UCLA Weight Management Program
Lecture Series
“Personalized Nutrition”

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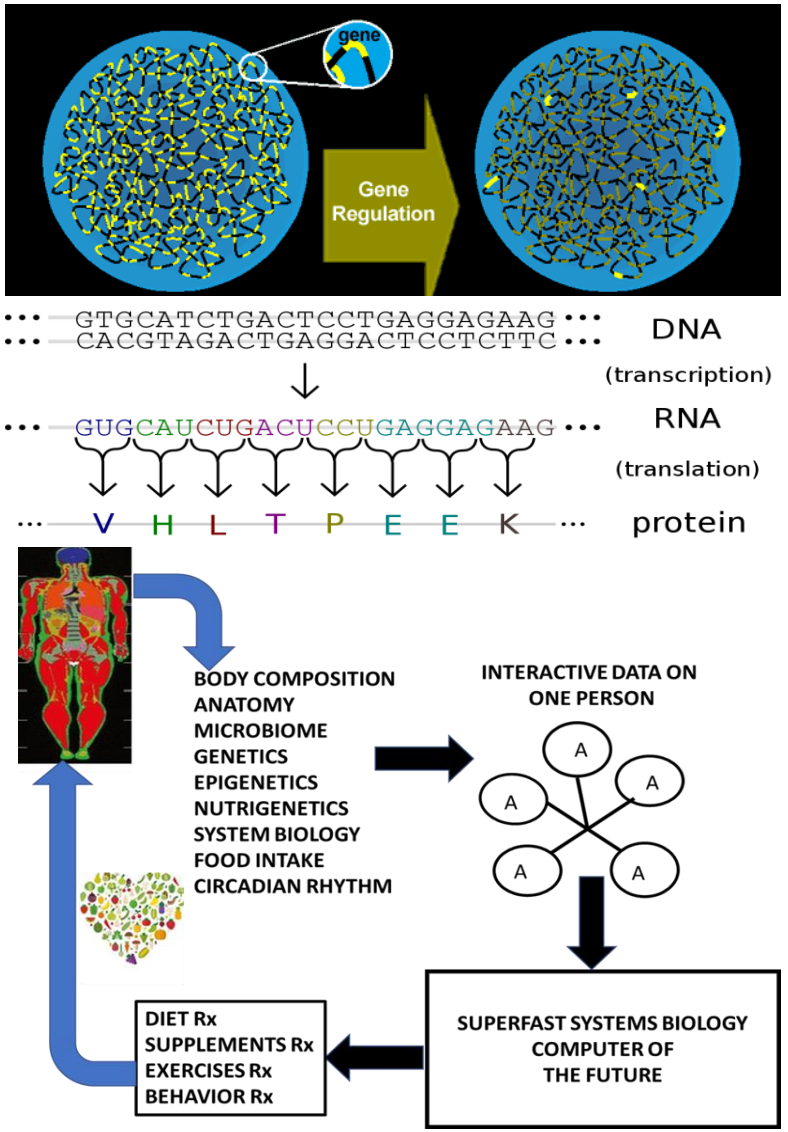
Professor Emeritus of Medicine and Public Health
and Founding Director,
UCLA Center for Human Nutrition

David Heber, M.D., Ph.D.

- B.S. Magna Cum Laude, UCLA in Chemistry, 1969
- M.D., Harvard Medical School, 1973
- Ph.D. in Physiology, UCLA, 1978
- Over 250 Scientific Papers, 50 Book Chapters, and 4 Books for the Public
- Founding Chief of the Division of Clinical Nutrition, 1983
- Founding Director, UCLA Center for Human Nutrition,* 1996
- Practicing obesity treatment at UCLA for the last 28 years
- Directed National Institutes for Health-funded Centers at UCLA*
- Professor Emeritus of Medicine and Public Health, UCLA* , 2014
- Best Doctors in America 2000, 2001, 2002, 2005, 2007-2015
- Award for Outstanding Career in Nutrition Education, 2009
- Fellow, American Society for Nutrition, 2013
- Most Influential Scientific Minds 2014, Reuters

WHAT DOES PERSONALIZED MEAN??

1. ALL HUMANS ARE 99.9% GENETICALLY IDENTICAL BUT YOUR GENES ARE ACTIVATED DIFFERENTLY FROM OTHERS DEPENDING ON MANY FACTORS THAT DETERMINE WHO YOU ARE AND HOW YOUR BODY BEHAVES.
2. YOUR MICROBIOME RESPONDS TO YOUR DIET RAPIDLY AND IDENTICAL TWINS CAN HAVE UP TO A 20% DIFFERENCE IN THEIR MICROBIOME SO DIET INFLUENCES YOUR TOTAL GENES.
3. PERSONALIZATION MATCHES YOUR DIET AND LIFESTYLE TO A PROGRAM OF BALANCED NUTRITION AND HEALTHY ACTIVE LIFESTYLE BY USING TODAY'S AVAILABLE TOOLS.



PERSONALIZED NUTRITION TOOLS

1. PERSONALIZED NUTRITION TODAY STARTS WITH A LIFESTYLE QUESTIONNAIRE, BODY COMPOSITION, BLOOD TESTING, MICROBIOME AND GENETIC TESTING.
2. FOOD INTAKE BASED ON AN ELECTRONIC DIARY IS AN EVOLVING TECHNOLOGY.
3. PHYSICAL ACTIVITY, HEART RATE, AND GPS ARE MEASURED WITH WEARABLE DEVICES.
4. FEEDBACK ON RESPONSES ARE PROVIDED TO THE INDIVIDUAL SO THAT DIET AND EXERCISE BEHAVIORS CAN BE OPTIMIZED.
5. PERSONALIZATION EVOLVES AS YOU TRANSFORM YOUR BODY CHANGING HOW YOUR GENES ARE ACTIVATED.

BMI is an *Index* of Obesity

Height	6'0"	5'4"
Weight	225 lbs	180 lbs
BMI	31 kg/m^2	31 kg/m^2

Beyond BMI

- BMI
- Impedance, anthropometry
- Body water dilution
- DXA, UWW, BodPod

BEST PERSONAL SHAPE #2

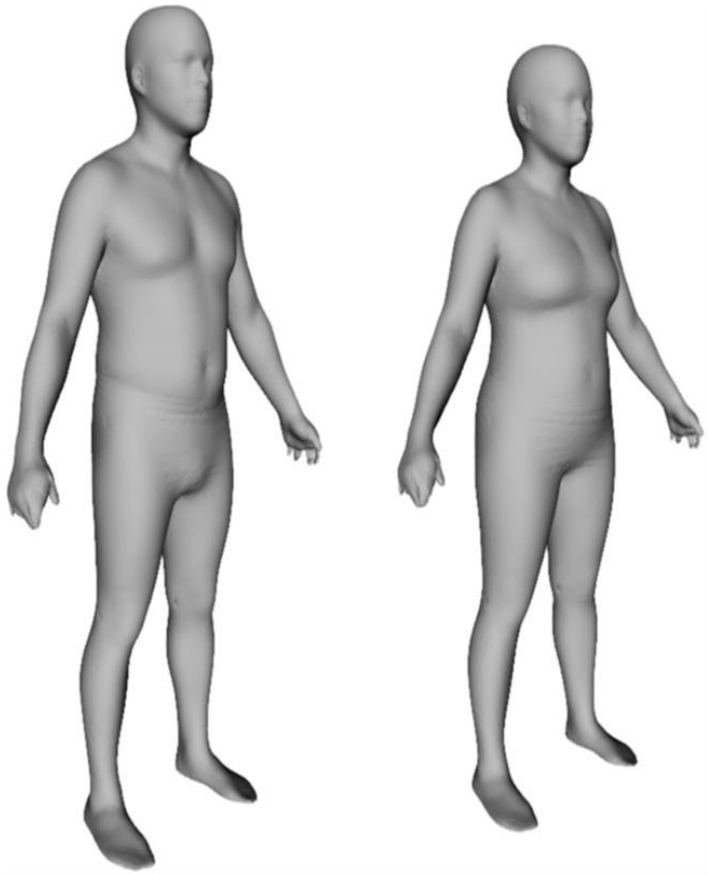
WHY BODY SHAPE ?

1. BODY WEIGHT IS EASY FOR YOU TO FOLLOW TO ASSESS THE BENEFITS OF YOUR PROGRAM OF BALANCED NUTRITION.

2. BODY WEIGHT CAN GO UP WHEN YOUR GAIN MUSCLE AND LOSE FAT CAN AS YOU WORK TO GET YOUR BEST PERSONAL SHAPE, BECAUSE MUSCLE WEIGHS MORE THAN FAT PER UNIT VOLUME.

3. WEIGHT CHANGES CAN ALSO BE DUE TO FLUID SHIFTS OF SALT AND WATER IN EITHER DIRECTION OF WEIGHT GAIN OR LOSS.

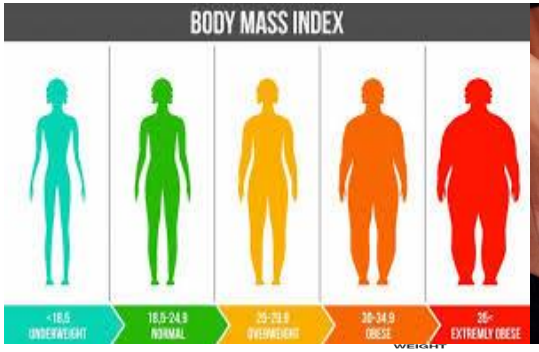
4. FOLLOW YOUR WEIGHT BUT CHECK OUT YOUR BODY SHAPE EVERY 90 DAYS TO SEE THAT YOU ARE ON THE WAY TO BEST PERSONAL SHAPE.

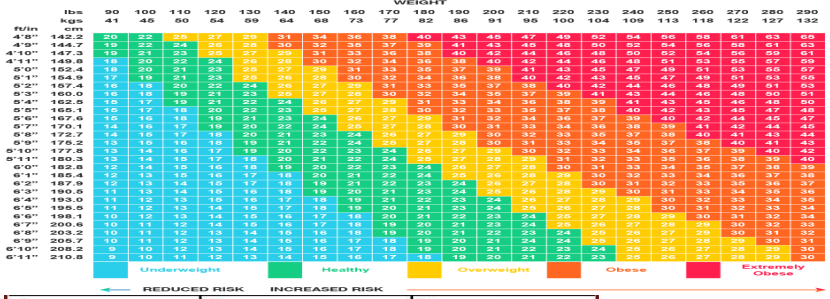


BEST PERSONAL SHAPE #3

BODY FAT AND SHAPE VS. BMI

1. BMI (BODY MASS INDEX) IS CALCULATED AS WEIGHT DIVIDED BY HEIGHT SQUARED AND CAN BE FOUND ON TABLES (SEE SLIDE) BMI < 18.5 IS UNDERWEIGHT
BMI 18.5-24.9 IS NORMAL WEIGHT
BMI 25-29.9 IS OVERWEIGHT
BMI 30-39.9 INDICATES OBESITY
BMI > 40 INDICATES MORBID OBESITY
2. AT BMI < 35, AN INCREASED WAIST CIRCUMFERENCE INCREASES RISK.
3. BODY FAT CAN BE ESTIMATED FROM AN X-RAY (DEXA) SCAN, UNDERWATER OR AIR WEIGHING, SKINFOLDS ALL OF WHICH ARE ESTIMATES.
4. BODY SHAPE CAN BE MODELED USING AN INFRARED BEAM REFLECTED OFF THE BODY WHILE YOU ROTATE FOR 35 SECONDS YIELDING 14 EXACT CIRCUMFERENCES.
5. KNOWING BODY COMPOSITION CAN DETERMINE YOUR PROTEIN NEEDS.



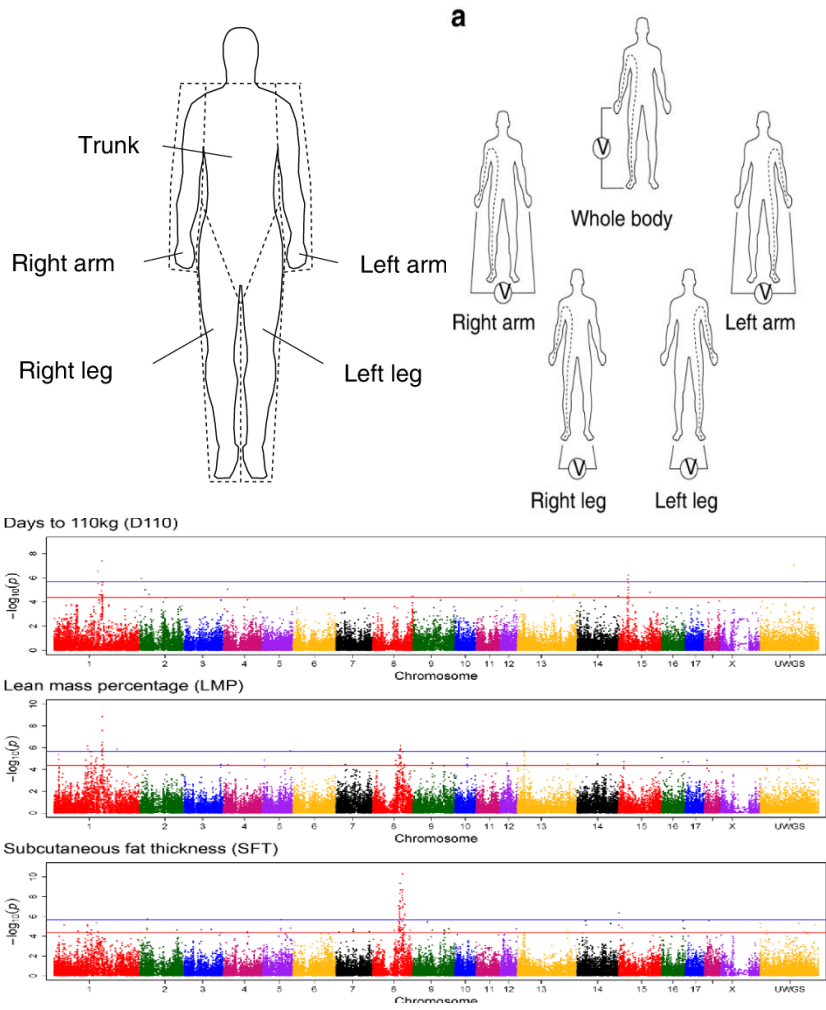


BEST PERSONAL SHAPE #4
THE GENETICS OF BODY SHAPE

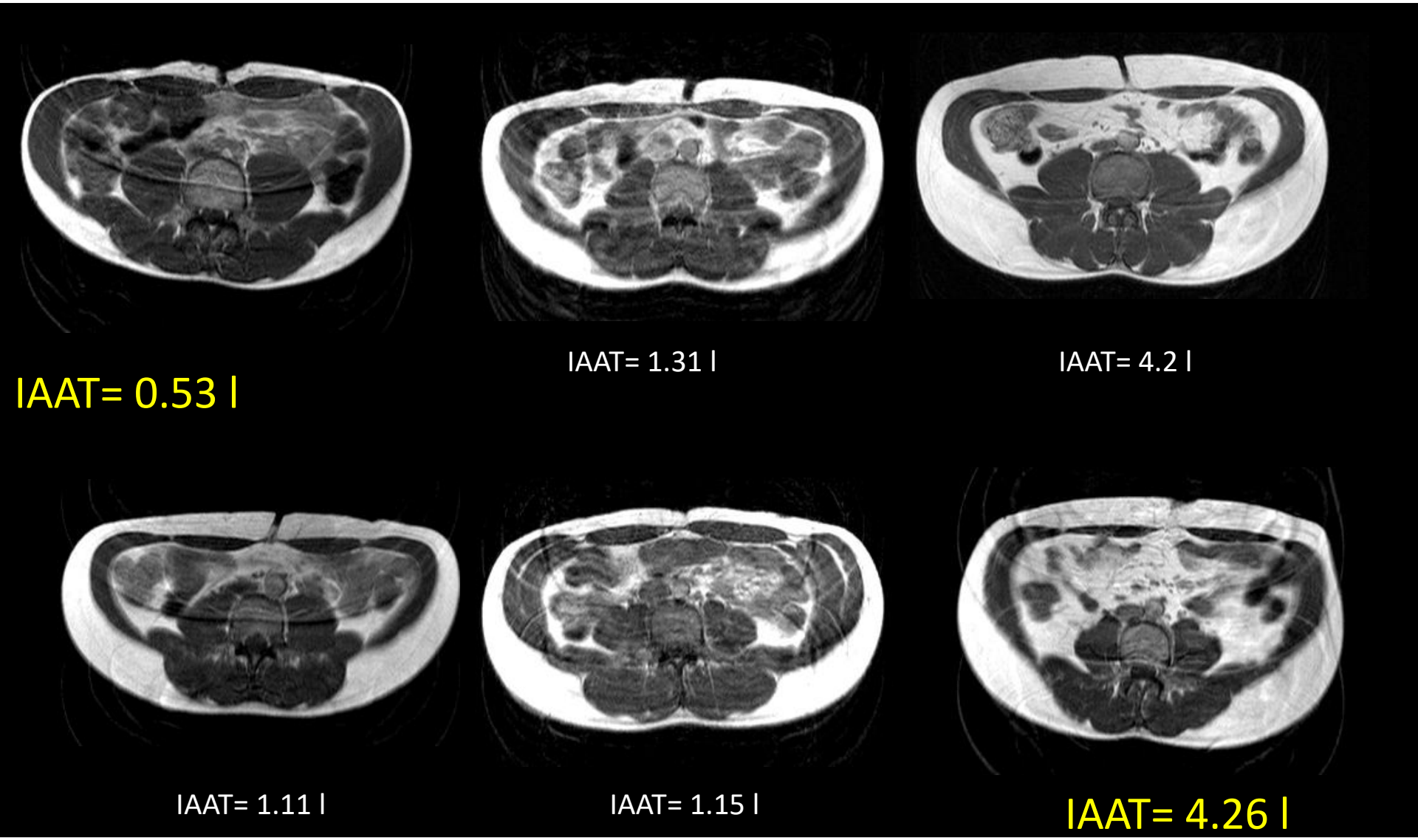
1. GENETIC STUDIES IN 362,499 INDIVIDUALS FROM THE UK BIOBANK DEMONSTRATED THAT THE PROPORTION OF BODY FAT IN THE ARMS, LEGS AND TRUNK WERE ASSOCIATED WITH 98 GENES WITH 37 ASSOCIATIONS STRONGER IN FEMALES COMPARED TO MALES.

2. YOU CANNOT CHANGE YOUR GENES, BUT YOU CAN REACH YOUR BEST PERSONAL SHAPE THROUGH A PROGRAM OF HEALTHY ACTIVE LIFESTYLE WITH THE RIGHT AMOUNT OF PROTEIN TO CONTROL HUNGER AND BUILD MUSCLE.

3. BURN FAT AND THEN BUILD SPECIFIC MUSCLE GROUPS SO THAT YOU CAN DEVELOP YOUR BEST PERSONAL SHAPE.



Waist Circumference

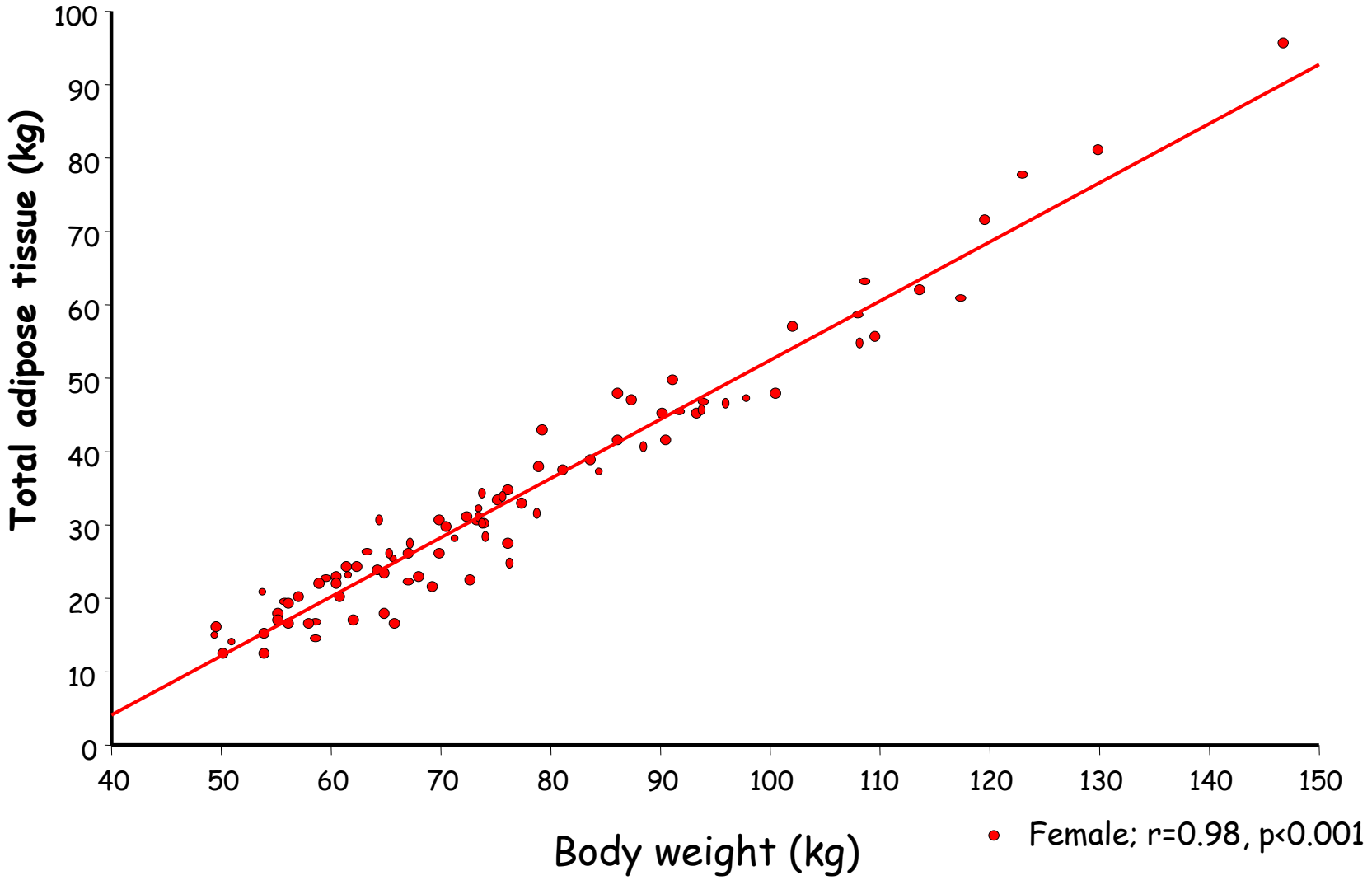


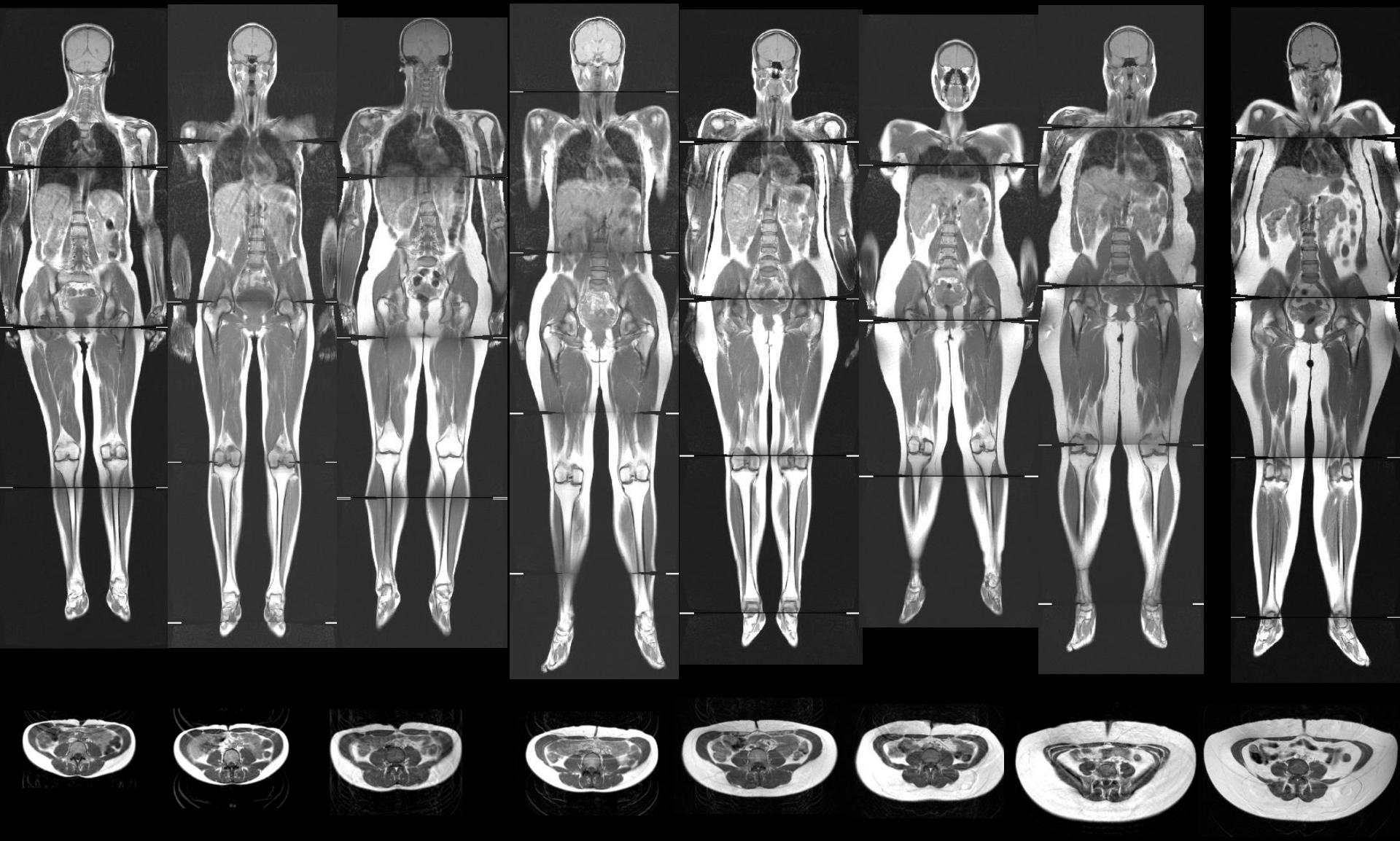
Gender and Ethnic Differences

- Significant differences in incidences of IR and Type II diabetes in *males* compared to *females* (premenopausal) *Isomaa et al 2001*

- Increased incidences of IR and Type II diabetes in *South Asians Mather et al 1985*

- Increased incidences of IR and Type II diabetes associated with *low birth-weight Barker et al 1993*

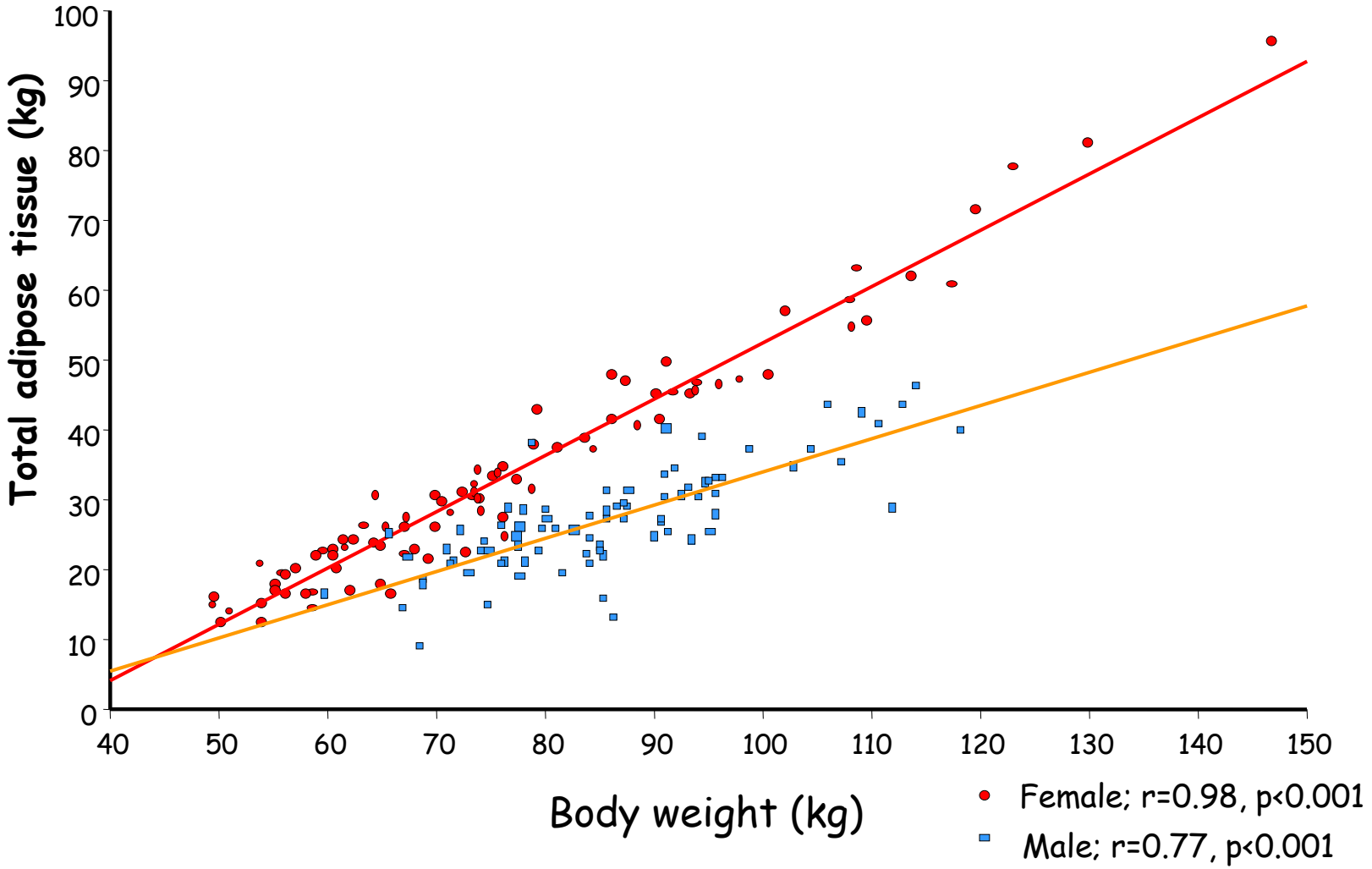

Total adipose tissue (kg)
100
90
80
70
60
50
40
30
20
10
0
40
50
60
70
80
90
100
110
120
130
140
150
Body weight (kg)
Female; r=0.98, p<0.001



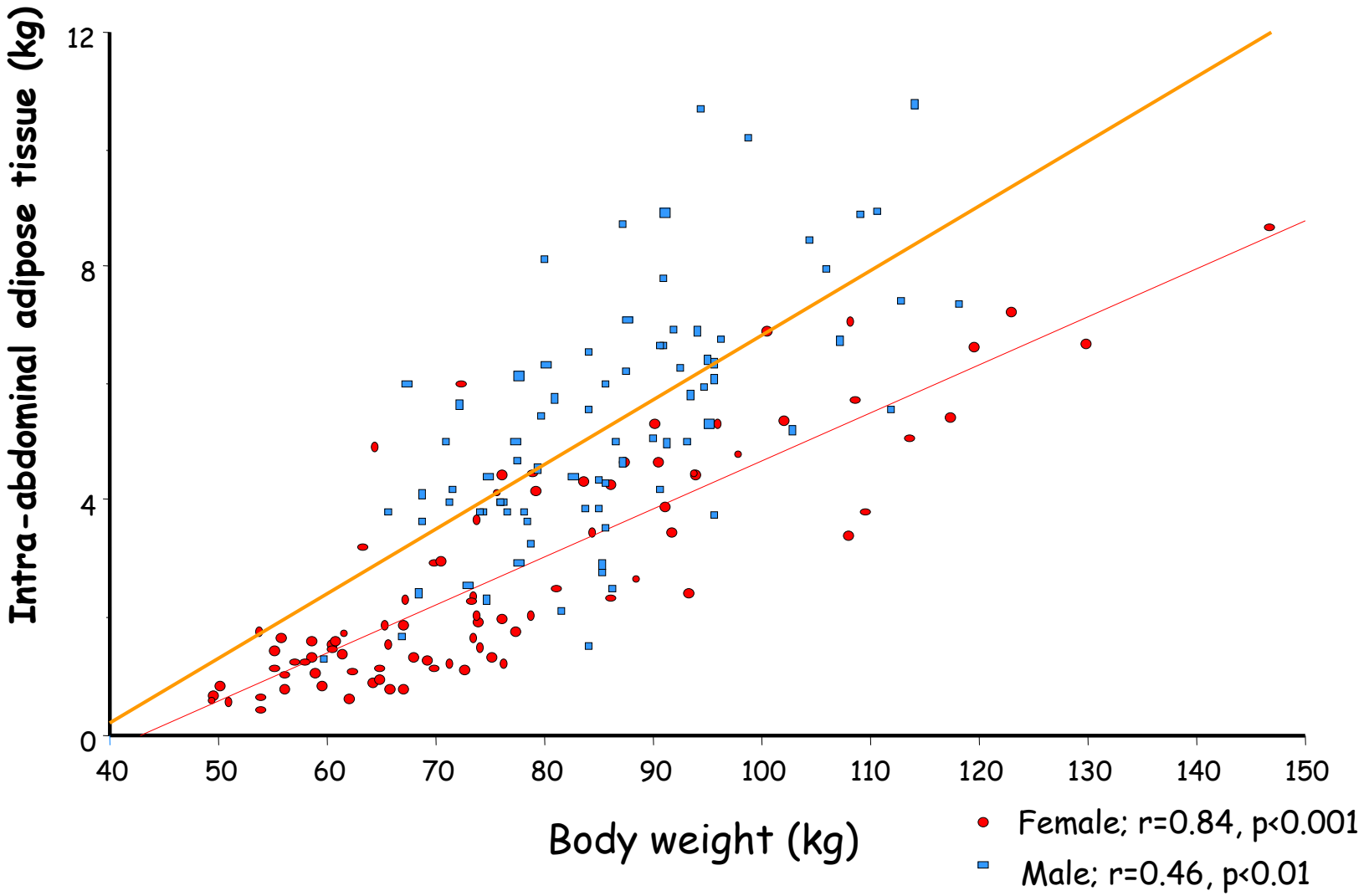
Size 6 Size 8 Size 10 Size 12 Size 14 Size 16 Size 18 Size 20

Size 12 Size 12 Size 12 Size 12 Size 12 Size 12 Size 12 Size 12

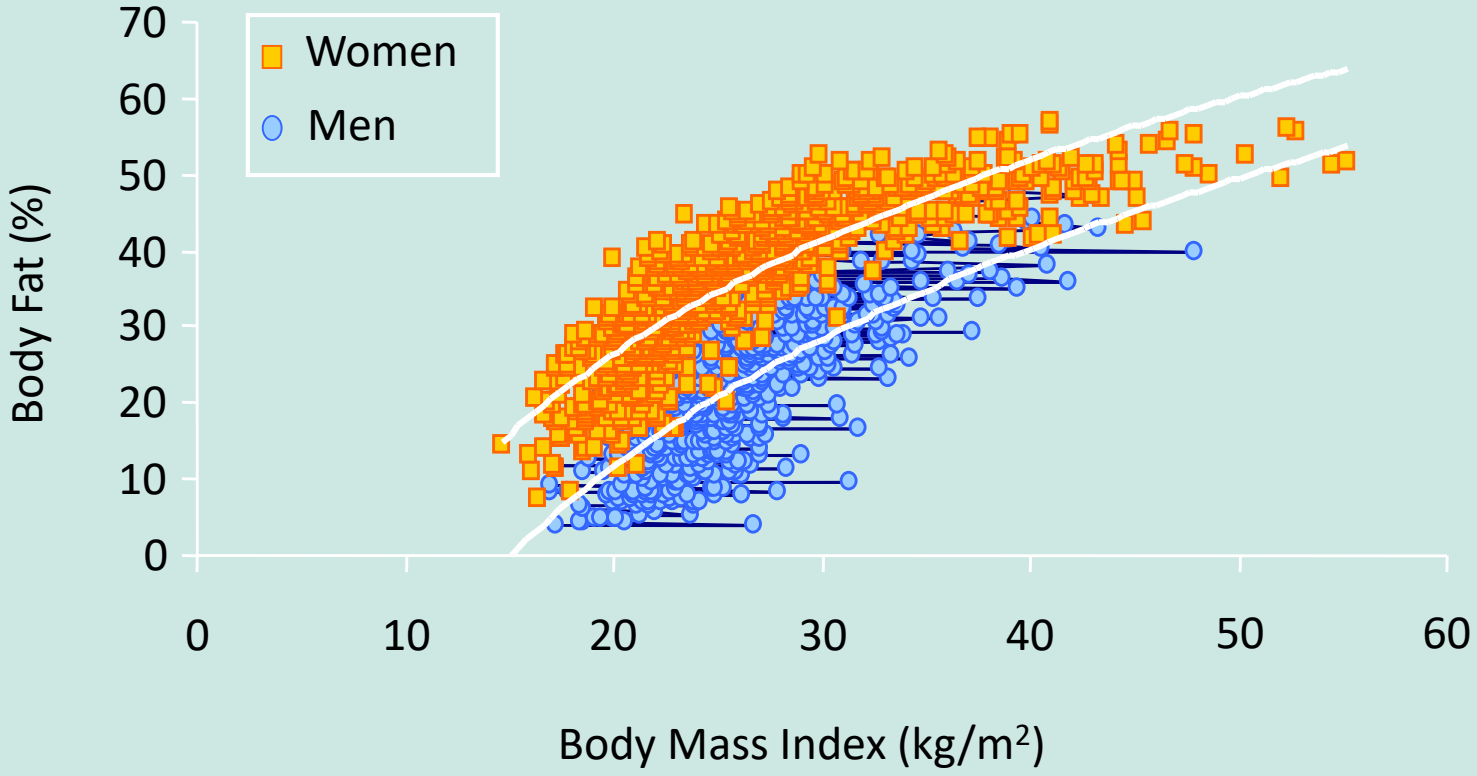
Male vs. Female Adipose Mass



Male vs. Female Intra-Abdominal Fat



Relationship Between BMI and Percent Body Fat in Men and Women



Adapted from: Gallagher et al. *Am J Clin Nutr* 2000;72:694.

Many of Us Lose Muscle with Age: Inadequate Protein & Too Little Exercise

Same Weight, Different Muscle Mass

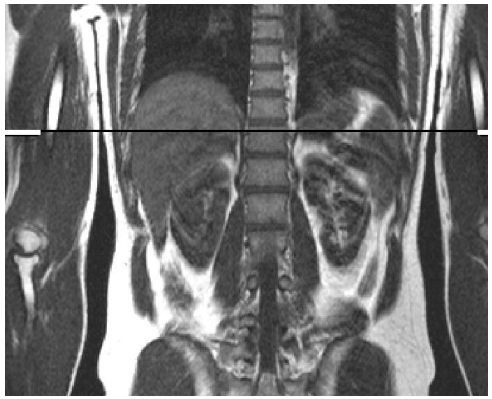
21 year old Female

(BMI = 24.3 kg/m^2)

73 year old Female

(BMI = 24.5 kg/m^2)

TOFI
(Thin Outside Fat Inside)



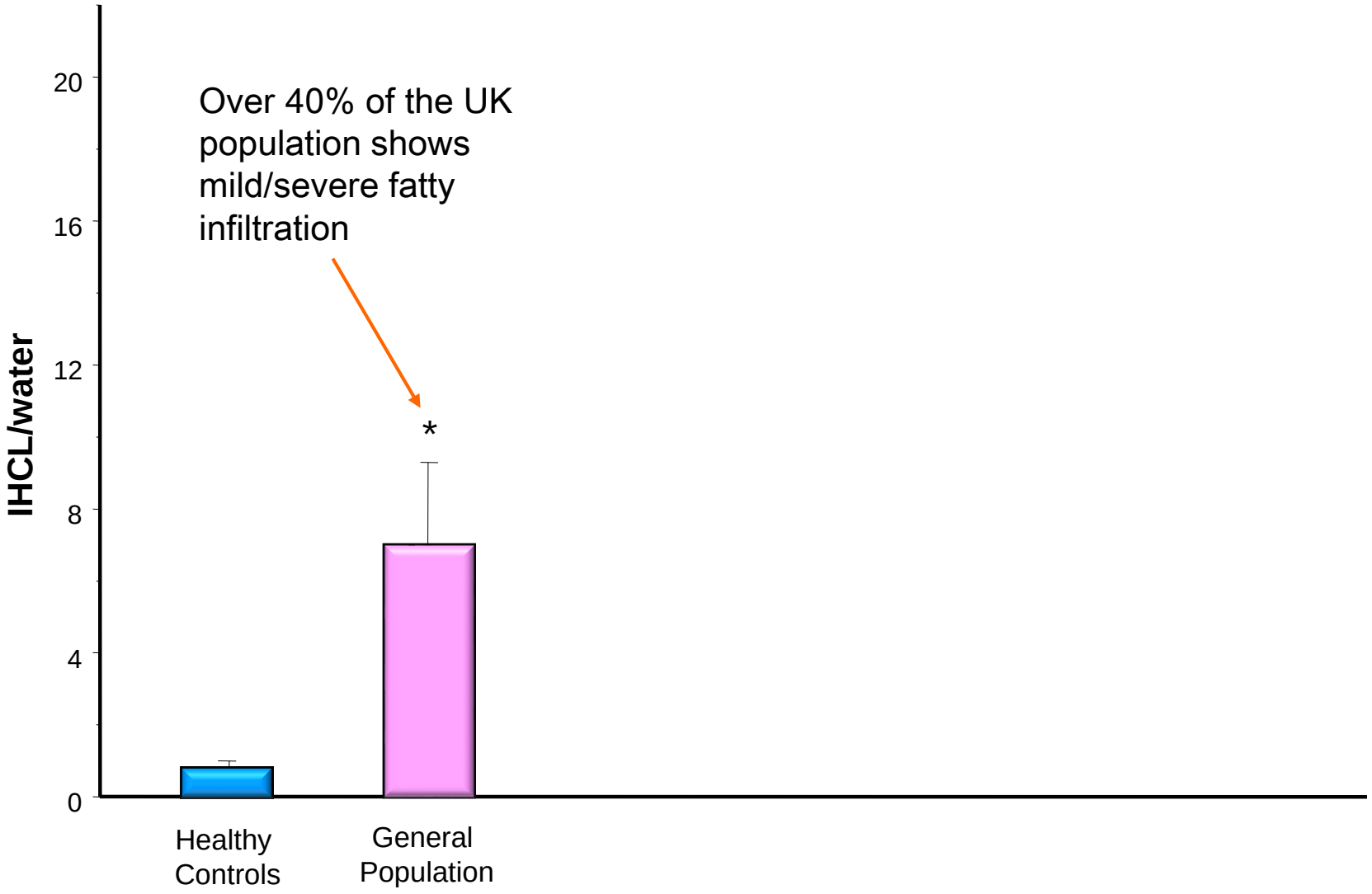
TOFI	**Control**
BMI 25.8 kg/m^2	BMI 26.5 kg/m^2
IAAT = 3.3 litres	IAAT = 2.2 litres
TAT = 22.3 litres	TAT = 20.8 litres

Male TOFI = 15.9 % of lean males
Female TOFI = 11.5% of lean females

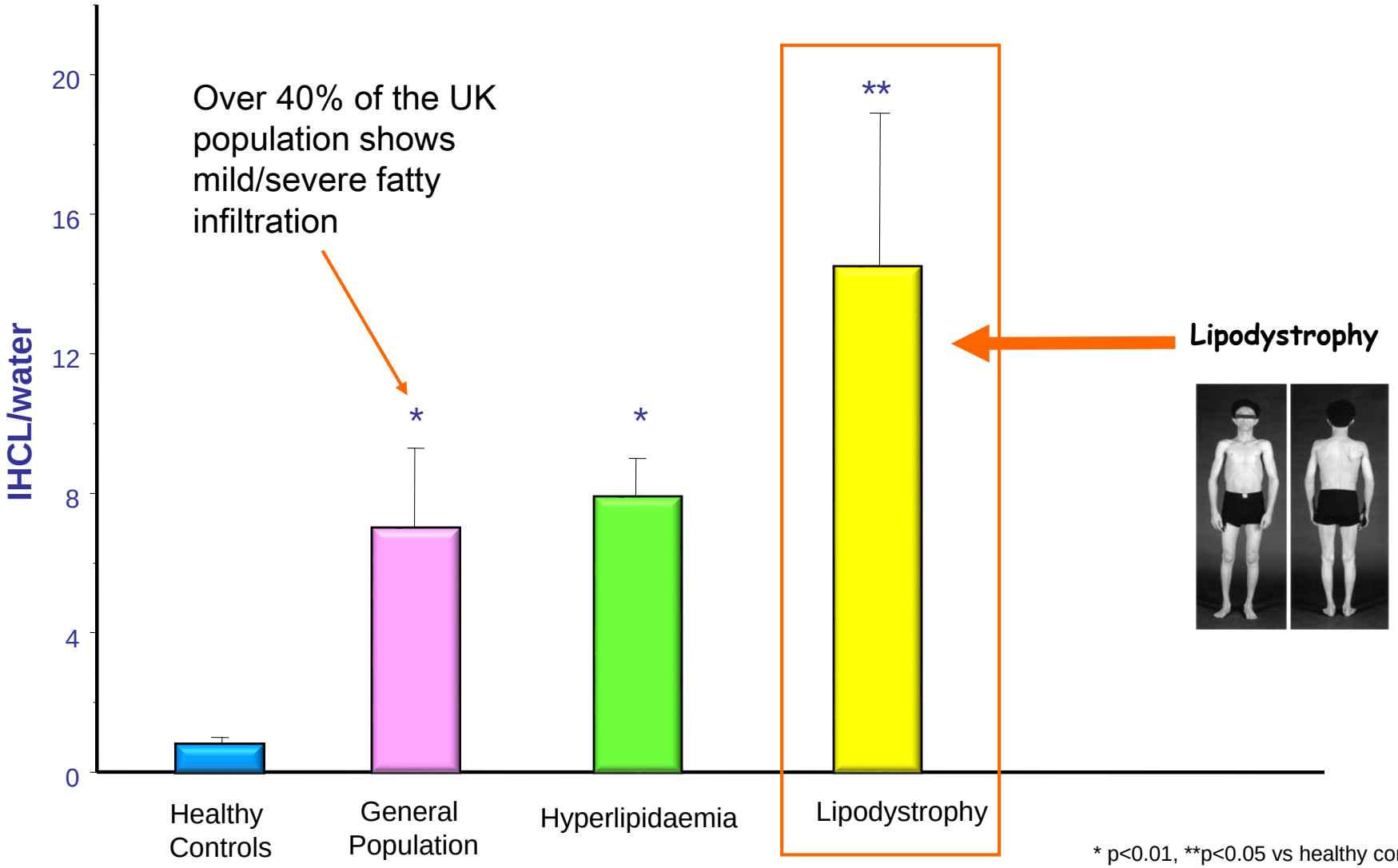
Ectopic fat

- Liver
- Heart
- Pancreas

Intrahepatic Lipid Content

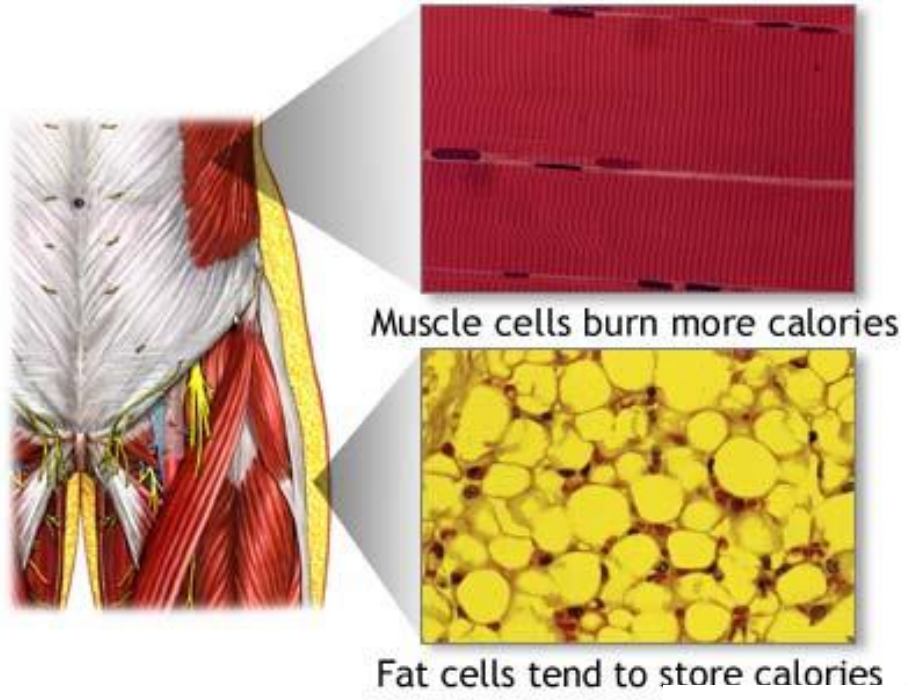


Intrahepatic Lipid Content



* p<0.01, **p<0.05 vs healthy control
‡ p<0.01 vs general population

The Difference Between Muscle and Fat Cells



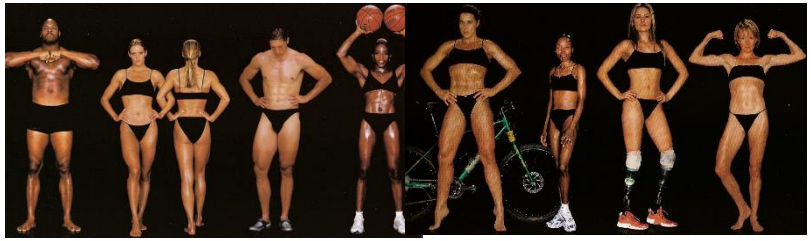
Muscle Burns 30 kcal/kg

Fat Burns 6 kcal/kg

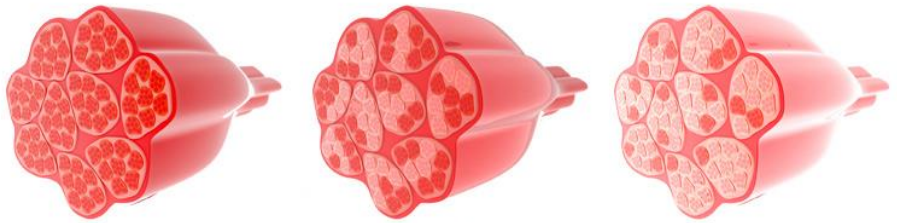
The Best Correlate of Resting Energy Expenditure is the Lean Body Mass
So When Muscle is Lost in Sarcopenic Obesity the Resting Metabolic Rate
Is Reduced and Weight Gain occurs without a large increase in food intake.

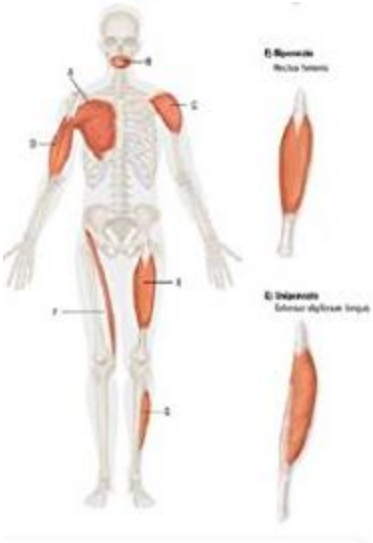
MUSCLE TYPES

1. THREE TYPES OF MUSCLE ARE RED, MIXED, AND WHITE. THE RED COLOR COMES FROM MYOGLOBIN, A PROTEIN THAT BINDS OXYGEN.
2. RED MUSCLES CAN MAINTAIN FORCE FOR LONG PERIODS OF TIME, USE FAT FOR ENERGY THROUGH THE MITOCHONDRIA.
3. WHITE MUSCLES ARE OF TWO TYPES (A,B) WHICH PROVIDE MORE FORCE AND USE GLYCOGEN AND CREATINE-P FOR ENERGY, HAVE FEWER MITOCHONDRIA AND FATIGUE.
4. YOUR GENETICS AND EXERCISE TRAINING DETERMINE YOUR MUSCLE TYPES.



RED MIXED WHITE

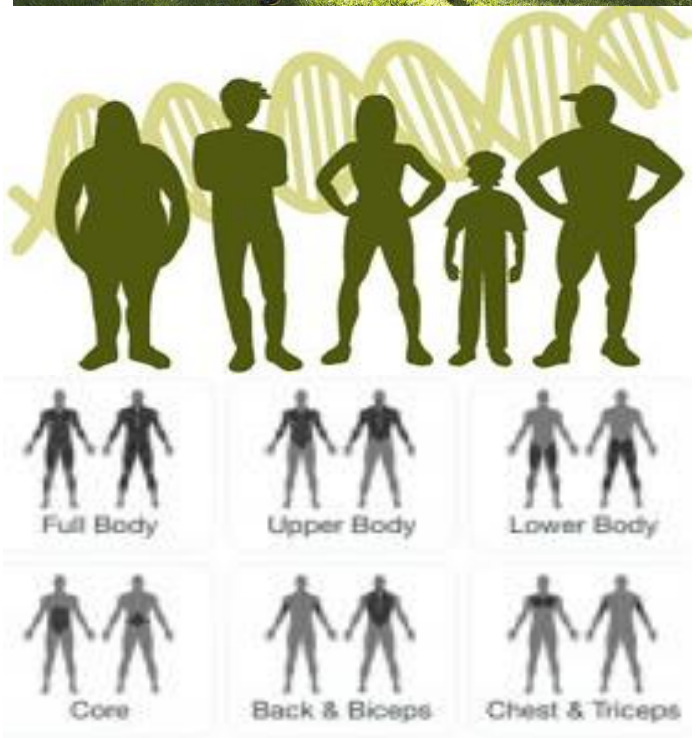




	Slow-Twitch (Type I)	Fast-Twitch A (Type IIa)	Fast-Twitch B (Type IIb)
contraction time	slow	fast	very fast
size of motor neuron	small	large	very large
resistance to fatigue	high	intermediate	low
activity	aerobic	long-term anaerobic	short-term anaerobic
force production	low	high	very high
mitochondrial density	high	high	low
capillary density	high	intermediate	low
oxidative capacity	high	high	low
glycolytic capacity	low	high	high
major storage fuel	triglycerides	creatine phosphate, glycogen	creatine phosphate, glycogen

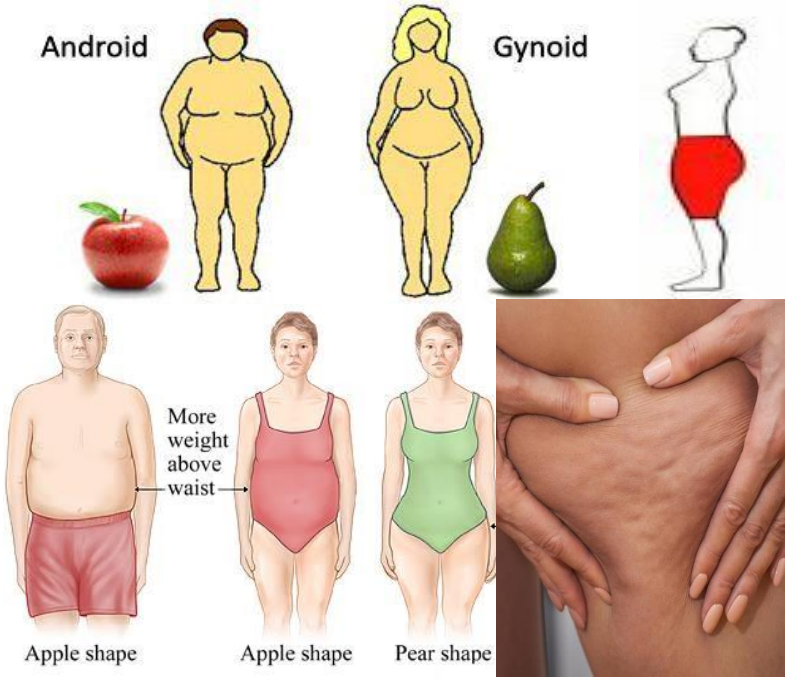
PERSONALIZED EXERCISES

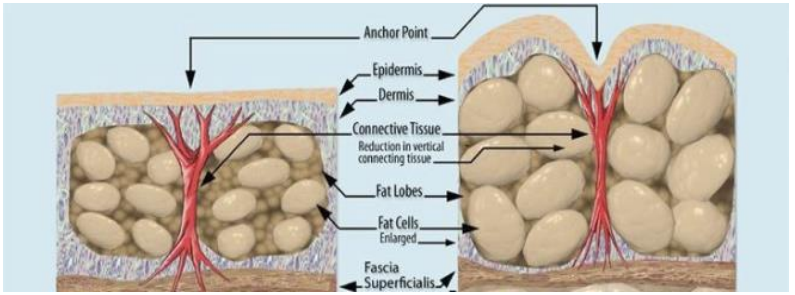
1. YOUR BODY TYPE IS DETERMINED BY HEREDITY AND ENVIRONMENT INCLUDING YOUR NUTRITION IN THE FIRST 1000 DAYS OF LIFE INCLUDING IN YOUR MOTHER'S WOMB.
2. YOUR ADULT SHAPE IS PERSONAL AND YOUR DESIRES TO OPTIMIZE THAT SHAPE ARE ALSO PERSONAL.
3. OBTAINING INFORMATION ON HOW TO RESHAPE YOUR BODY TO ITS BEST PERSONAL SHAPE IS AVAIALABLE ON THIS INSTAGRAM SITE AND IN MANY BOOKS, ARTICLES, AND VIDEOS.
4. PLANNING, CONSISTENCY, AND A MULTIYEAR DETERMINATION TO RESHAPE AND MAINTAIN YOUR MUSCLES ARE NEEDED FOR YOUR BEST PERSONAL SHAPE AND THE REWARDS THAT BRINGS.



UPPER VS. LOWER BODY FAT

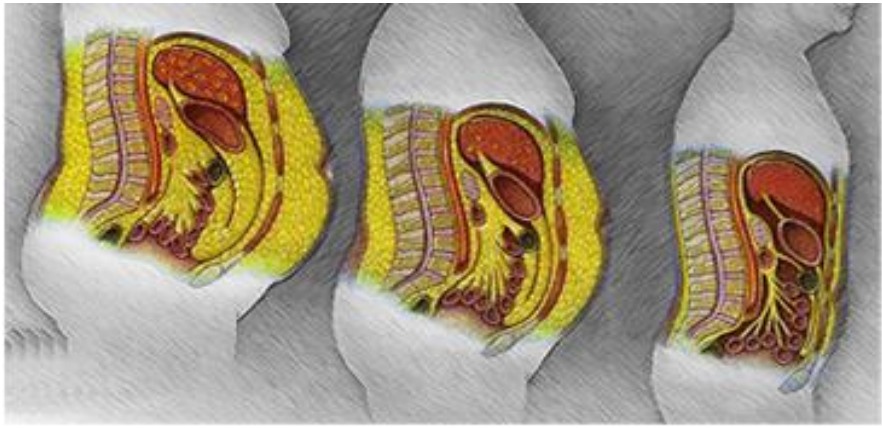
1. LOWER BODY FAT CELLS ARE ALMOST ALWAYS PRESENT IN WOMEN.
2. THEY DEVELOP UNDER THE INFLUENCE OF ESTROGEN.
3. THE LOWER BODY FAT IS HEALTHY FAT THAT SECRETES AN ANTI-INFLAMMATORY HORMONE CALLED ADIPONECTIN.
4. ADIPONECTIN LEVELS GO DOWN WITH WEIGHT GAIN AND UP WITH WEIGHT LOSS.
5. THIS FAT IS DEPOSITED TO SAVE THE 500 CALORIES PER DAY NEEDED FOR BREASTFEEDING AND GROWS MORE DURING PREGNANCY.
6. LOWER BODY FAT CAN DEVELOP DIMPLING, SOMETIMES CALLED CELLULITE AS GROWING FAT CELLS BREAK DOWN COLLAGEN BETWEEN FAT CELLS.

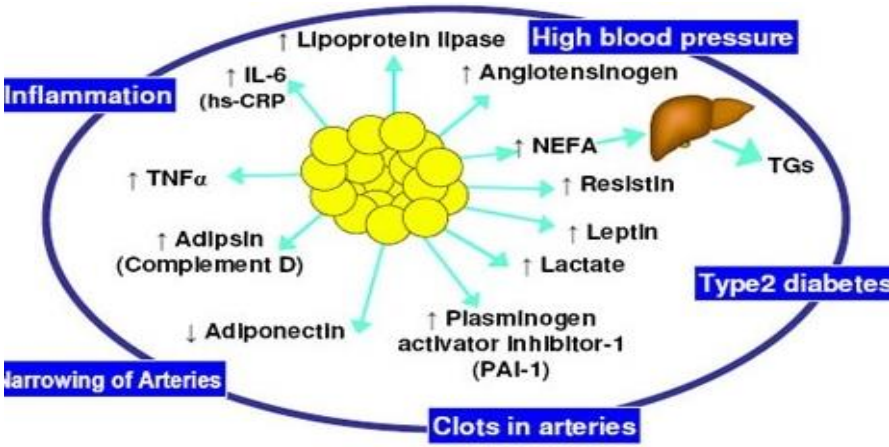




BEST PERSONAL SHAPE #7
FAT IN THE ABDOMEN

1. THE FIRST PLACE YOU GAIN WEIGHT OR LOSE WEIGHT IS IN THE FAT AROUND THE INTESTINES.
2. THIS FAT CAN RELEASE A NUMBER OF HORMONES AND OTHER FACTORS INTO THE BLOOD WHICH PROMOTE INFLAMMATION AND INCREASE THE RISK OF SOME OF THE MOST COMMON INFLAMMATION-ASSOCIATED INCLUDING HIGH BLOOD PRESSURE, DIABESITY, ASTHMA, AND DEMENTIA.
3. IN LONDON, 45% OF WOMEN AND 60% OF MEN HAD EXCESS ABDOMINAL FAT AT A NORMAL BMI (WEIGHT FOR HEIGHT) AND NORMAL WAIST CIRCUMFERENCE.
4. SO YOU DON'T HAVE TO BE OBESE TO BENEFIT FROM LOSING YOUR EXCESS BODY FAT.



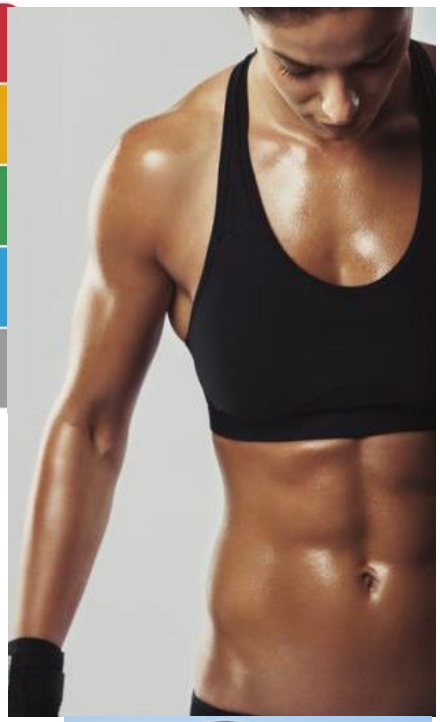


SCULPT YOUR FAT WITH “HIIT”

1. HIGH INTENSITY INTERVAL TRAINING(HIIT) WORKOUTS PROVIDE SHAPING BENEFITS AS QUICKLY AS POSSIBLE, BECAUSE HIIT WORKOUTS BURN MORE CALORIES THAN REGULAR WORKOUTS.

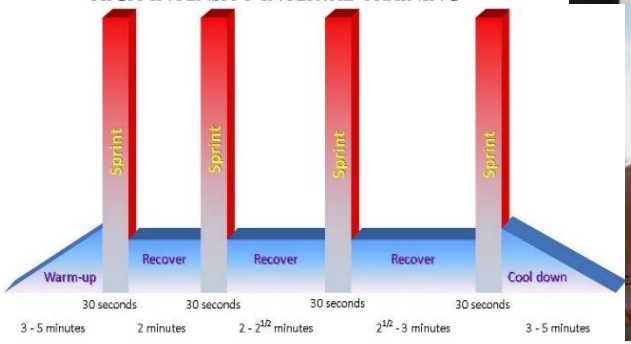
2. THE POST-EXERCISE BURN IS CALLED “EPOC”, WHICH STANDS FOR “EXCESS POSTEXERCISE OXYGEN CONSUMPTION” ADDS 6% TO 15% MORE CALORIE BURN TO EACH OF YOUR WORKOUTS OVER THE TWO HOURS AFTER EXERCISE.

4. FEEL THE BURN AND GET YOUR BEST PERSONAL SHAPE.



FEEL THE BURN
LOSE THE FAT

HIGH INTENSITY INTERVAL TRAINING

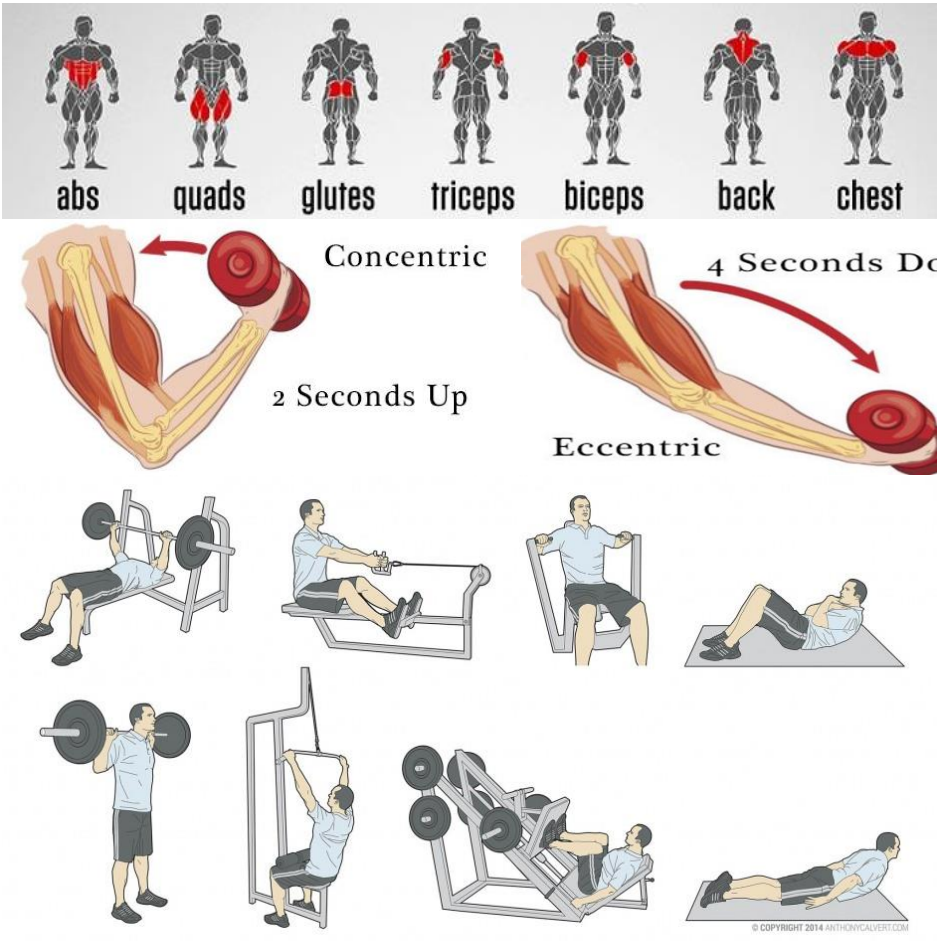


MUSCLE AND SHAPE

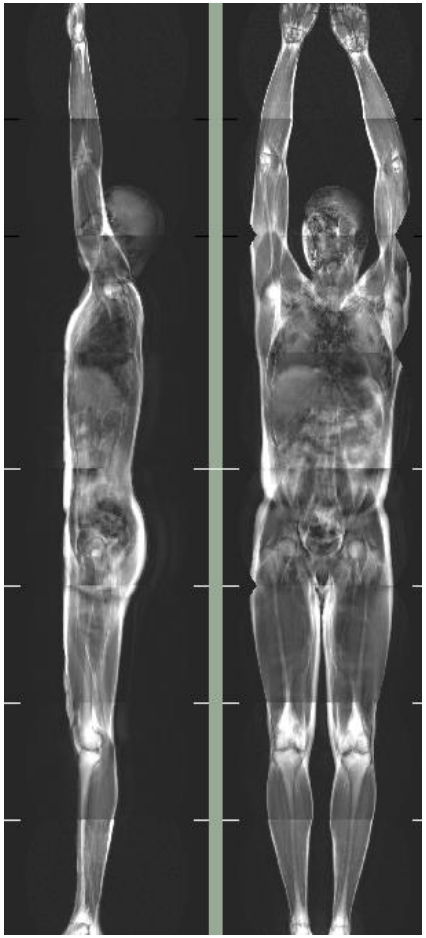
1. STRENGTH TRAINING INVOLVES LIFTING A WEIGHT IN TWO STEPS: UP FOR 2 SECONDS AND THEN LOWERING THE WEIGHT FOR 4 TO 6 SECONDS TO MAXIMIZE STRENGTH GAIN.

2. ECCENTRIC EXERCISES CAN BE PERSONALIZED TO MEET YOUR GOALS BECAUSE THE MUSCLE FORCES THAT ARE GENERATED DURING SLOW ECCENTRIC OVERLOADING ARE HIGH COMPARED TO TRADITIONAL CONCENTRIC RESISTANCE EXERCISE.

3. DO EXERCISES WITH PURPOSE PROPERLY IN TERMS OF POSITION AND TEMPO FOR SHAPING!!



MRI



Measurements of Body Fat

Body Fat Mapping

- Total adipose tissue
- Regional adipose tissue:
  - Subcutaneous
    - Peripheral
    - Abdominal
  - Internal
    - Peripheral
    - **Abdominal (Visceral)**
  - Inter-muscular (EMCL)
  - Intramyocellular (IMCL)
  - Pericardial
  - **Hepatic (IHCL)**
  - Pancreatic
  - Popliteal

EVEN IF YOU ARE THIN YOU CAN BE FAT

MRI reveals fat around the Heart, Liver and Intestine in Individuals with Normal Waist Circumference

Of the women scanned by Bell and his colleagues, as many as 45 percent of those with normal BMI scores (20 to 25) actually had excessive levels of internal fat. Among men, the percentage was nearly 60 percent.

Role of Protein: providing amino acids

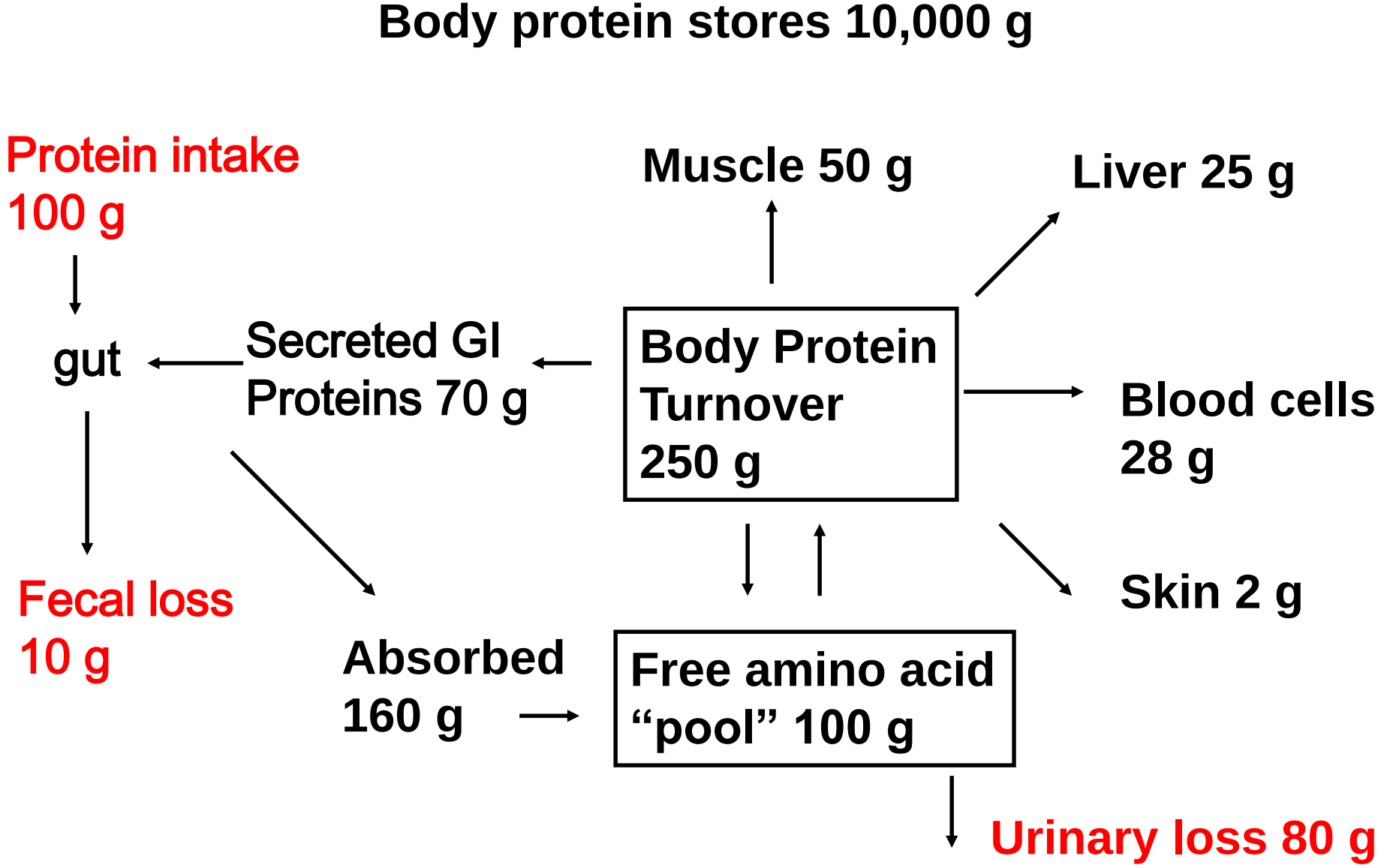
- building blocks for new proteins
- providing energy – limited (~15% of daily kcal)

but specific – muscle, liver, brain, pancreas, adipose

- metabolic signals

tryptophan → serotonin→ neurotransmitter
arginine → nitric oxide → vascular function
leucine → mTOR→ protein synthesis

Dynamics of protein turnover

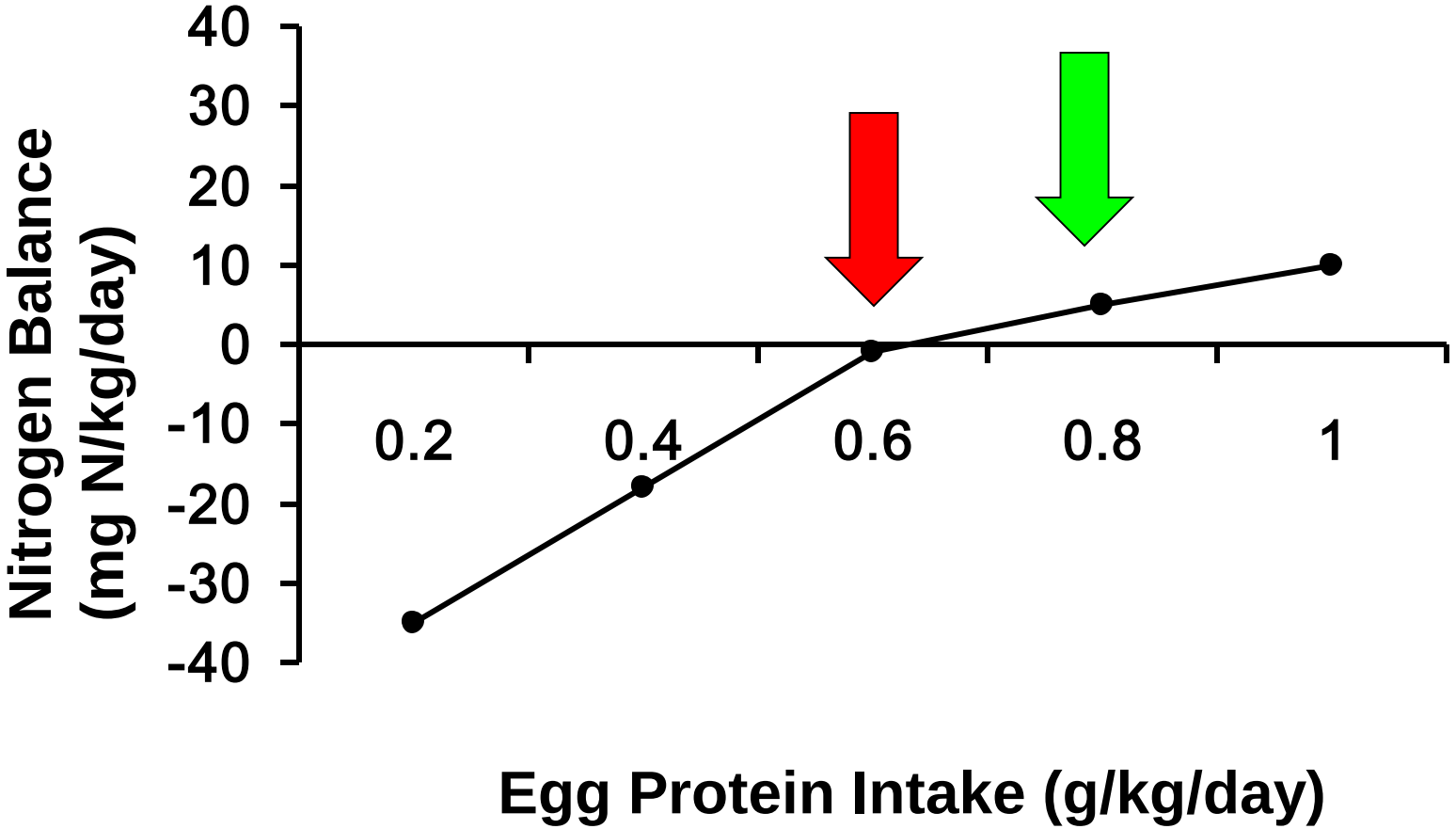


One Index of Protein Balance is Nitrogen Balance

$$N_{balance} = N_{intake} - N_{output}$$

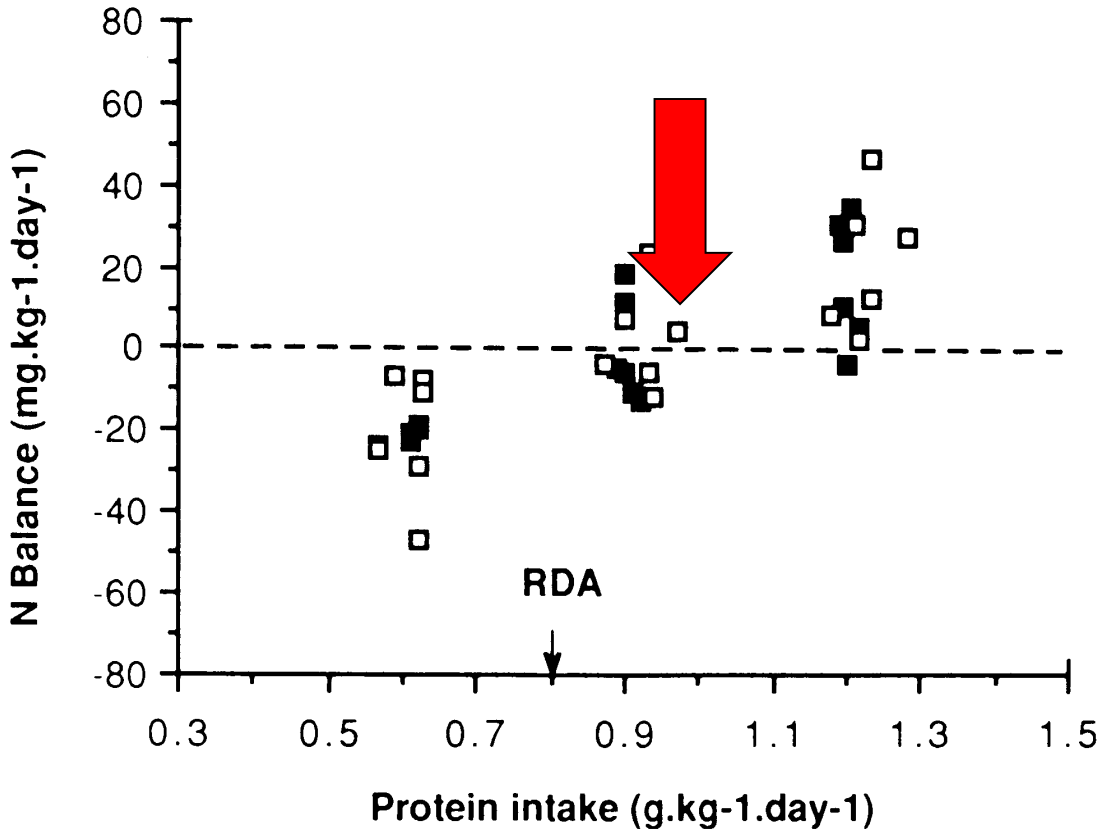
Assess balance at several different protein intakes above and below the estimated requirement level to end up with the RDA.

Determining the RDA



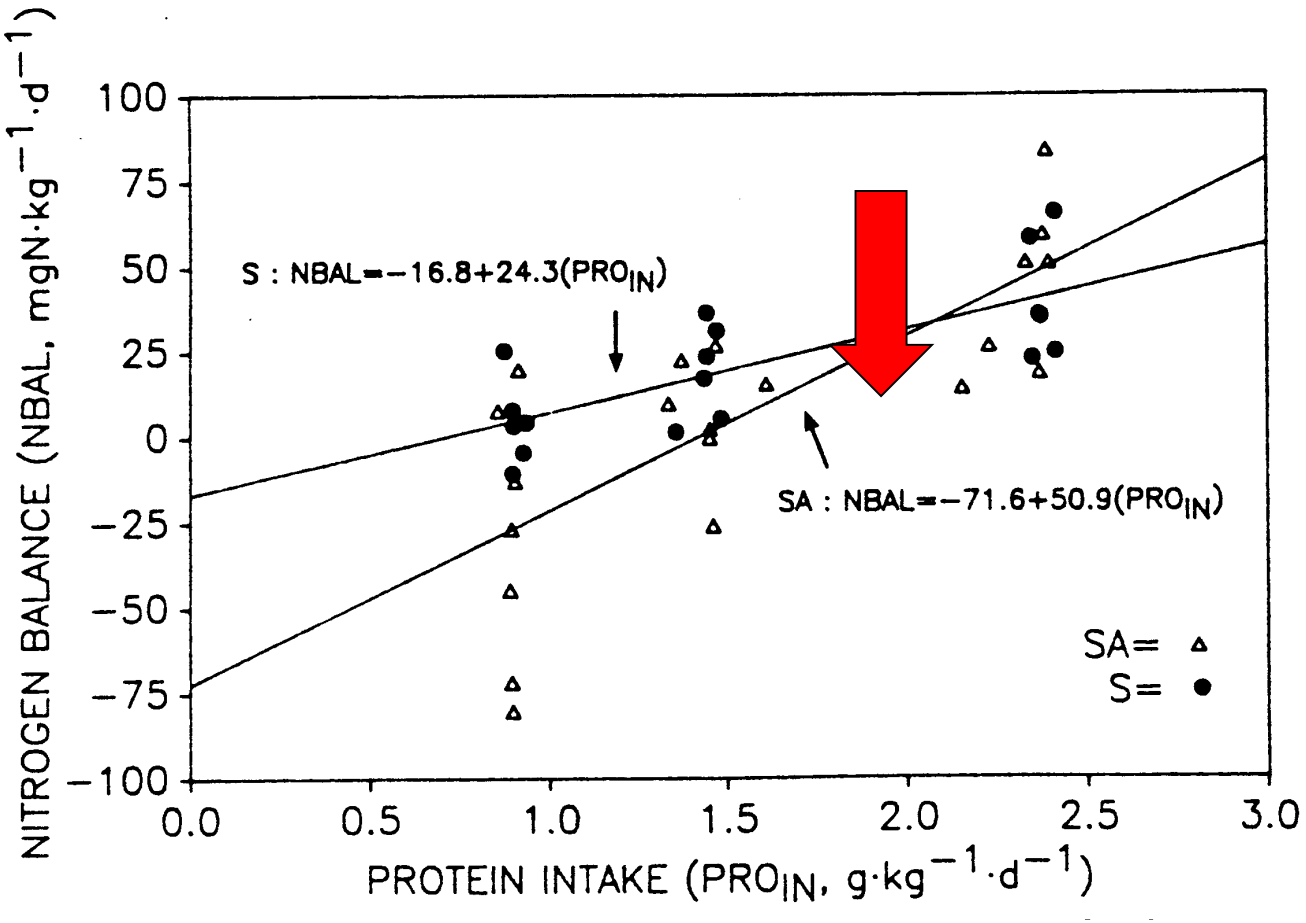
Young et al. 1973

Protein requirements in endurance athletes:



Meredith et al. 1989

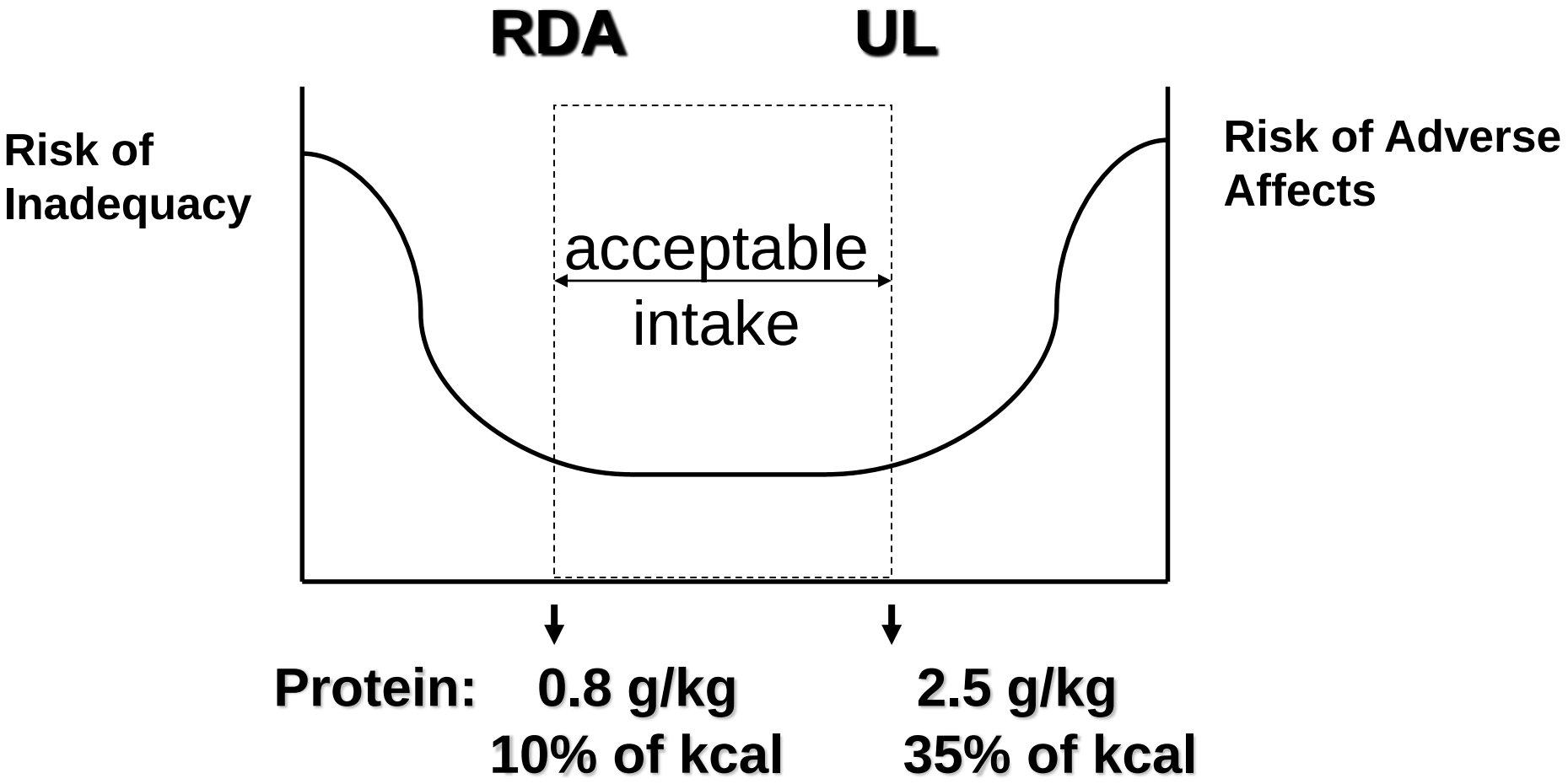
Weightlifters in Balance at 2.5 g/kd/day



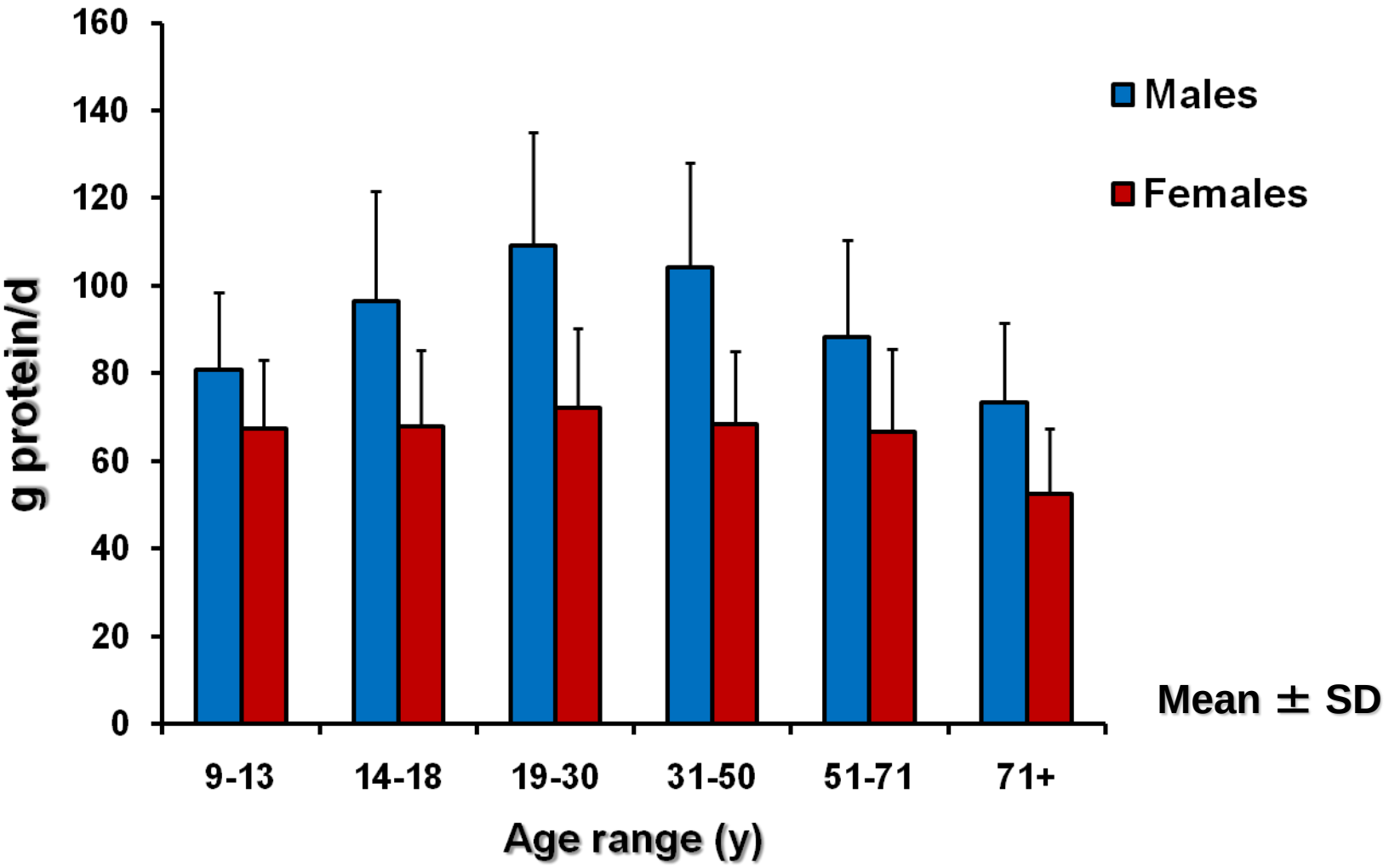
Tarnopolsky et al. 1992

Dietary Reference Intakes (DRI)

Acceptable Range of Macronutrient Intake for Protein

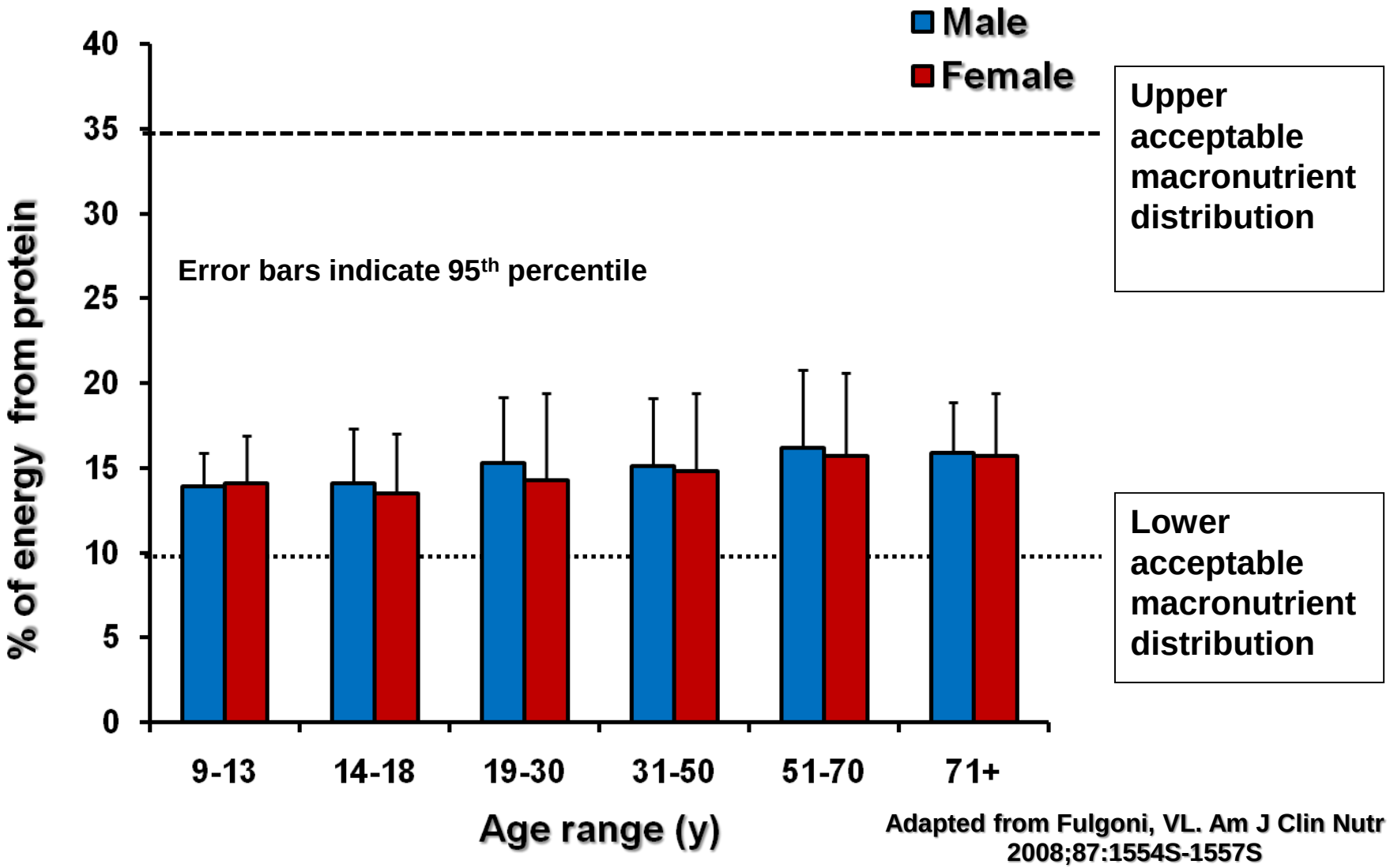


Habitual protein intakes in the U.S.



Adapted from Fulgoni, VL. Am J Clin Nutr 2008;87:1554S-1557S

Habitual protein intakes in the U.S.



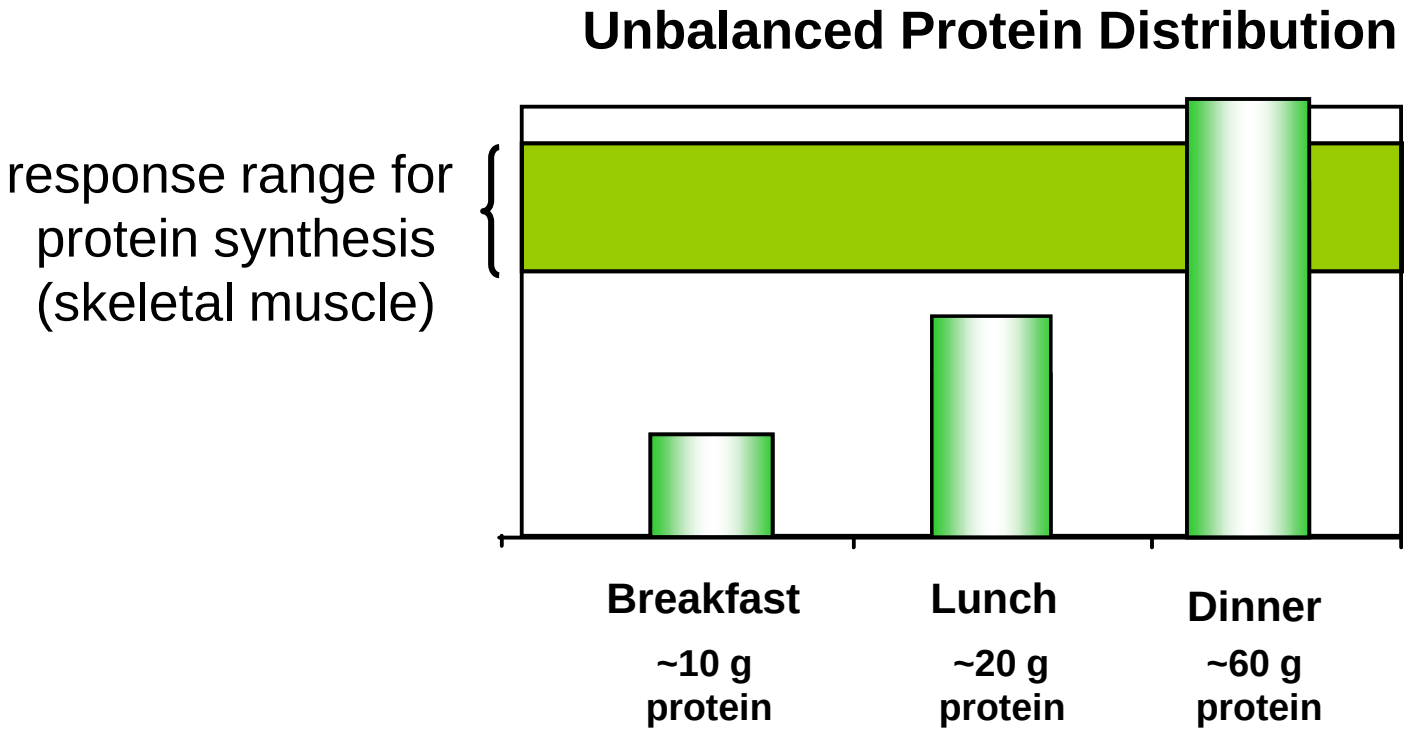
Adapted from Fulgoni, VL. Am J Clin Nutr 2008;87:1554S-1557S

Daily patterns of protein intake in younger and older adults

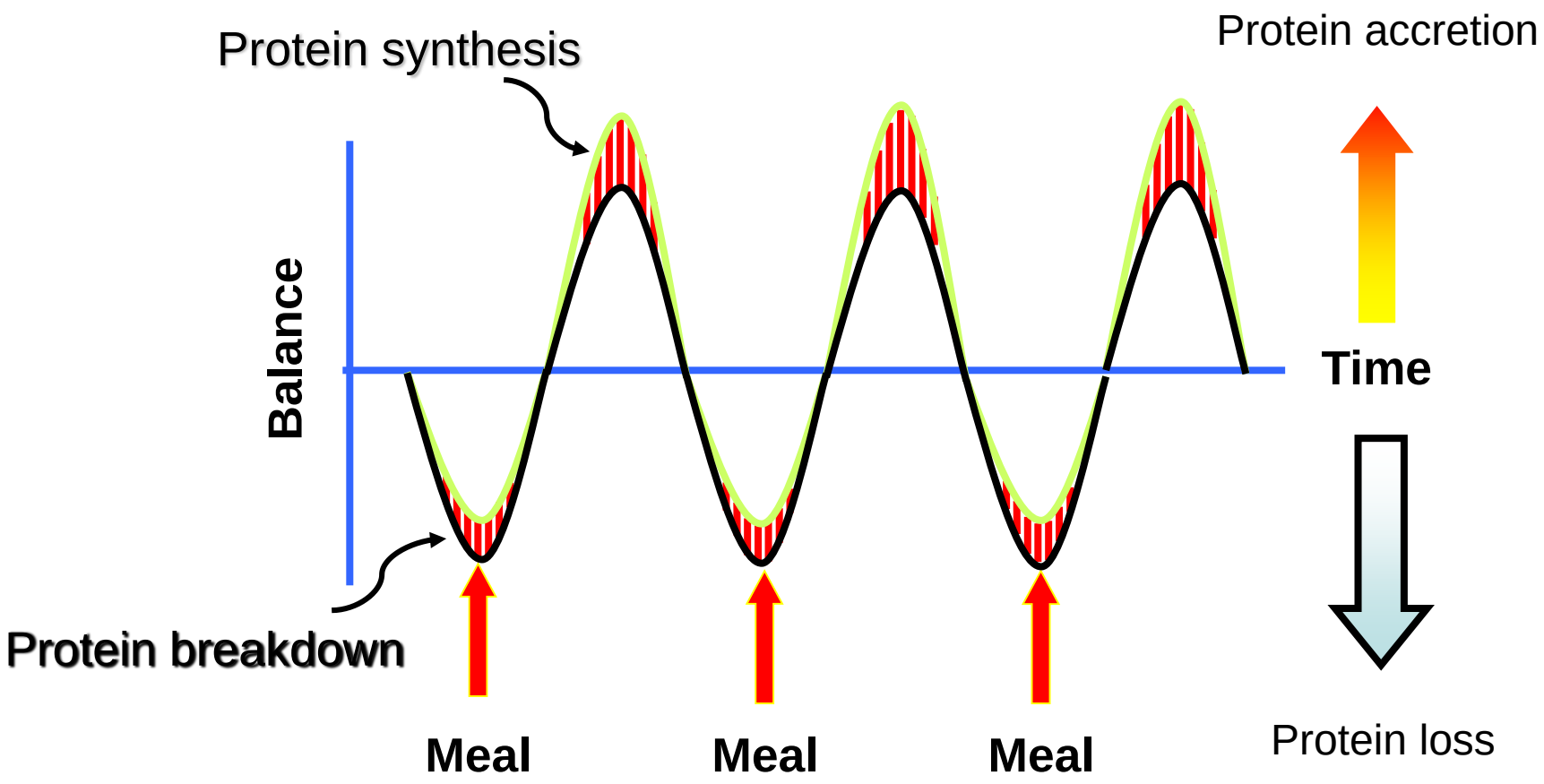
	Bkft	Lunch	Dinner	Snack	Total
	Protein intake (g/d)				
Younger	11.1	25.4	43.0	8.8	88.3
Older	13.3	20.2	35.8	7.2	76.5
	Protein intake (% of energy)				
Younger	11.8	16.1	18.8	7.5	14.8
Older	13.1	16.8	18.7	8.1	15.3
	Energy intake (kcal/d)				
Younger	377	631	914	469	2391
Older	405	479	766	355	2005

Adapted from Howarth, NC. Int J Obes 2007;31:675-684

Meal Patterns:

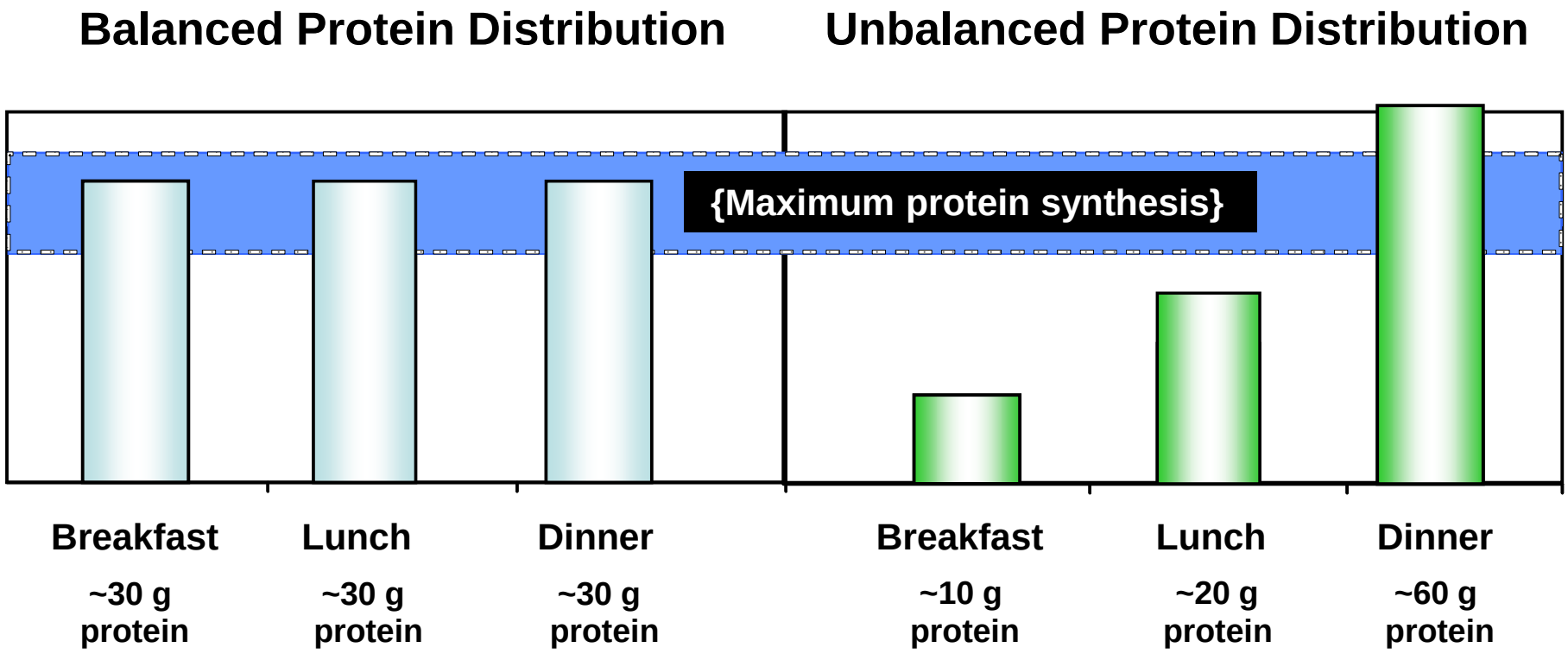


Muscle **Protein Balance**

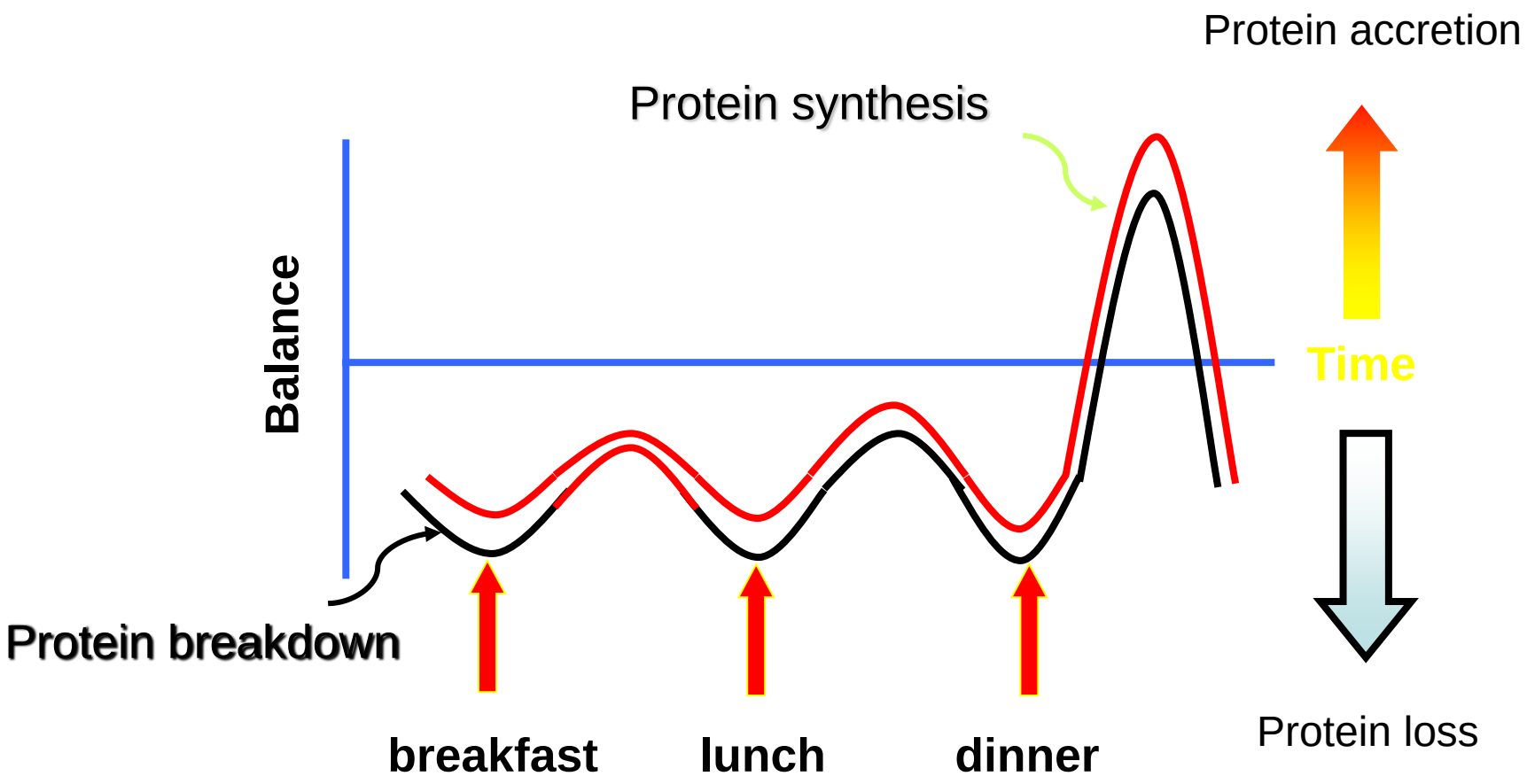


Phillips. Nutrition '04

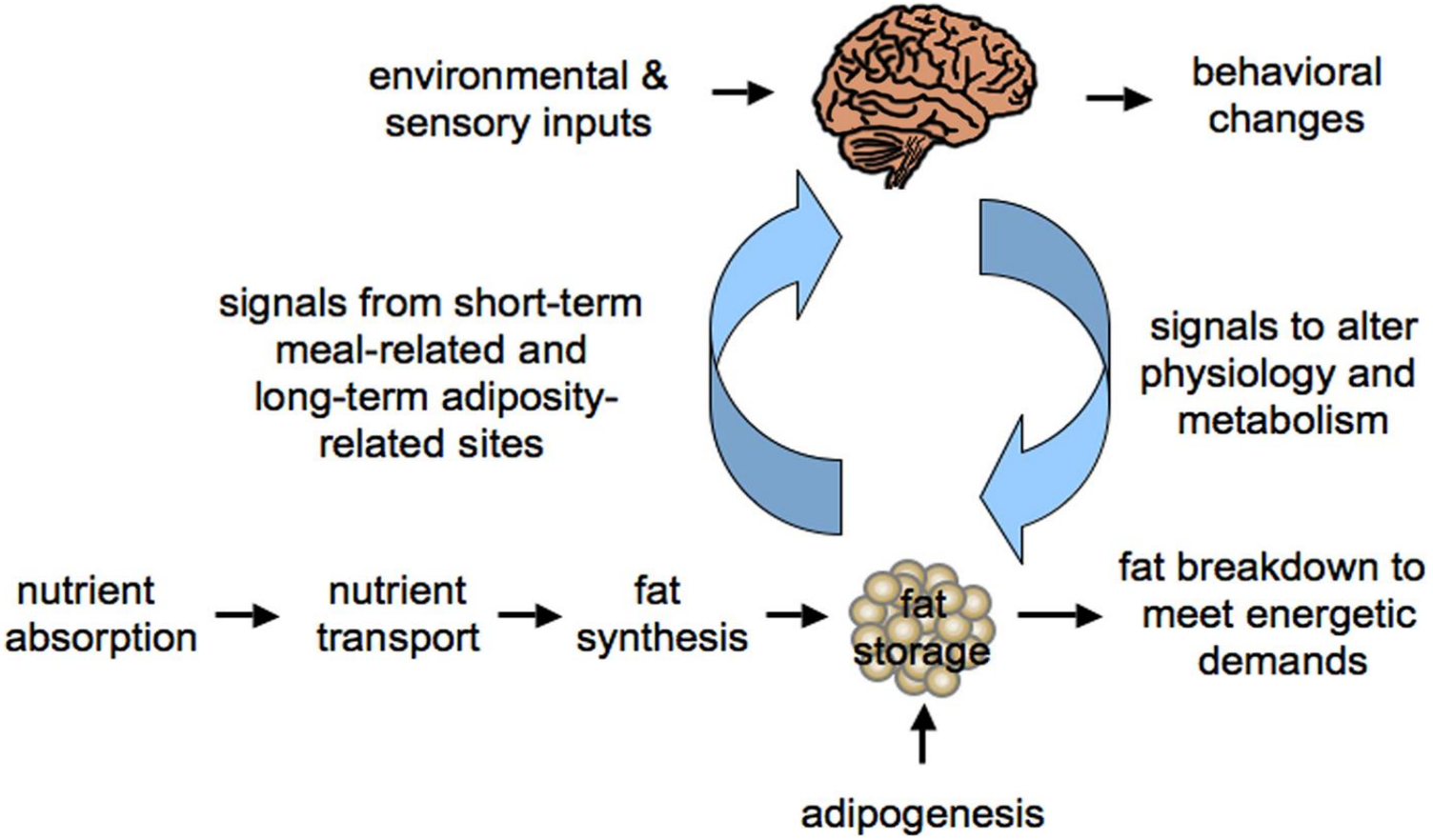
Meal Patterns:



Muscle Protein Balance

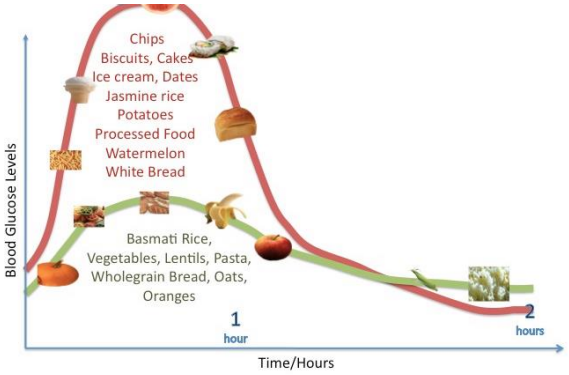


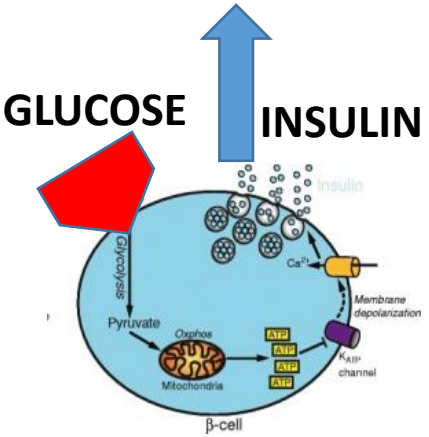
From the brain to the fat cell, we are adapted to store energy

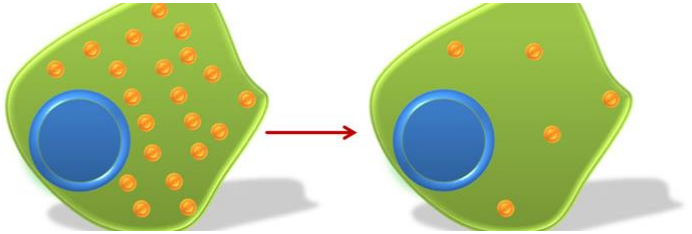


GLYCEMIC INDEX OF FOODS

1. THE GLYCEMIC INDEX IS A NUMBER THAT INDICATES HOW RAPIDLY THE BODY DIGESTS A PARTICULAR TYPE OF FOOD AND CONVERTS IT INTO BLOOD SUGAR (GLUCOSE).
2. SOME STUDIES SUGGEST THAT LOWER-GLYCEMIC-INDEX DIETS MAY OFFER IMPORTANT HEALTH BENEFITS FOR MEN—LIKE A REDUCED RISK OF HEART DISEASE AND DIABETES.
3. THE GLYCEMIC LOAD (GL) OF FOOD IS THE GLYCEMIC INDEX (GI) MULTIPLIED BY THE GRAMS OF AVAILABLE CARBOHYDRATE IN THE FOOD DIVIDED BY 100.
4. EATING A LOWER GLYCEMIC LOAD DIET IS GOOD FOR YOU REGARDLESS OF YOUR GENES HELPING SOME MORE THAN OTHERS.







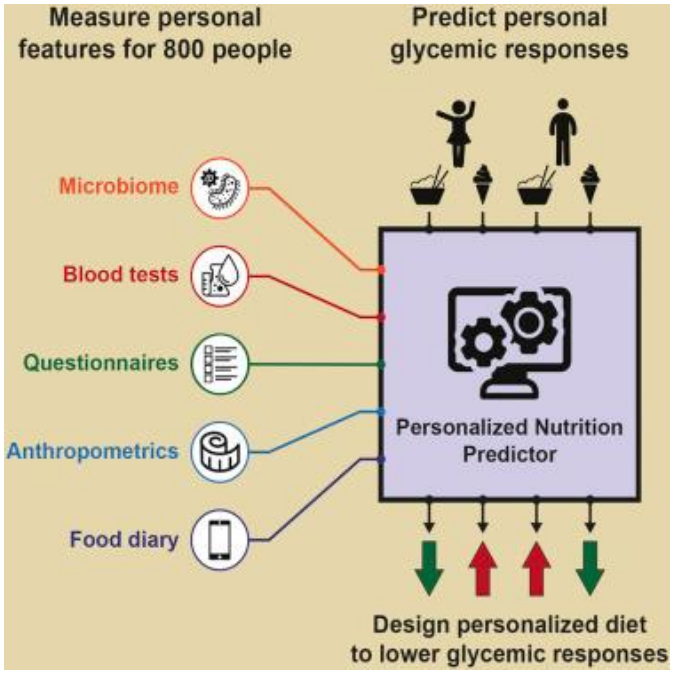
OVER TIME THE PANCREAS BURNS OUT

GLUCOSE RESPONSES TO FOODS

1. IDENTICAL MEALS CAUSED VARIABLE POST-MEAL BLOOD GLUCOSE RESPONSES IN 800 PEOPLE, BUT IN ANY INDIVIDUAL THEY WERE HIGHLY PREDICTABLE.

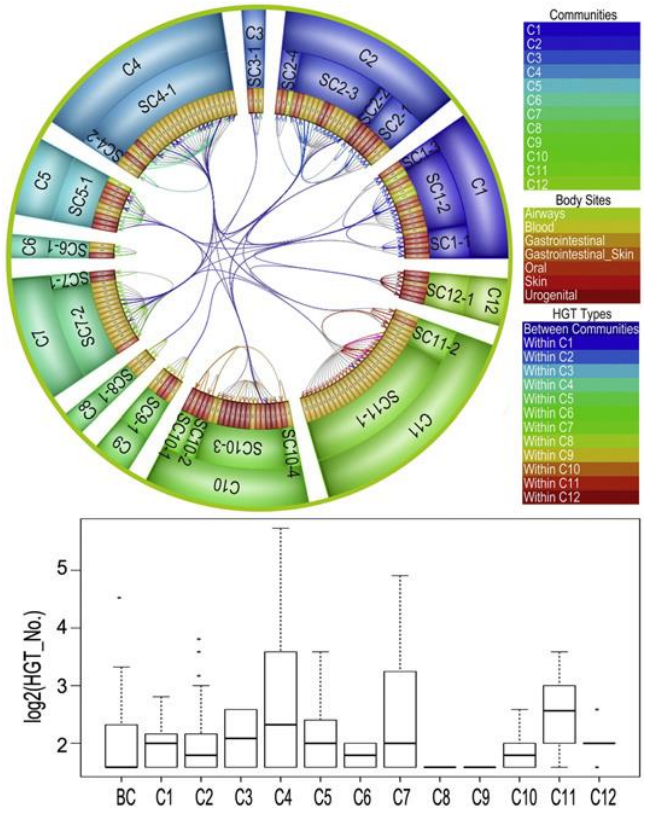
2. PERSONALIZED DIETS CREATED IN 100 PEOPLE USING A COMPUTER PREDICTED BLOOD GLUCOSE RESPONSE THAT INTEGRATED DIETARY HABITS, PHYSICAL ACTIVITY, AND GUT MICROBIOTA WERE ABLE TO REDUCE POSTMEAL BLOOD GLUCOSE RESPONSES AS WELL AS A PROFESSIONAL RESEARCH DIETITIAN-DESIGNED DIET.

3. SOME DAY, THESE COMPUTERIZED SYSTEMS WILL BE ABLE TO DESIGN DIETS THAT LOWER BLOOD SUGAR AND PREVENT SOME OF THE LONG-TERM CONSEQUENCES OF HIGH BLOOD SUGAR WHICH ARE SO COMMON.



From: David Zeevi, Tal Korem, Niv Zmora,Zamir Halpern, Eran Elinav, Eran Segal Personalized Nutrition by Prediction of Glycemic Response. 2015, Cell 163, 1079–1094

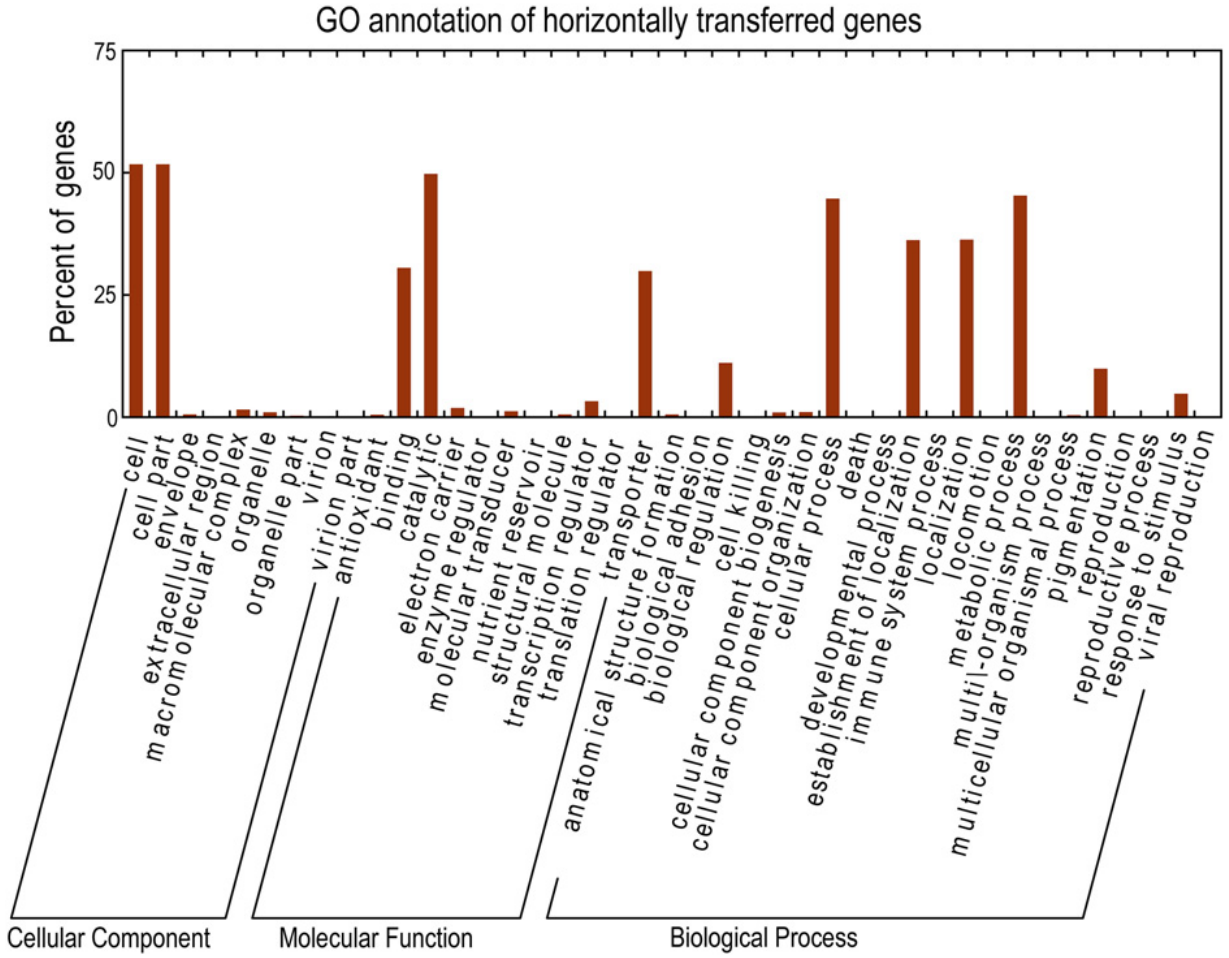
The microbiome



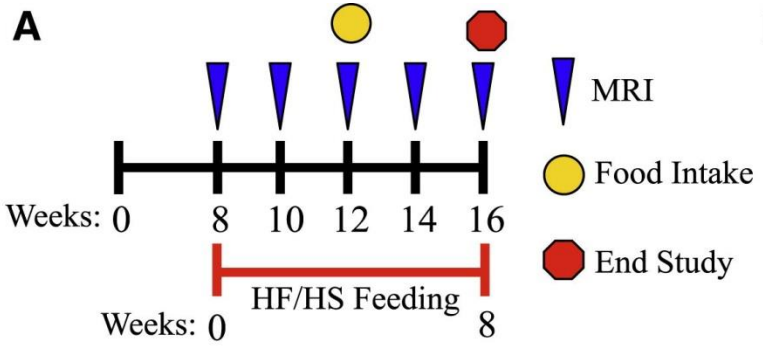
The body houses a large number of different microorganisms, including bacteria, archaea and fungi. These micro-organisms inhabit different parts of the body, including the skin, mouth, and intestinal tract.The total number of microbial cells hosted by the human body is huge, about 10 times the number of human cells in the body. The gut harbors the majority of these microbes, comprising more than 1000 species and more than 100 billion microbes. The number of genes in the human microbiome is more than 100 times the number of genes in the human genome.

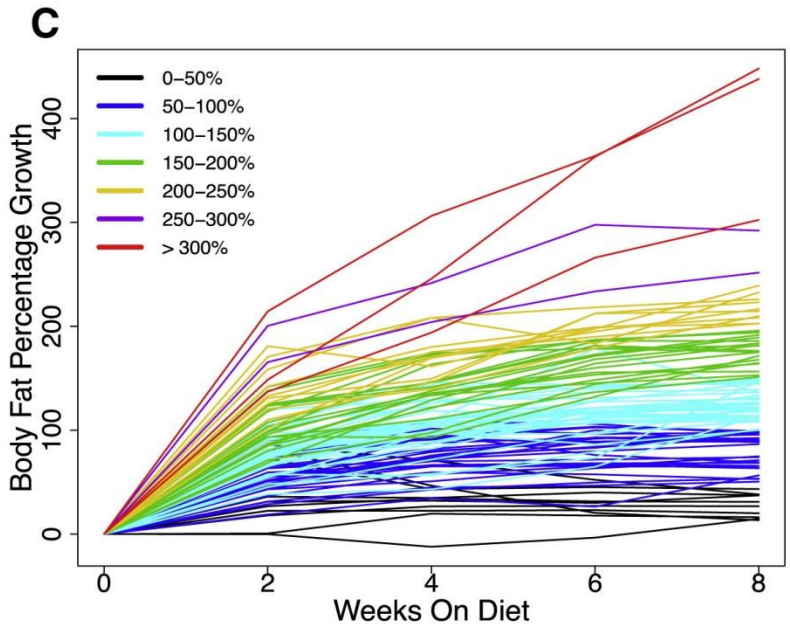
The panel shows the hierarchical structure of the HGT network composed of 165 reference genomes. The 12 parts represent microbial communities with their respective sub-communities. The 165 reference microbes are indicated on the inner ring with a color representing their location in or on the human body. The edges are bundled to reduce visual clutter in the center of the ring [50]. Edges between different communities are indicated in blue color, while intra-community edges follow the color representing each respective community. B. The panel shows the weight distribution of the edges. BC denotes “between communities” edges, C1–12 denotes community 1 to 12.

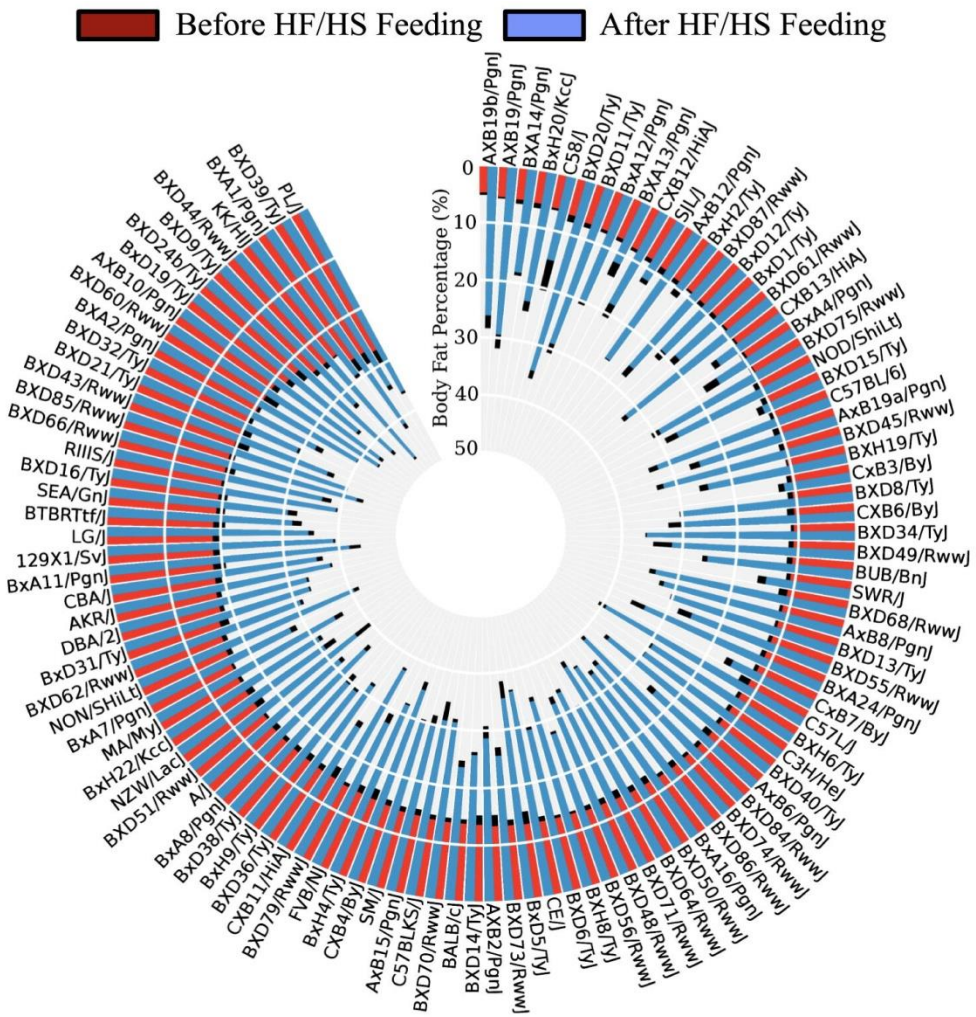
Gene Ontology Analysis Of Horizontally Transferred Genes



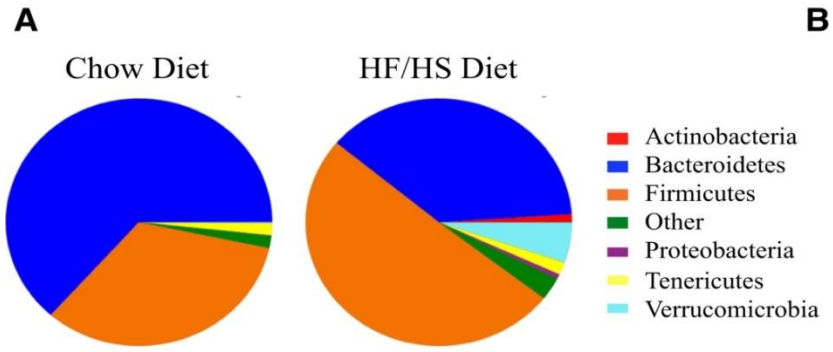
Genetics of Dietary Responsiveness in Mice

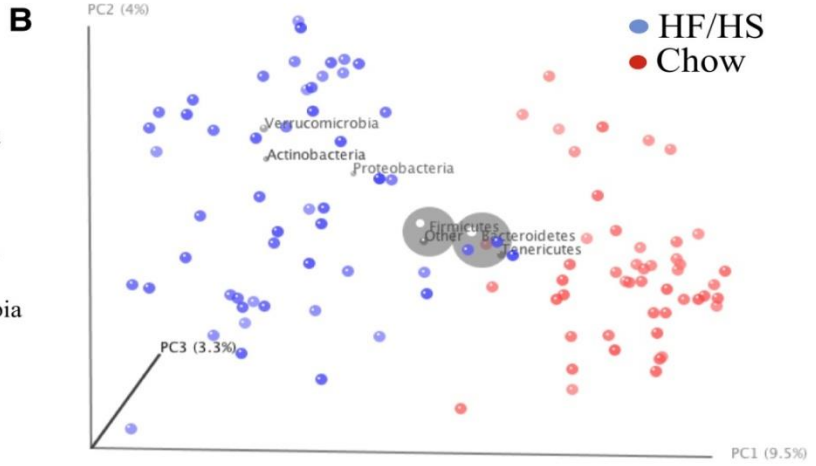


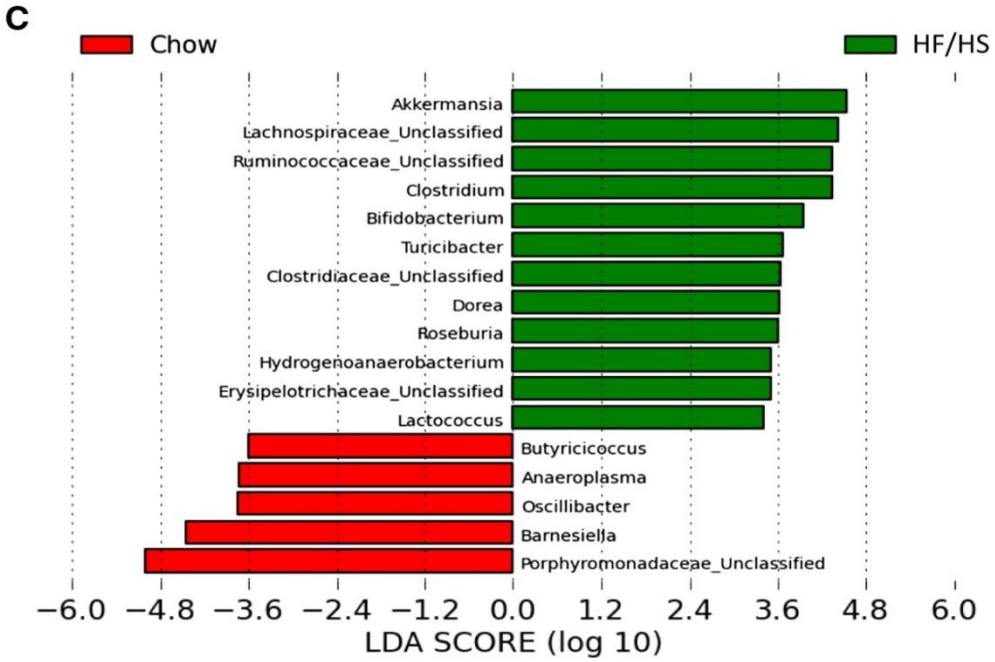




Gut Microbiome Changes Following High Fat/High Sugar Feeding in Mice





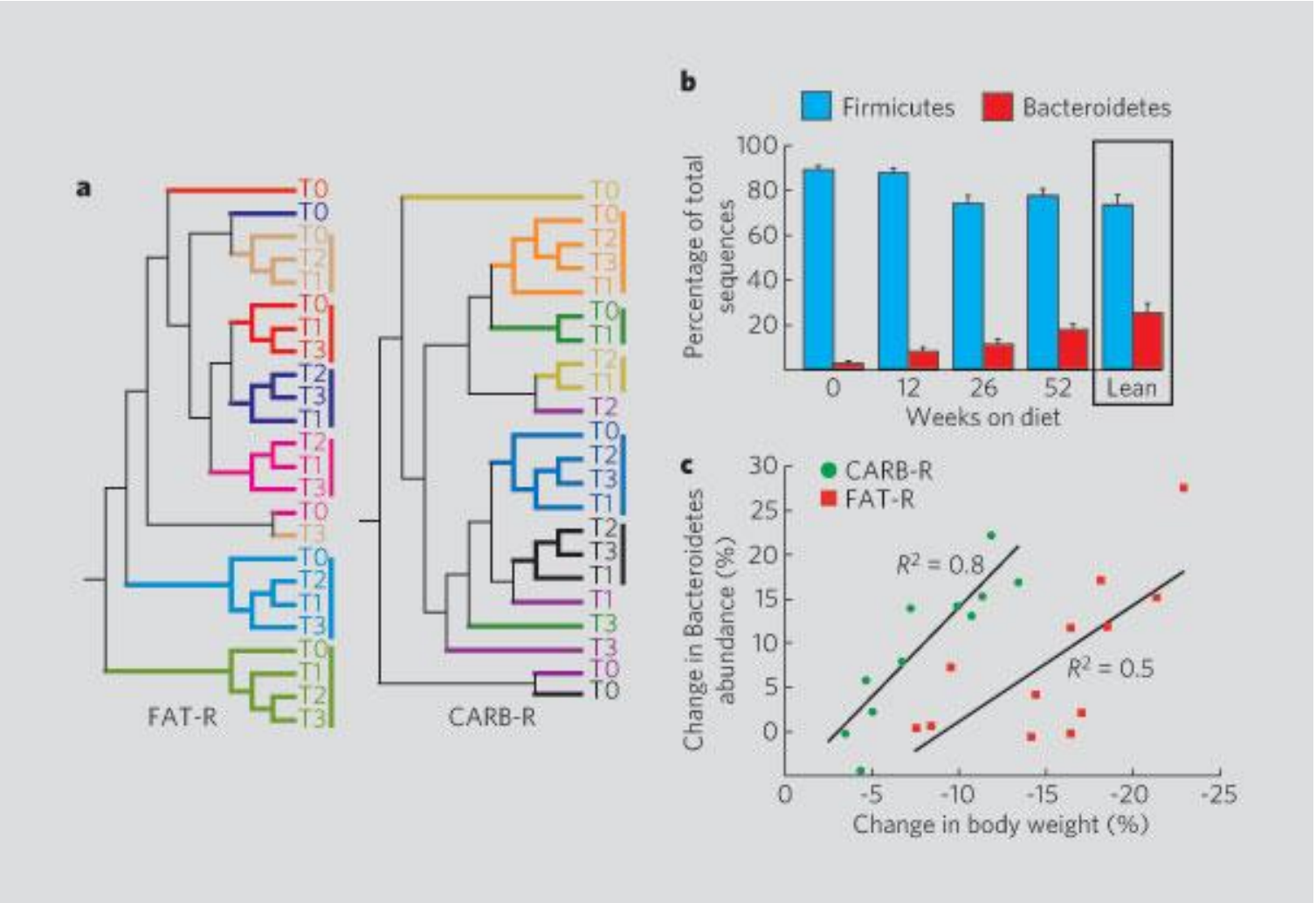


The shifts between the two dominant phyla Bacteroidetes and Firmicutes after HF/HS feeding are consistent with previous reports

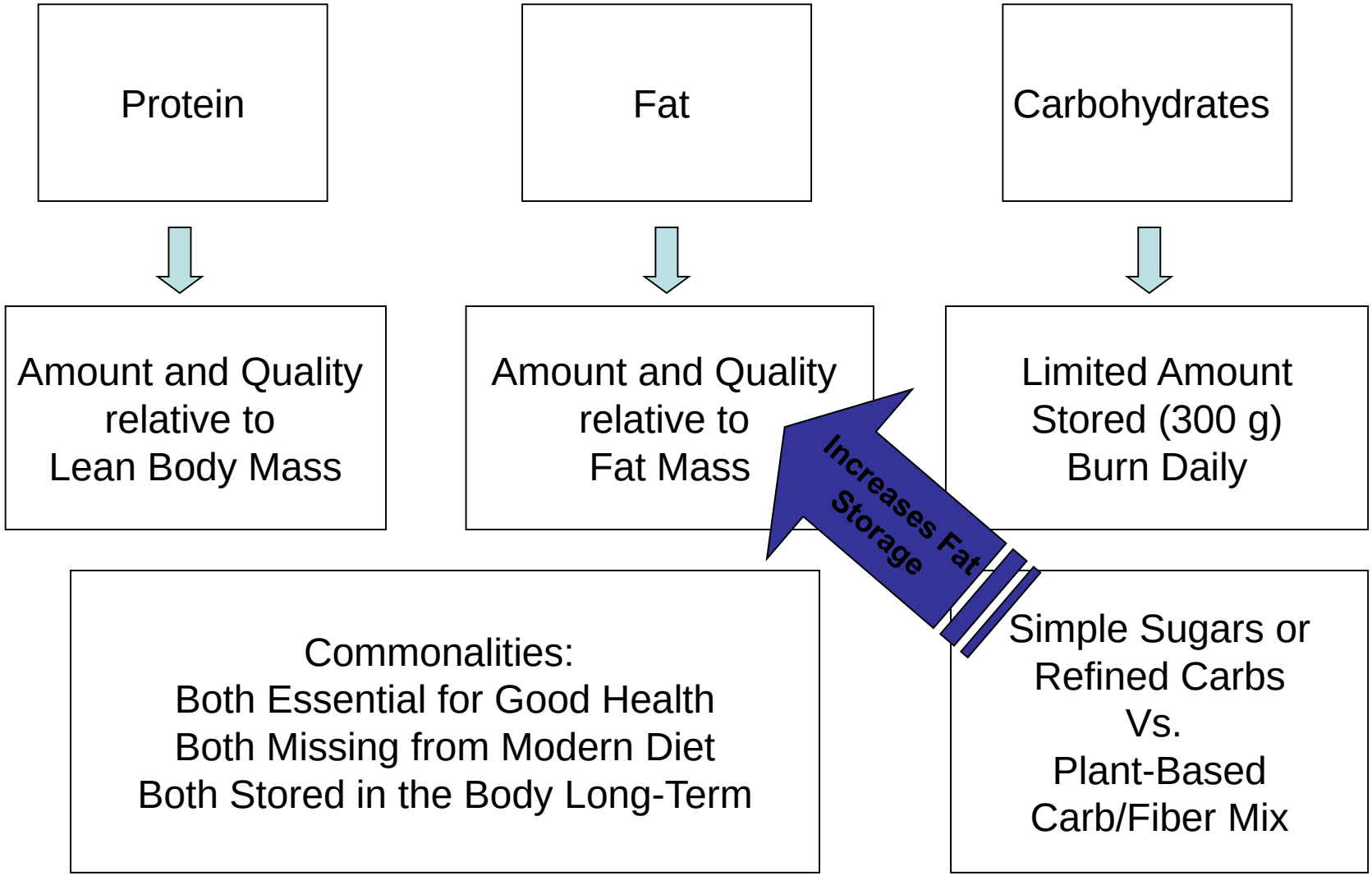
Cell Metabolism Volume 17, Issue 1 2013 141 - 152

The bacteria that make you fat

Human gut microbes associated with obesity



Nature **444**, 1022-1023, 2006


Protein
Fat
Carbohydrates
Amount and Quality relative to Lean Body Mass
Amount and Quality relative to Fat Mass
Limited Amount Stored (300 g) Burn Daily
Increases Fat Storage
Commonalities:
Both Essential for Good Health
Both Missing from Modern Diet
Both Stored in the Body Long-Term
Simple Sugars or Refined Carbs
Vs.
Plant-Based Carb/Fiber Mix

Only in Los Angeles, CA

It Takes A Lot of Exercise to Make Up for a Little Dietary Indiscretion

If you eat or drink:

You have to increase activity to burn these calories by :

2 oz potato chips

Running 3 miles in 30 min

or

or

2 regular sodas

Bicycling 8 miles in 30 min

Eating at night?

- Recent studies in animals linking energy regulation and the circadian clock at the molecular, physiological, and behavioral levels raise the possibility that the timing of food intake itself may play a significant role in weight gain.
- About 25% of the obese population admits to night snacking. (Arble, et al. Circadian Timing of Food Intake Contributes to Weight Gain. *Obesity* 2009)

Best Medical Center in the West

Best Weight Management Program.....Period