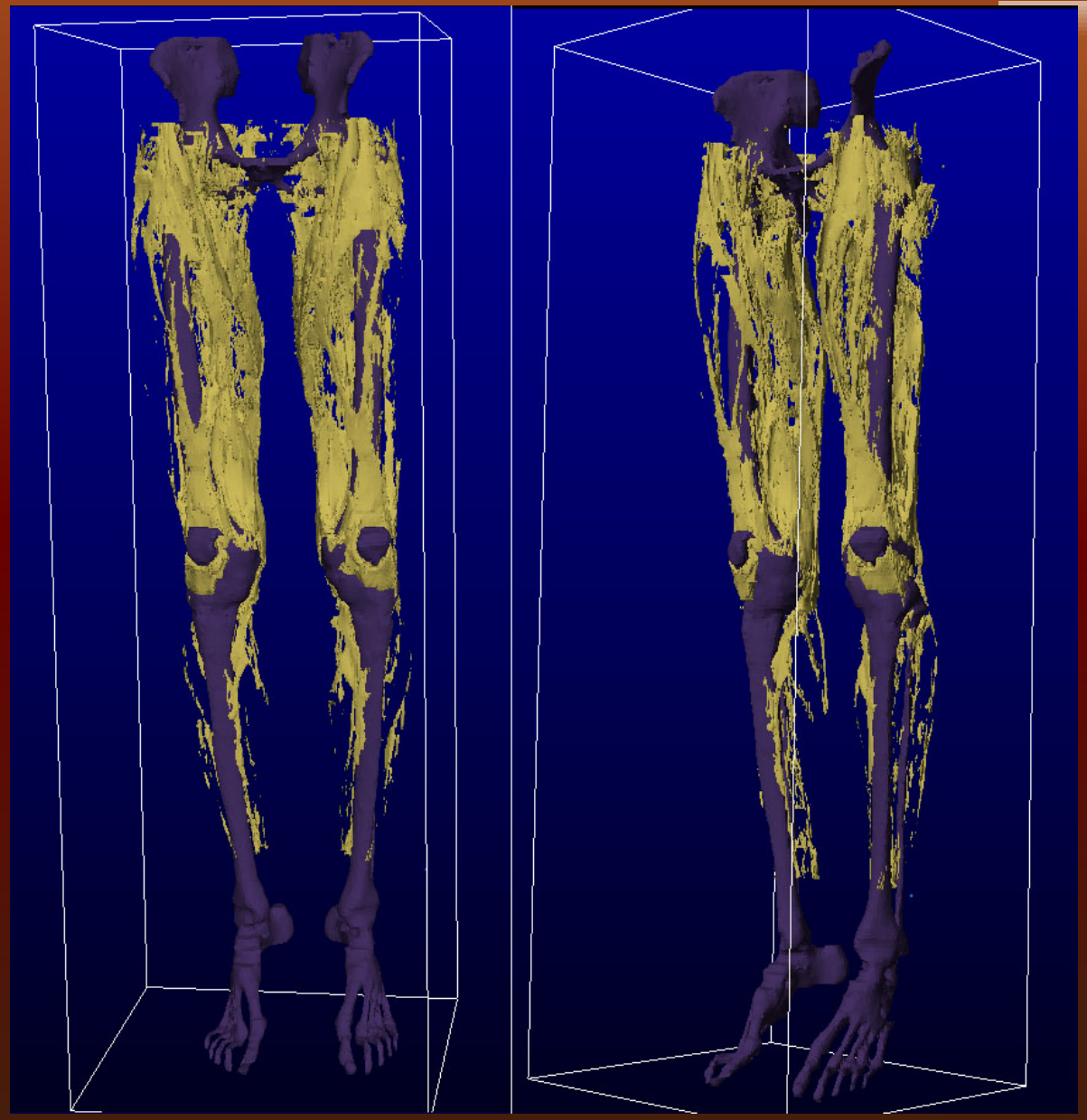


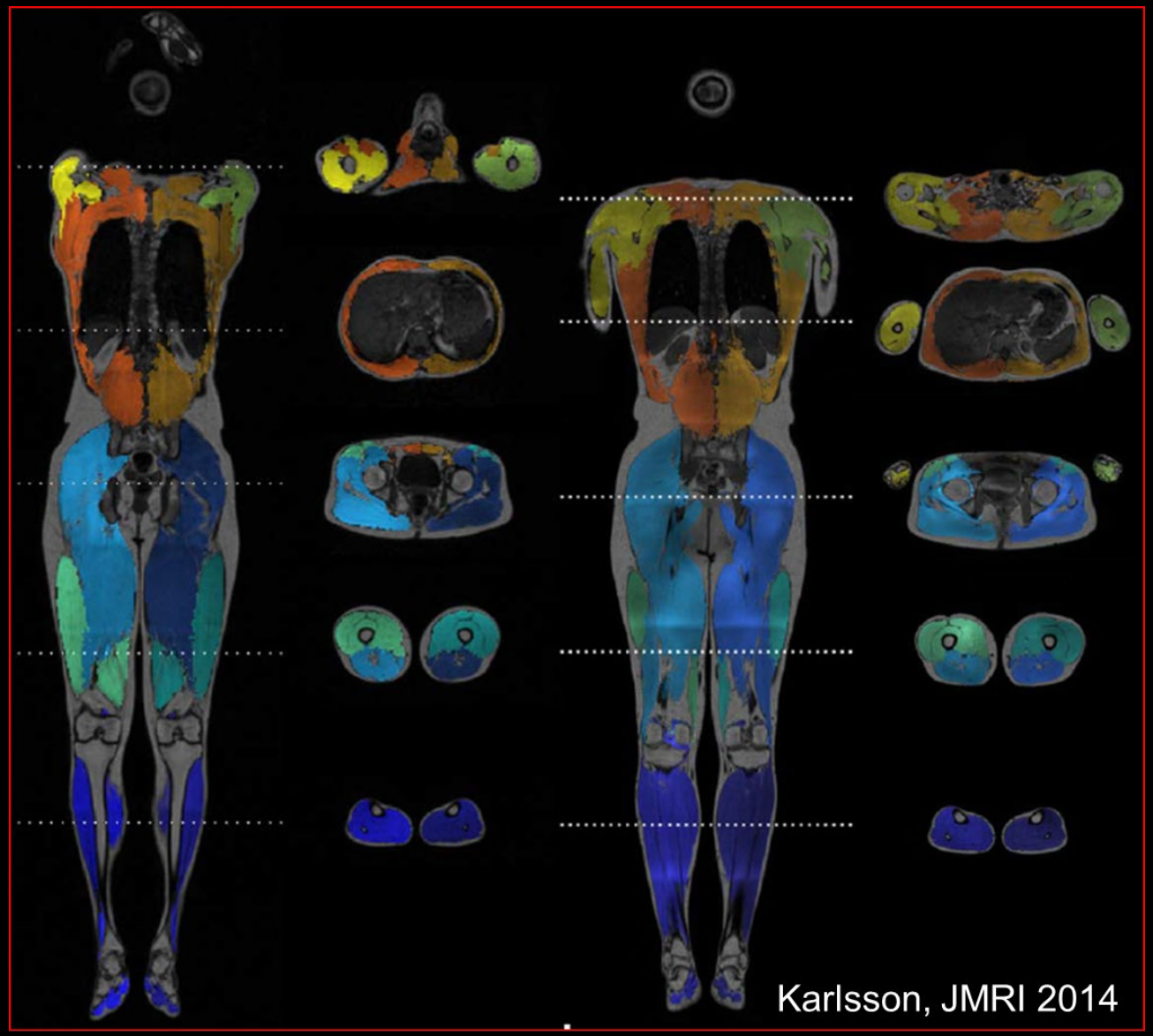
Aubrey, Acta Physiologica, 2014

Magnetic Resonance Imaging



Whole-Body MRI for Body Composition Measurement

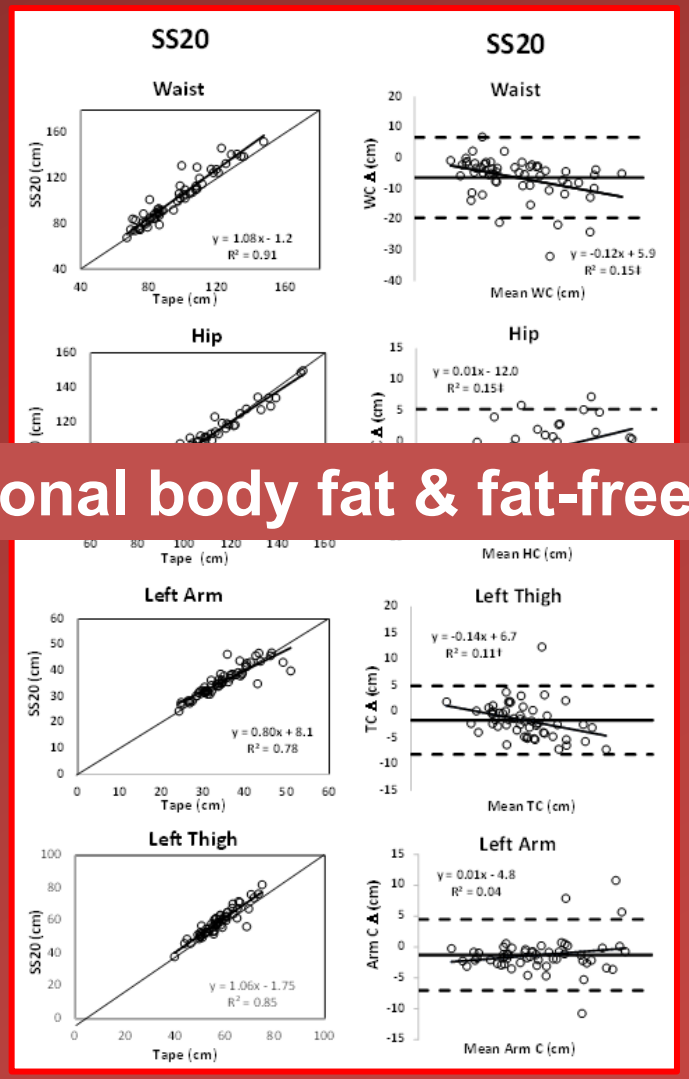



Karlsson, JMRI 2014

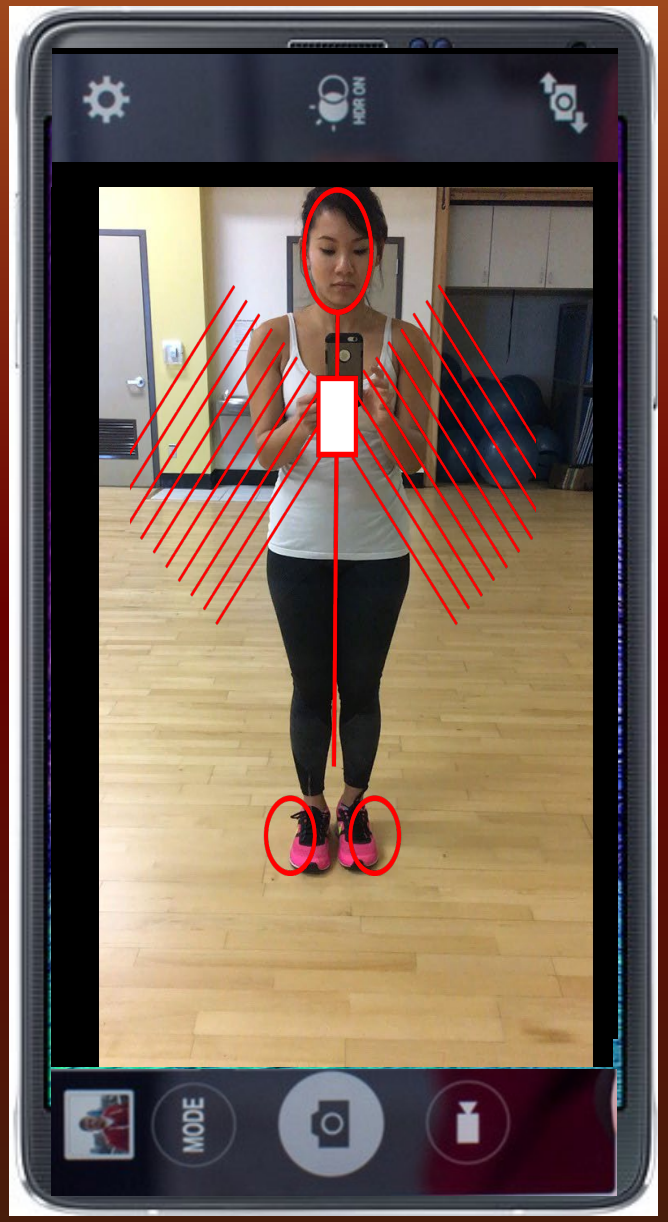
1990s

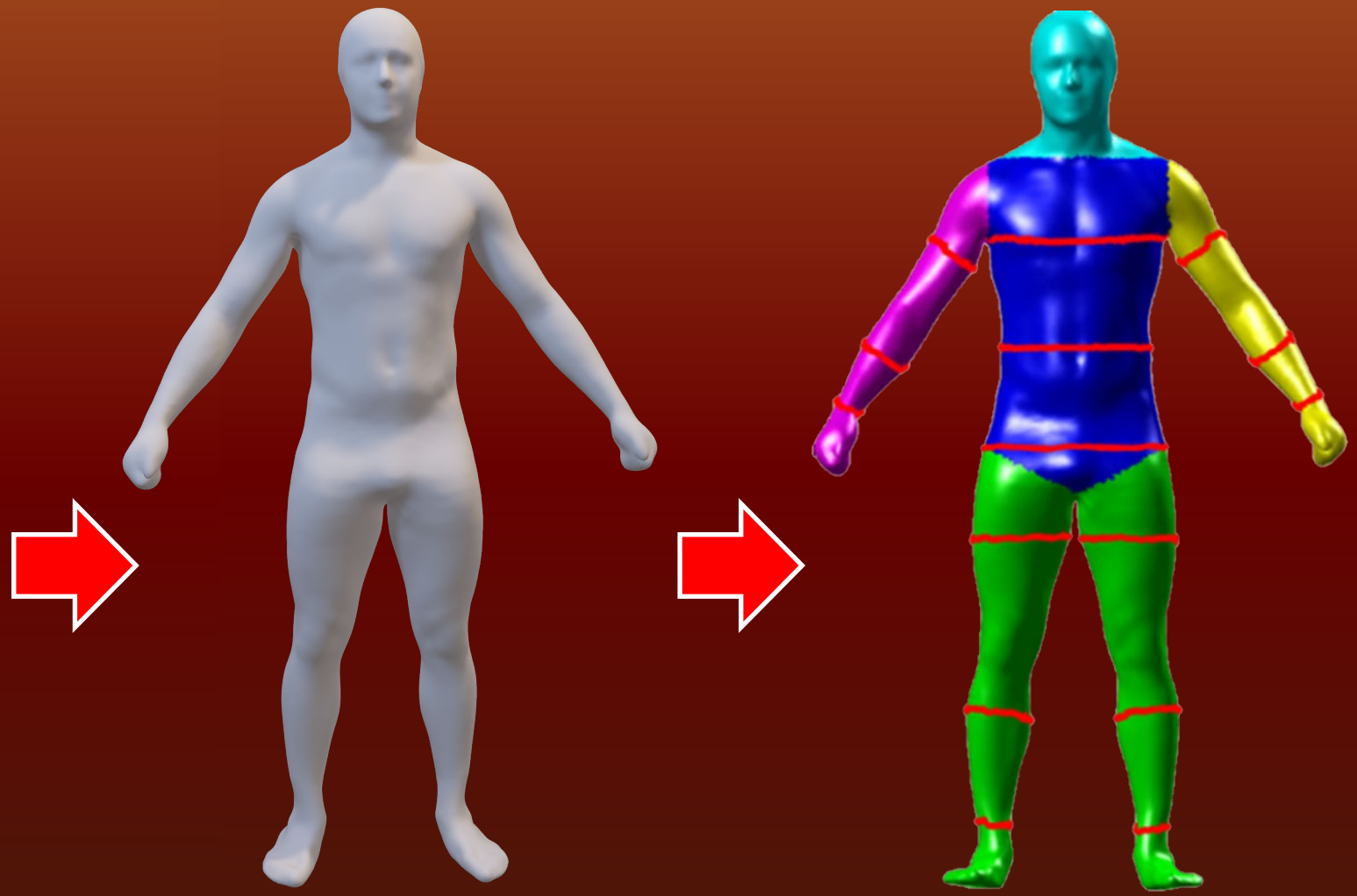
Development of Laser Scanners

Advances in Digital Anthropometry

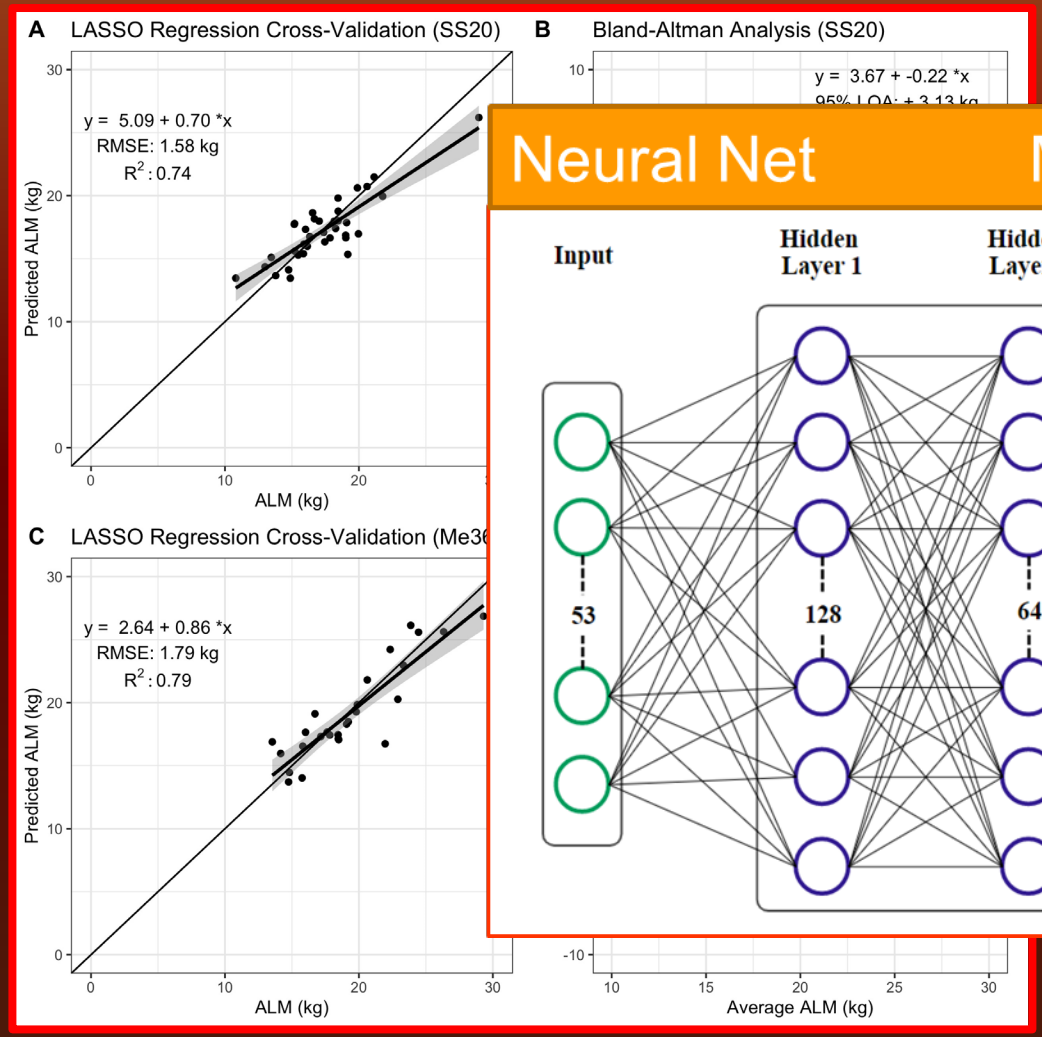


Good predictions of total and regional body fat & fat-free mass


HDR ON
MODE



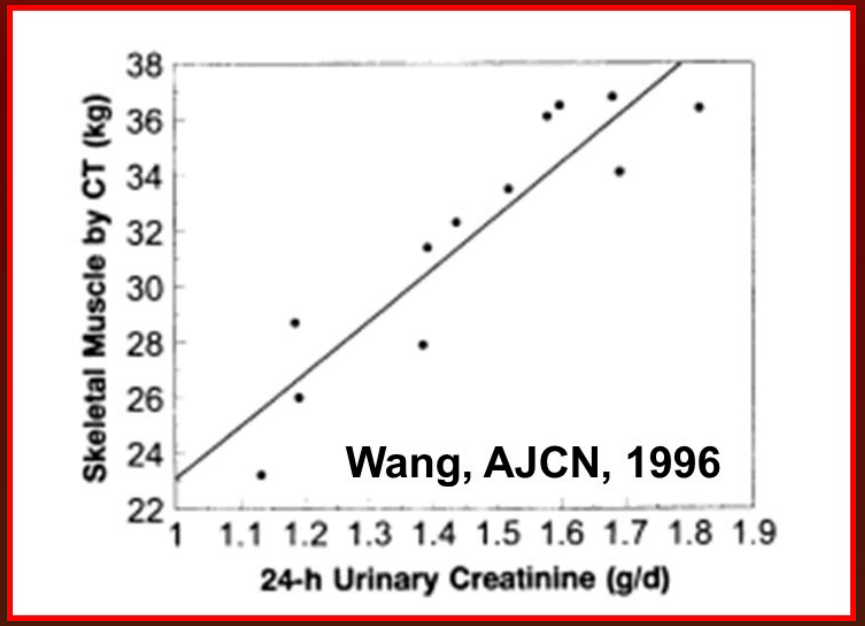
Skeletal Muscle Prediction

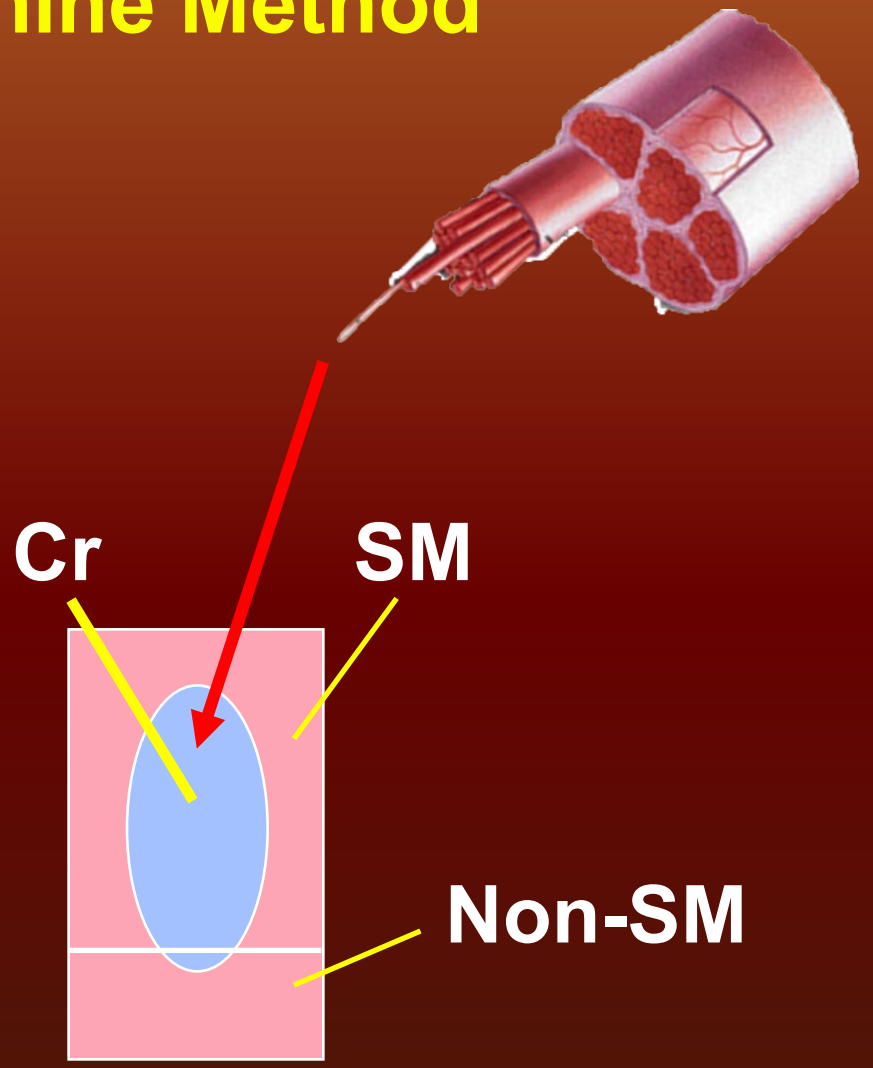


Muscle Mass: Urinary Creatinine Method

$$SM = k \times Cr_{urine}$$

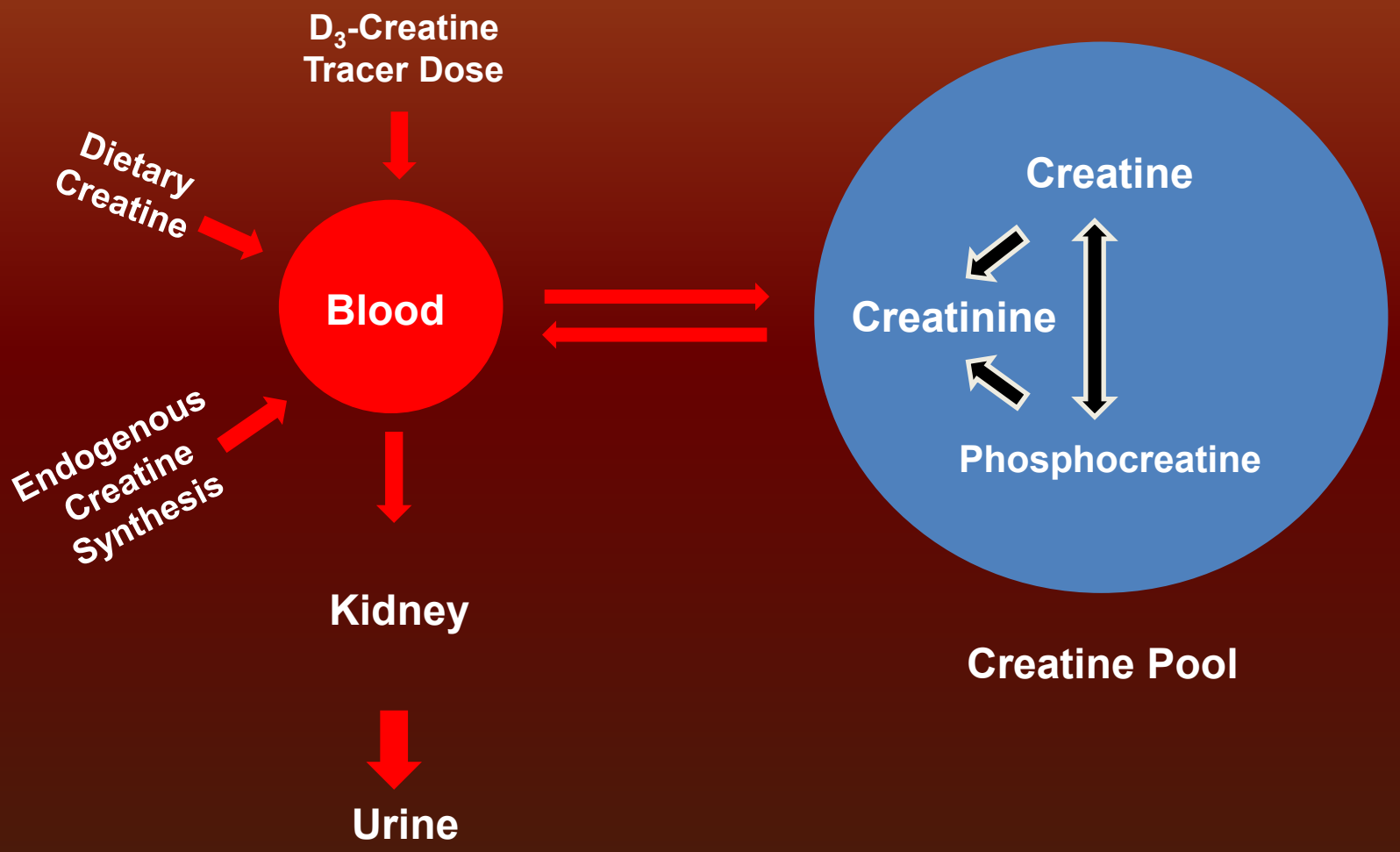
$$SM = a \times Cr_{urine} + b$$

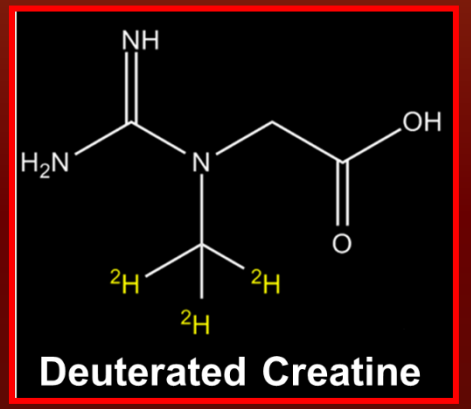




a = 22 kg SM/g Cr_{urine}

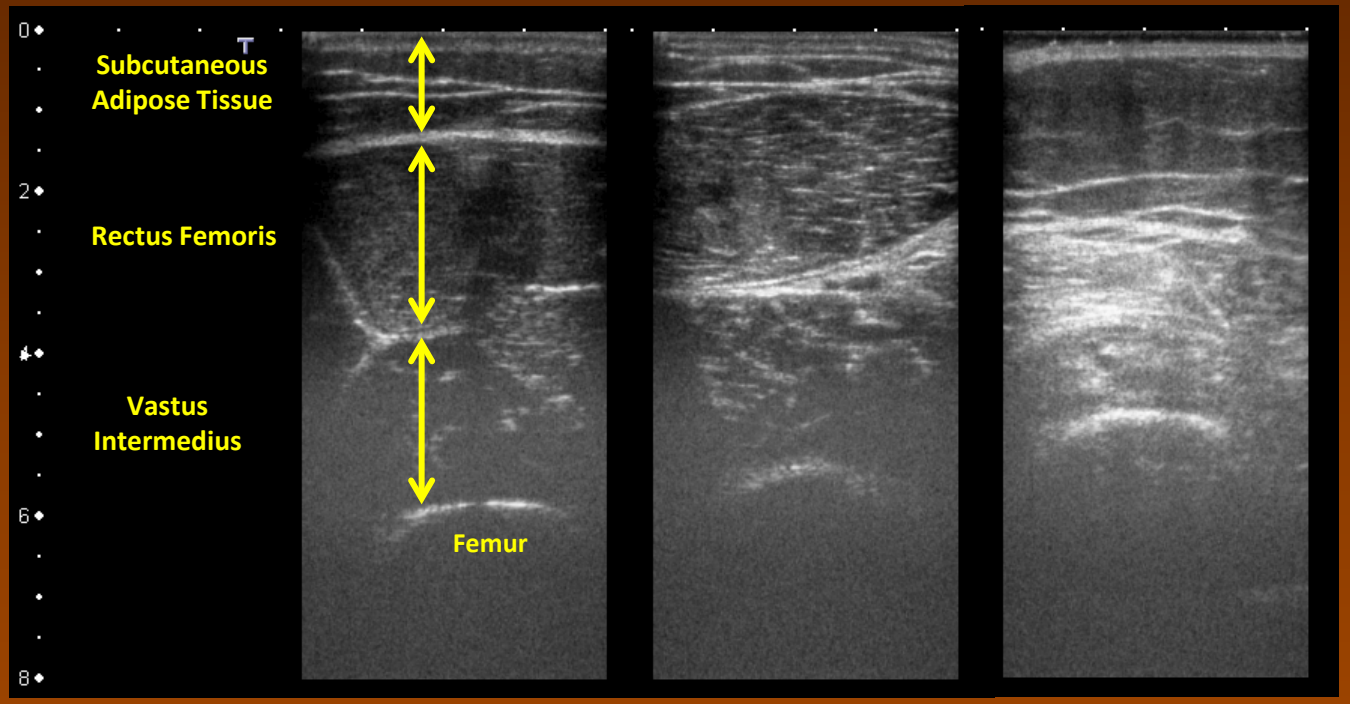
Muscle Cell Mass: D_3-Creatine Dilution Method





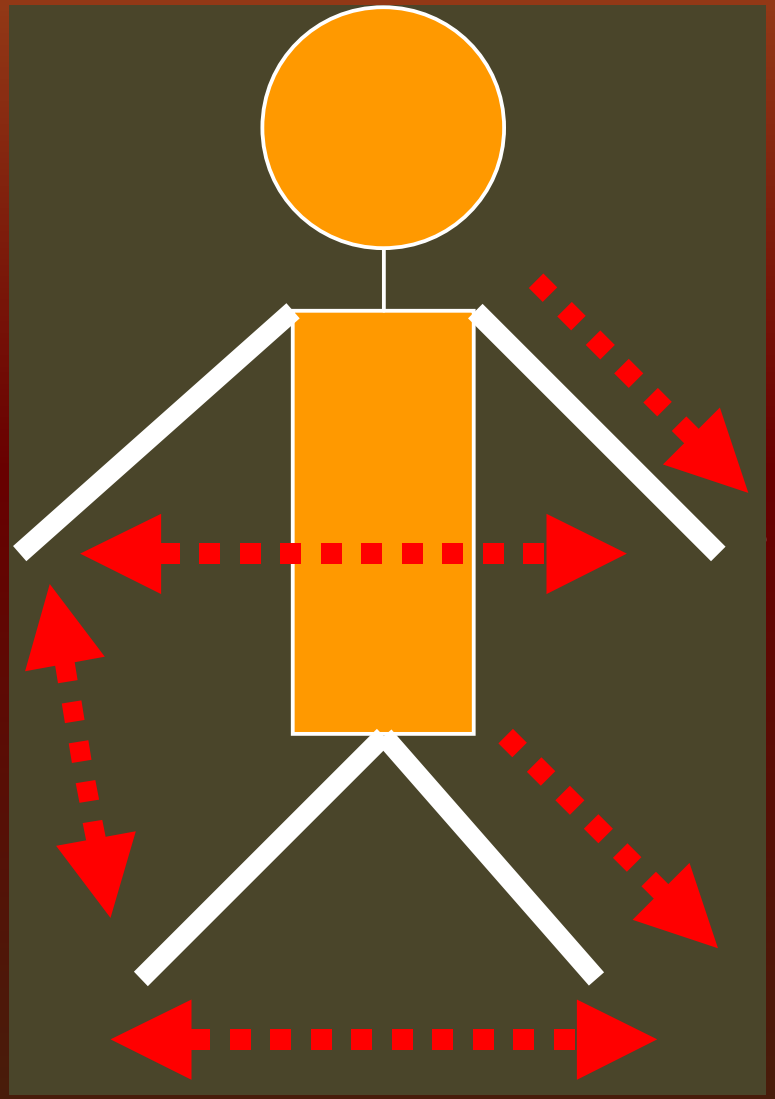
McCarthy, SCWD, 2022

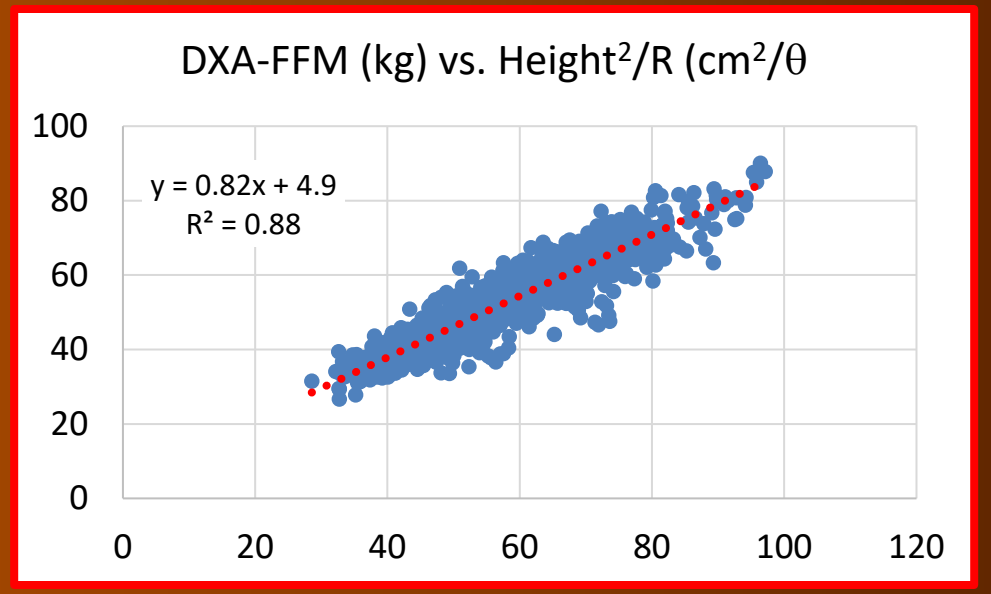
1942 Ultrasound



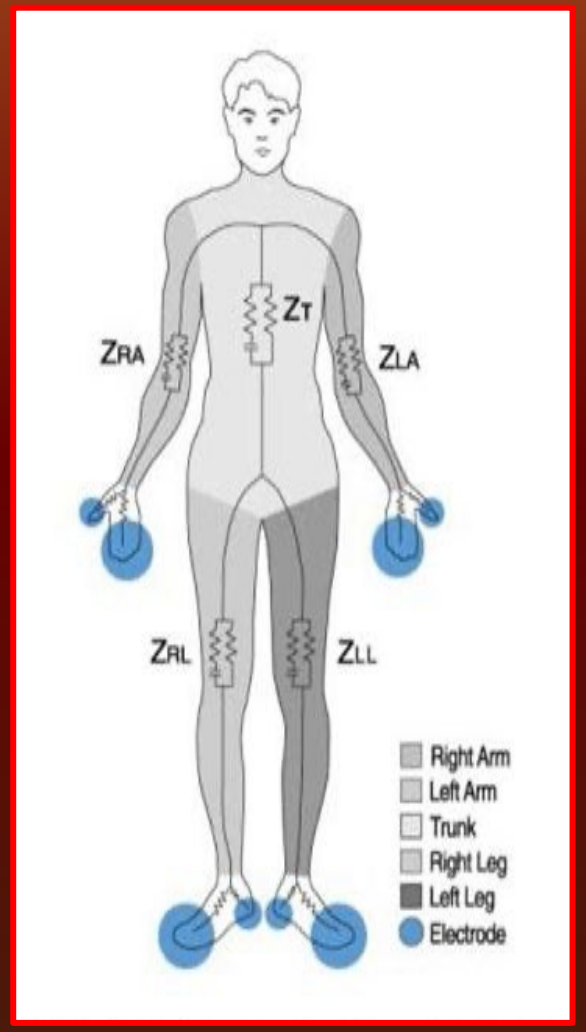
Dussik, K.T. Neurol. Psychiat. 1942.

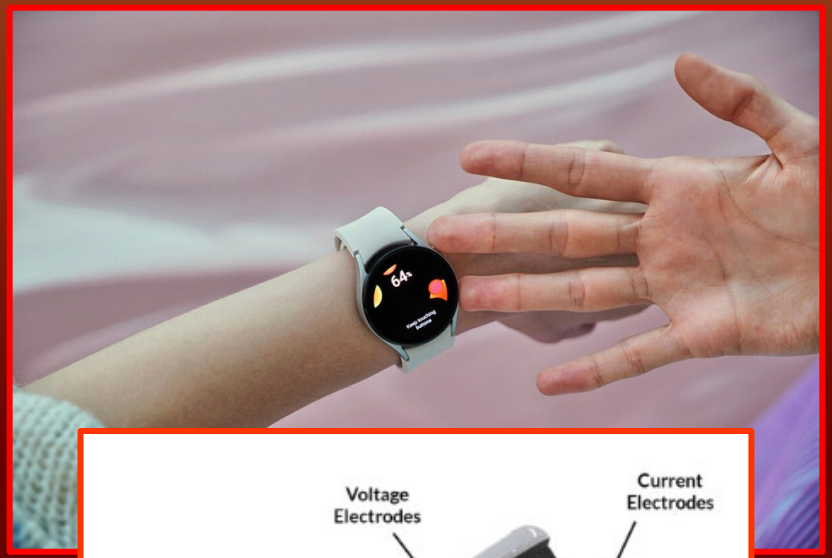
Bioimpedance Analysis



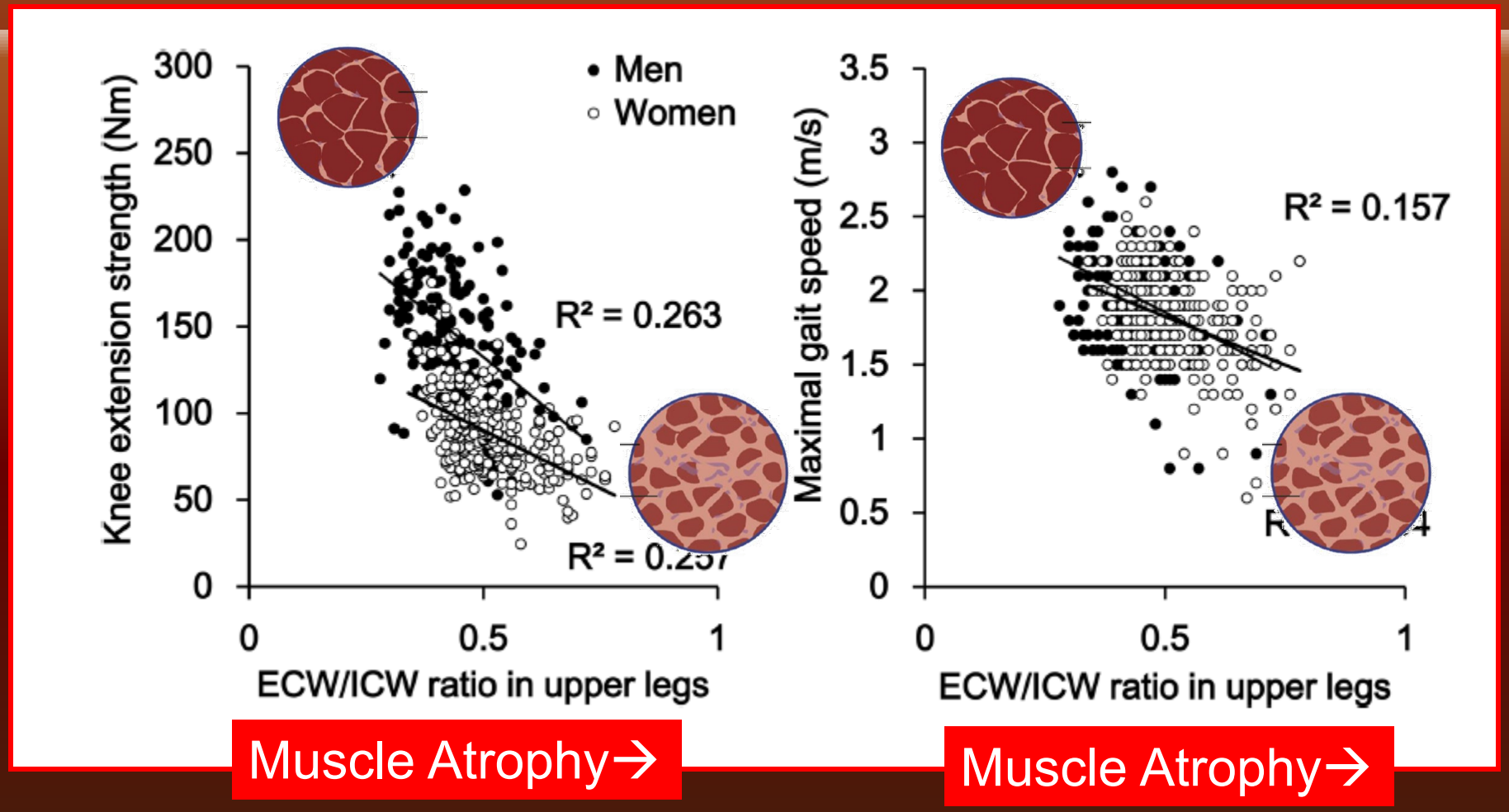


Bioimpedance Analysis





BIA and Muscle Composition

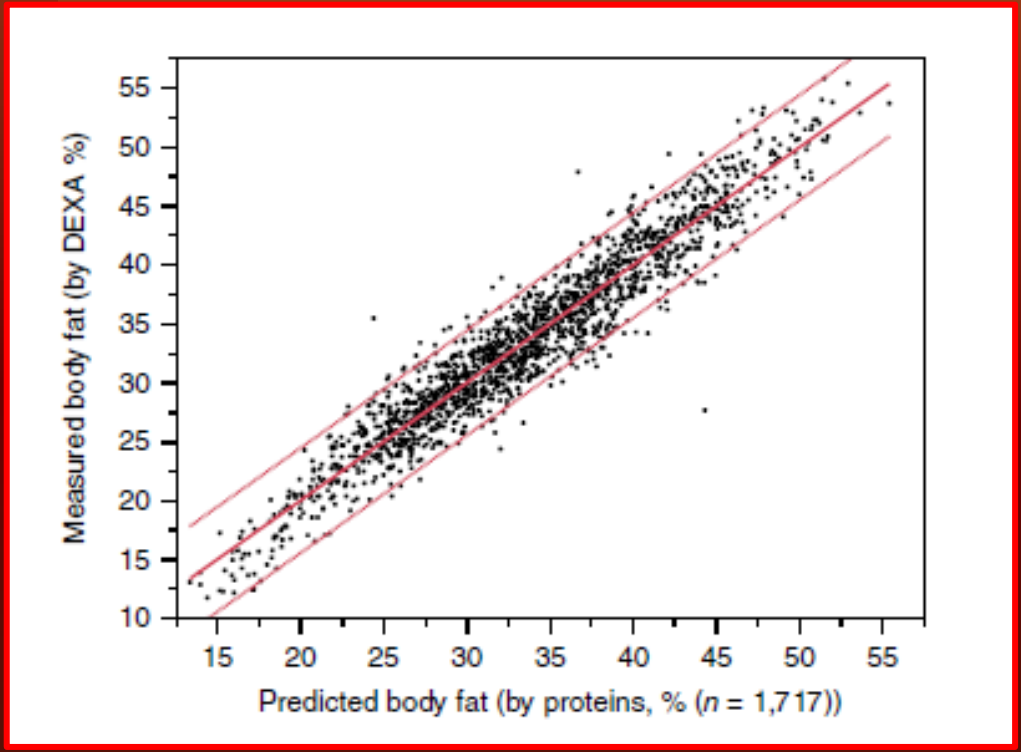


Muscle Atrophy→

Muscle Atrophy→

Yamada et al. J Gerontol 2016

Adiposity Estimation from Blood Measurements



Predictor Variables:

Leptin

FABP (fatty acid binding protein)

SFRP4 (secreted frizzled-related protein 4)

General Metabolics: Metabolomics
SomaLogic: Proteomics

Williams et al., Nature Med 2019

Gaps

- Accurate detection of small changes in body components.
- Need for improved/reproducible/practical field methods.
- Lower-cost advanced imaging technology.
- Approaches for measuring body (muscle) (contractile) proteins.
- Need for integrated advanced dynamic energy balance-body composition models.