Metabolism: Static Versus Dynamic Energy Balance

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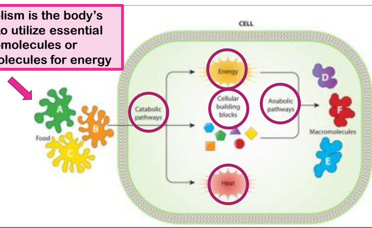
2021 IDEA FITNESS LEADER OF THE YEAR

Strategies?

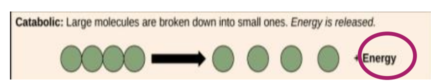
Eat Less
Move More
Weight Loss

What is Metabolism?

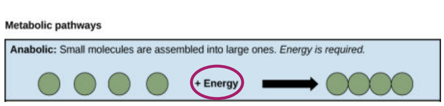
Metabolism is the body's ability to utilize essential biomolecules or macromolecules for energy



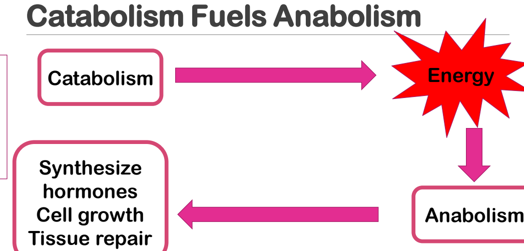
Catabolic Pathways



Anabolic Pathways



Catabolism Fuels Anabolism



Metabolic Rate

TDEE

NREE (30%)

+

REE (70%)

TEF (~10%)

NEAT (~15%)

TEA (~5%)

BMR/RMR (70%)

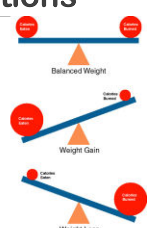
Energy In vs Energy Out

Energy Balance Equations

Weight Maintenance = Energy Balance
- Energy IN = Energy OUT

Weight Gain = Positive Energy Balance
- Energy IN > Energy OUT

Weight Loss = Negative Energy Balance
- Energy IN < Energy OUT



Static vs Dynamic Energy Balance

Static

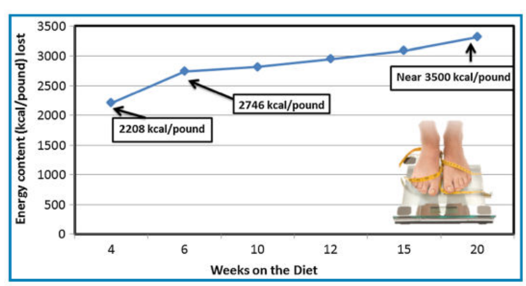
Energy intake does not change energy expenditure.

Kcal for Weight Loss

Length of dieting period

Composition of diet

Involvement in physical activity



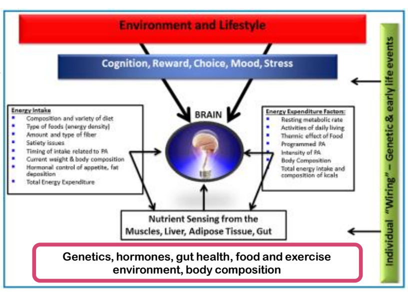
Static vs Dynamic Energy Balance

Dynamic

Energy intake does change energy expenditure.

Age
Sex
Baseline wt
Caloric restriction
Hormonal influences

Dynamic Energy Balance



Dynamic Energy Balance: Weight Loss

Weight Loss = (-) Energy Balance + Body Composition Changes

Phase I = Rapid Weight Loss

Phase 2 = Slower Weight Loss

Dynamic Energy Balance: Weight Loss

Caloric Restriction = Weight Loss

Weight Loss = EE Reductions

Intake Influences Expenditure

Adaptive Thermogenesis

Decrease in RMR > The loss of body weight and the corresponding changes in fat and lean tissues

Phase I
Water
Glycogen
Protein

Hormones
Neural
Changes

Phase II
Adipose
Tissue

Adaptive Thermogenesis

↓ TDEE

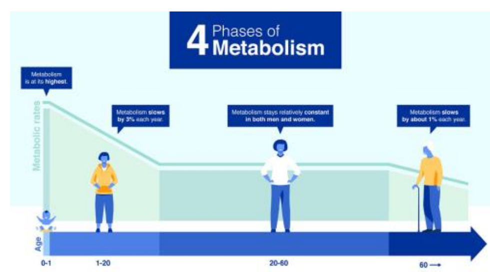
- Decrease FFM RMR
- Decrease TEF
- Decrease Intake… again
- Decrease BW NEAT TEA

- # Metabolic Rate

RMR Differences

♀ vs ♂

- 0.892 kcal·kg−1·h−1
- 0.839 kcal·kg−1·h−1



RMR and Changes in Weight

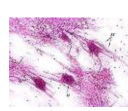
↓ Weight = ↓ RMR

< 10% of TDEE

RMR and Changes in Weight

FFM → RMR

50%



RMR and Changes in Weight

Brain Organs > Resting Skeletal Muscle Bone

RMR and Changes in Weight

RMR

65% Brain, Heart, Kidneys, Liver

35% Skeletal Muscle

RMR and Changes in Weight

↓ Skeletal Muscle and Fat Mass

↔ Organs and Tissues

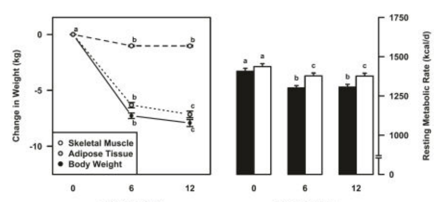


Fig. 1 Changes in body weight, skeletal muscle, adipose tissue, and resting metabolic rate over the course of 12 months of calorie-restricted weight loss. Left: Changes in body weight (closed symbols), skeletal muscle (open symbols), and adipose tissue (gray symbols) over the course of the first 12 months of calorie-restricted weight loss. Right: Changes in measured (black bars) and predicted (white bars) resting metabolic rate over the course of the first 12 months of calorie-restricted weight loss.) Data points with different letters are significantly different from one another ($p < 0.001$).

RMR: Muscle vs Fat Loss

↓ Skeletal Muscle

↓ RMR

25%

Fat Mass

RMR and Fat Loss

Highly Metabolic

Storage Site

Endocrine Functions

Why the Difference?

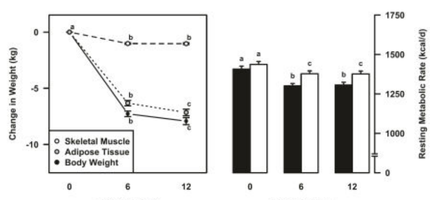
Overall FFM vs Specific Components

Skeletal muscle = ~13 kcal/kg/d
Organs = ~200–450 kcal/kg/d

Bottom Line

Skeletal Muscle Decline
≠
RMR Decline

Fat Loss
=
RMR Decline



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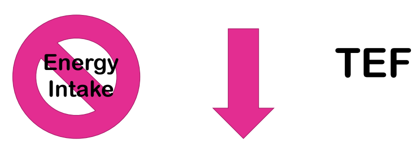
Thermic Effects of Feeding



Spontaneous Activity: NEAT

NEAT

Highly variable
Strong positive predictor TDEE
Influenced by environmental and biological factors

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NEAT

↓ Energy Intake = ↓ NEAT

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NEAT

↑ NEAT = ↓ Weight Gain

↑ Volume of exercise = ↓ NEAT

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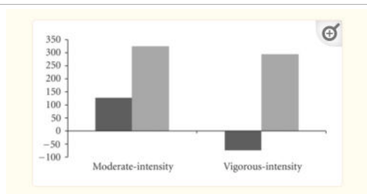
NEAT vs TEA



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Action Steps

- Establish Baseline
- Educate
- Encourage Movement

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Thermal Effects of Activity

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Energy Intake Effects on Exercise

↓ Energy Intake

↓ Body Mass

↓ Exercise Energy Expenditure

Exercise Effects on Energy Intake

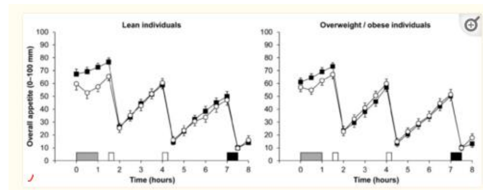
Acute Exercise

Exercise-Induced Anorexia

Returns 30-60 min

No change in intake

Appetite: Lean vs Overweight/Obese



Appetite: Active vs Non-Active

Inactive
Impaired EI Regulation
+ Energy Balance
Weight Gain

Resistance Training
No EI compensatory changes

Chronic Exercise and Energy Intake

Resistance Training = No Change

Chronic Exercise and Energy Intake

Alters Sensitivity of Appetite Control

Drive to Eat

Satiety Response

Chronic Exercise: Overweight/Obese

Increased fasting hunger & postprandial satiety
May improve EI – EE connection

Improved sensitivity to high energy preloads

Chronic Exercise: Active vs Non-Active

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Active

↓ Satiety
↑ Hunger
↑ EI

↓ EI
After High Preload

Acute Exercise & Appetite Hormones

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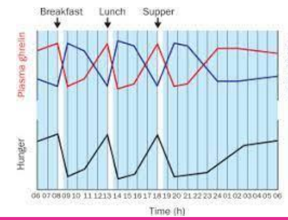
Ghrelin
Lean: ↓
Obese: ↓
Active: ↓
Non-Active: ↓



Acute Exercise & Appetite Hormones

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PYY, GLP-1, PP
Lean: ↑
Overweight/Obese: ↑
Active/Non-Active: ↔

Acute Exercise & Appetite Hormones

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Resistance Training Session
=
No Changes

Chronic Exercise & Appetite Hormones

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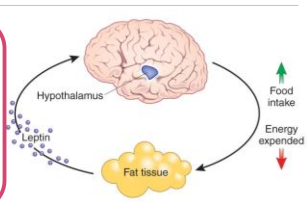
↓ Leptin Following Aerobic and Resistance Training



Exercise and Energy Balance

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Body fat mass does not control:
Appetite: Exercise-induced Anorexia
Appetite-related Hormones
Energy Intake Response

Physically Active:
Improved Appetite Sensitivity

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Dynamic Prediction Equations

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Dynamic Prediction Equations

- RMR
- Body size
- Fat & lean tissue mass
- Thermic effects of food
- Voluntary physical activity
- Energy costs of fat & protein synthesis

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NIH Prediction Equation

https://www.niddk.nih.gov/health-information/weight-management/body-weight-planner?dkrd=lgdmn0001

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