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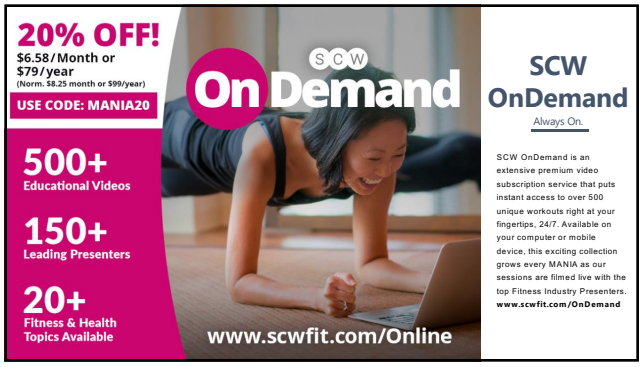
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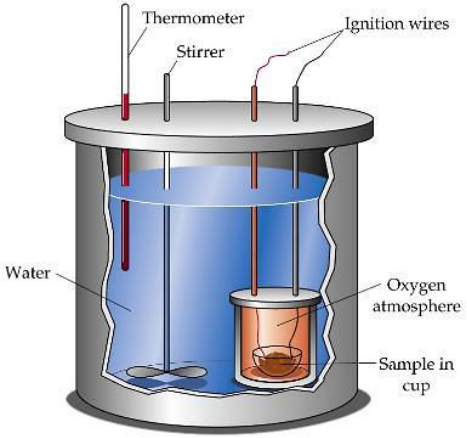
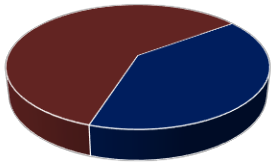
Are All Calories Equal?



Fuel Utilization



■ Fats ■ Carbohydrates

Developed by:

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NASM CPT, CES & PES; ACE CPT & HC; ACSM HFS; CSCS; CISSN

Introduction …

Genesis Wellness Group

Nutritional Science Essentials

What do we know and use?

Carbohydrates	Proteins	Fats	Alcohol	Non-caloric Sweeteners
4 kcal / gram	4 kcal / gram	9 kcal / gram	7 kcal / gram	0.2 - 4.3 kcal / gram
10g = 40 kcal	5g = 20 kcal	3g = 27 kcal	5g = 35 kcal	Why 0 kcal?

3,500 kcal = 1 lb.

- Prudent weight loss = 1- 2 lbs. per week
- Equivalent to 500 – 1,000 kcal daily deficits.

Factoid: Non-caloric sweeteners (e.g., Spenda®, Truvia®) all contain kcal ranging between 0.2 - 4.3 kcal/g, but because their sweetening power is > 100+ times sweeter than sugar, we only use a small amount with less than 1 kcal – therefore classified as 0 kcal.

Introduction …

Scenario #1 – how do you tackle this?

- Sample dietary intake:

Carbohydrates (g)	Protein (g)	Fats (g)	Alcohol (g)
205g	95g	85g	12g
x4 kcal/g = 820 kcal	x4 kcal/g = 380 kcal	x9 kcal/g = 765 kcal	x7 kcal/g = 84 kcal
Total: 2,049 kcal			
Macronutrient Distribution: What Would you Propose? – Scope of Practice			
40.0%	18.5%	37.3%	4.1%
2016 USDA Guidelines:			
45-65% of total kcal	10-35% of total kcal	20-35% of total kcal	NA

Is this even accurate?

- Comparison of food energy v. available energy?
  - Fiber?
  - Co-efficient of digestibility?
  - Intra- and inter-person differences?

Introduction …

Scenario #2 – Look at one meal

- How do you tackle this?

Analysis	Carbohydrates (g)	Fats (g)	Proteins (g)
Bread (2)	15g + 15g	0g	3g + 3g
Turkey	0g	3g	7g
Cheese	0g	8g	7g
Mayonnaise	0g	5g	0g
Food Totals:	30g	16g	20g
Calorie Sub-totals	30 x 4 = 120 kcal	16 x 9 = 144 kcal	20 x 4 = 80 kcal
Meal Total	344 kcal (120 + 144 + 80)		
% Contribution	120 ÷ 344 = 35%	144 ÷ 344 = 42%	80 ÷ 344 = 23%

Coaching or Prescriptive?

- Quantitative or qualitative?

Should we really obsess over calories?

Calories …

Calories

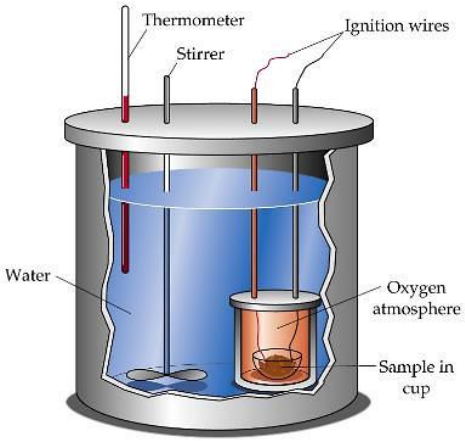
By definition, energy = the capacity to do work.

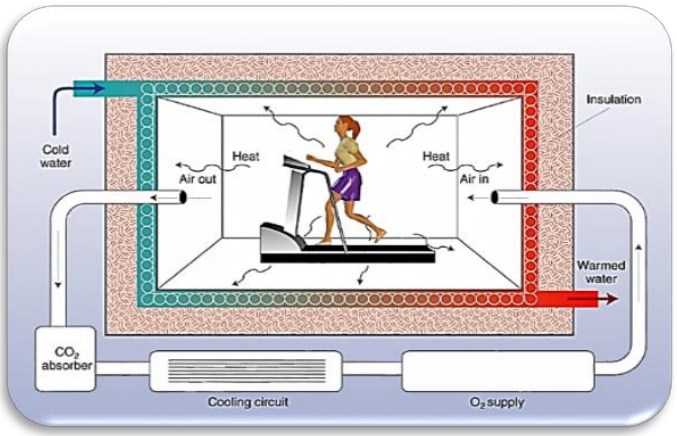
- Measured in calories (kcal or food calories) – kilojoules in Europe.
  - 1 kcal = 4.184 kj.
- One kcal = quantity of heat required to raise temperature of 1 Kg of water by 1° C from 14.5° C (58° F) to 15.5° C (60° F).
  - What does this mean and how are calories and heat related?

Primary method to determine energy value of food:

- Direct Calorimetry: Heat production generated from combusting food in a closed chamber.

1st Law of Thermodynamics
Energy is never created and never destroyed, but passes through many forms, but ultimately degrades to heat.





Calories …

Energy Yield – Direct Calorimetry (Atwater Factors)

- Heat or kcal energy released from burning 1.0g (~ 4g = 1 tsp.) of a food varies by food source.

Food Source	Direct Yield	Considerations	Net Yield *
Carbohydrates	Average = 4.2 kcal/g • 1g glucose = 3.75 kcal/g • 1g glycogen/starch = 4.25 kcal/g	Absorbed at ~ 97% efficiency	4.0 kcal / gram
Fats	Average = 9.4 kcal/g • 1g meat, eggs, fish = 9.5 kcal/g • 1g dairy products = 9.25 kcal/g • 1g vegetable oils = 9.3 kcal/g	Absorbed at ~ 95% efficiency	9.0 kcal / gram
Proteins	Average = 5.65 kcal/g	Absorbed at ~ 92% efficiency	4.0 kcal / gram
Alcohol	Average = 7.1 kcal/g	Absorbed at ~ 99% efficiency	7.0 kcal / gram

* Known as Ingested Energy (IE) or Gross Energy from Food – reflects food energy available from direct calorimetry (heat production).

Calories …

Direct Calorimetry – Atwater Factors

- Why does protein demonstrate such a large drop?

Food Source	Direct Yield	Considerations	Net Yield
Proteins	Average = 5.65 kcal/g*	Absorbed at ~ 92% efficiency	4.0 kcal / gram

- Elements into energy pathways:
  - C, H, O – energy held in H-ions
  - No need for N – removed as NH_2= 19% loss in gross energy value.

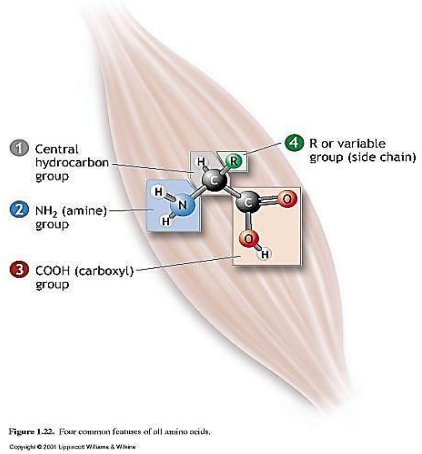
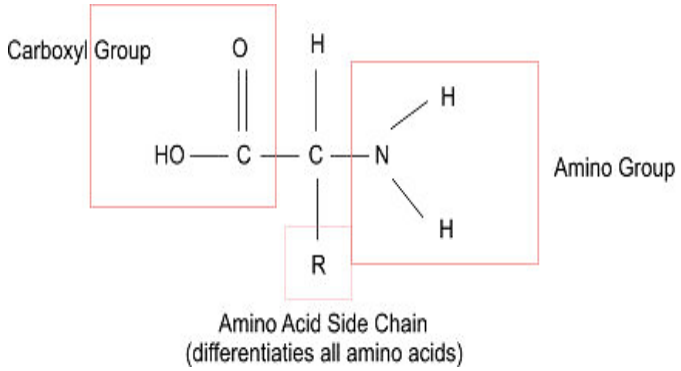


Figure 1.22. Four common features of all amino acids.

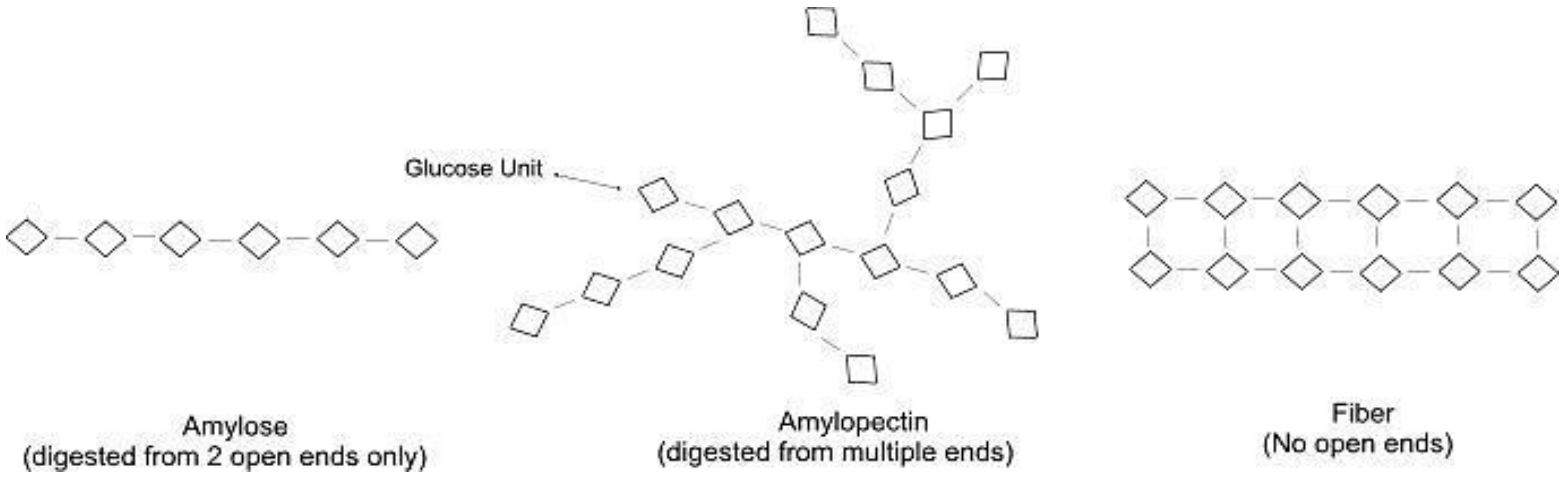


Calories …

Direct Calorimetry – Atwater Factors

- What about carbohydrates?
  - For example: A food label indicates 25g of carbohydrates, but 5g of fiber.

Food Source	Direct Yield	Considerations	Net Yield
Carbohydrates	Average = 4.2 kcal/g	Absorbed at ~ 97% efficiency	4.0 kcal / gram



Calories …

Accuracy of Numbers?

Ingested Energy (IE) = Gross Energy in Food ---------- Atwater Factors

- Minus undigested energy
- Minus bacterial fermentation (to combustible gas)
- Plus formed short-chain fatty acids (from bacteria) – being absorbed.

Digestible Energy (DE)

- Minus urinary energy – energy lost from protein breakdown (urea)

Metabolizable Energy (ME)

- Minus digestive cost – cost of moving nutrients across membranes and into storage.
- Minus thermogenesis cost – energy from converting food to energy (ATP)

Net Metabolizable Energy (NME) ---------- This is more accurate

Calories …

Accuracy of Numbers?

- Appreciate the fact that the caloric value of food is decreased through digestion and absorption.

Carbohydrates	Proteins	Fats
NME is impacted by elevation in metabolism for 40-60 min post-prandial – called Thermic Effect of Food (TEF).		
TEF = ~ 7%. • Fibrous vegetables up to 20%.	TEF = ~ 30%.	TEF = ~ 3%.

- Animal- v. vegetable-based proteins: Animal-based can be absorbed with 40-50% more efficiency.
- Nuts and seeds: Only 68-95% of kcal absorbed v. some fiber-rich foods which increase available kcals.
- Intestinal bacteria: Can enhance food absorption by up to 150 kcal/day.

Calories …

Accuracy of Numbers?

Net Metabolizable Energy (NME) reflects food energy available for bodily functions requiring energy.

- IE and NME differences for a particular food can be as large as 22%
- Mixed diets of humans – overall error estimated to be ≤ 2.5% for most.

Livesey's Net Metabolizable Kcal		
Carbohydrates	Proteins	Fats
3.8 kcal / gram	3.2 kcal / gram (mixed diet)	8.9 kcal / gram
Fermentable carbohydrates = 1.9 kcal / gram (usually unavailable, but bacterial action)		

Calories …

Genesis Wellness Group

Accuracy of Numbers?

Carbohydrates (g)	Protein (g)	Fats (g)	Alcohol (g)
205g	95g	85g	12g
x4 kcal/g = 820 kcal	x4 kcal/g = 380 kcal	x9 kcal/g = 765 kcal	x7 kcal/g = 84 kcal
Total: 2,049 kcal			

Carbohydrates (g)	Protein (g)	Fats (g)	Alcohol (g)
205g	95g	85g	12g
x3.8 kcal/g = 779 kcal	x3.2 kcal/g = 304 kcal	x8.9 kcal/g = 757 kcal	x7 kcal/g = 84 kcal
Total: 1,924 kcal			

125 kcal daily difference = ~13 lbs. per year

Calories …

Accuracy of Numbers?

Kcal listed form foods are estimates, but can actually vary significantly – examples:

Food	Medium Apple	1 cup Carrot Sticks	6-oz. Filet Mignon	⅓ cup Chopped Nuts
Kcal	83-116 kcal	37-61 kcal	323-506 kcal	213-276 kcal

- Once a food is cooked, or chopped, or blended, the amount of energy available for digestion and absorption changes (can increase or decrease).

Food	Egg – Raw to Cooked	Steak – Raw to Grilled	Potato – Raw to Baked
Kcal	50 to 75 kcal	190 to 260 kcal	101 to 193 kcal

Calories …

Accuracy v. Awareness?

24-hour Diet Recalls	Food Logs or Journals (3-day and 7-day)	Food Frequency Questionnaire
Rough quantitative estimate (24-hour) – not truly reflective. Insight into eating behaviors. **70-75% of food choices established as adults (defined by ~ 100 foods).** Provides valuable insight into general food choices.	Better representation of consistent eating behaviors, but relies heavily upon accuracy. Less enthusiasm/compliance unless simplified (e.g., self-sensing, push sensors). Time – labor-intensive	Maps consistent food choices.

Self-reported data = subjective bias (Hawthorne Effect) – Moral Licensing?

Selective or forgetful memories?

- Study: 5-minutes after eating dinner, 31% of people could not remember how much bread they ate (Italian restaurant).
  - Underestimated amount by 28%; 12% denied eating any bread at all.

Heavier Individuals	Leaner Individuals
Underestimate portion sizes by ≥ 30%	Underestimate portion sizes by ~ 20%

Calories …

Estimating Energy Expenditure

O_2 Kinetics	Heart Rate (HR)	Movement / Formulas
• Measurement of O_2 utilized (VO_2) and CO_2 produced. • Measures RMR, TEF & TEPA.	• HR correlates with VO_2 (sub-maximal exercise). • Chest strap (electrical – Polar) v. wrist (optical – Apple).*	• Single-plane and 3D accelerometers – track movement (and intensity). • Limited to limb location.
Most accurate method	Fairly accurate	General estimate.

- GPS.
- Combinations.

Wearable Technology – Do they work?

- HR variance: 1-2% up to 75% error.
  - Chest strap / eTextiles (garments) = most accurate.
  - Soft tissue sensing (e.g., forearm) = good accuracy.
  - Wrist-sensing = lower accuracy (e.g., Fitbit, Apple).
- Large errors in VO_2 / kcal estimates (~25% errors).

Exercise calories error by 25% = 100-200 kcal / day = 10½-21 lbs. per year.

Calories …

Metabolic Profiling – Qualitative (Awareness!!)

General Activity…. Not an Activity Log…

Goal is shift from a focus upon Outcomes (less control) to Behavioral Processes (more control)

Time of Day	Activity	Suggested Activities
00:00 – 06:30 am	Sleep	
06:30 – 07:30 am	Prepare for Work	5-min walk while coffee brews
07:30 – 08:30 am	Commute (drive)	
08:30 – 12:00 pm	Seated – computer	Standing work station; use a different floor for bathroom breaks
12:00 – 01:00 pm	Lunch - seated	Walk to a location to eat lunch with co-worker
01:00 – 05:00 pm	Seated – computer	Walking /standing work meetings; walk to co-worker office to deliver memos
05:00 – 06:00 pm	Commute (drive)	
06:00 – 07:00 pm	Gym	Shorter, intense bouts of exercise modalities (e.g., 8-min cardio, 8-min resistance, 8-min cardio)
07:00 – 07:30 pm	Commute (drive)	
07:30 – 08:30 pm	Bathing, cooking	
08:30 – 11:30 pm	Dinner, TV, reading	Stand during commercials
11:30 – 12:00 am	Prepare for bed	

‘Success may lie not in doing more, but in changing the way you do things’

Calories …

Metabolic Profiling – Quantitative

Develop points system using appropriate activities (highest = what they desire to accomplish).

- Goal: Move towards '+' points (e.g., 1-hr. standing v. 1-hr. sitting = 2-point change).
- Method allows calculation of quantitative values (e.g., calories and differences – one-hour sitting v. standing).
- Scoring matrix example provided below:

Activity and Intensity Equivalent	Points per Hour
Reclining / sitting activities	(-1) Exclude sleep
Standing – light activities	(+1)
Walking – 2.5 mph or equivalent	(+2)
Jogging – 5 mph / 8 km/h (12 minute mile pace) or equivalent	(+3)

Calories …

Genesis Wellness Group

Metabolic Profiling – Quantitative

Time of Day	Activity	Points
00:00 – 06:30 am	Sleep	0 points
06:30 – 07:30 am	Prepare for Work	+ 1.0 x 1 hour = + 1.0 point
07:30 – 08:30 am	Commute (drive)	- 1.0 x 1 hour = - 1.0 point
08:30 – 12:00 pm	Seated – computer	- 1.0 x 3½ hours = - 3.5 points
12:00 – 01:00 pm	Lunch - seated	- 1.0 x 1 hour = - 1.0 point
01:00 – 05:00 pm	Seated – computer	- 1.0 x 4 hours = - 4.0 point
05:00 – 06:00 pm	Commute (drive)	- 1.0 x 1 hour = - 1.0 point
06:00 – 07:00 pm	Gym	+ 3.0 x 1 hour = + 3.0 points
07:00 – 07:30 pm	Commute (drive)	- 1.0 x 1 hour = - 1.0 point
07:30 – 08:30 pm	Bathing, cooking	+ 1.0 x 1 hour = + 1.0 point
08:30 – 11:30 pm	Dinner, TV, reading	- 1.0 x 2½ hours = - 2.5 points
11:30 – 12:00 am	Prepare for bed	+ 1.0 x ½ hour = + ½ point
		Total: - 8.5 points

Using the MP:

- Awareness / quantifying activity.
- Daily / weekly challenges – gameification.
- Interact with social support (sharing aggregated data – ecosystems).

Calories …

Fitness Apps – telling us calories of activity – accurate?

- Most based of Compendium of Physical Activity Tracking Guide.

Reference: Ainsworth, Barbara, et al., (2011) Prevention Research Center, University of Southern Carolina.

Activity	Kcal	Activity	Kcal
Expressed as kcal / min / kg of body weight			
Racquetball – recreational	0.12	Cycling (light, <10mph)	0.07
Kayaking – leisure	0.04	Cycling (light-mod,10-12mph)	0.10
Dancing – general	0.08	Cycling (mod,12.1-14mph)	0.14
Golf (walking + bag)	0.09	Cycling (hard, 14.1-16mph)	0.18
Running - 5mph (12min/mile)	0.12	Cycling (v. hard, 16.1-19mph)	0.21
Running - 5.5mph (11min/mile)	0.14	Cycling (stationary, 50 Watts)	0.05
Running - 6mph (10min/mile)	0.16	Cycling (stationary, 100 Watts)	0.09
Running - 6.6mph (9min/mile)	0.19	Cycling (stationary, 150 Watts)	0.12
Running - 7.5mph (8min/mile)	0.22	Cycling (stationary, 200 Watts)	0.18
Running - 8.6mph (7min/mile)	0.24	Cycling (stationary, 250 Watts)	0.22
Running - 10mph (6min/mile)	0.28	Calisthenics (push-ups, etc.)	0.08
Chopping wood	0.09	Circuit Training	0.14
Mowing lawn (walking, power)	0.08	Weight Training – light	0.05

Example: a 165 lb. (75 kg) individual running at 6 mph for 20 min:

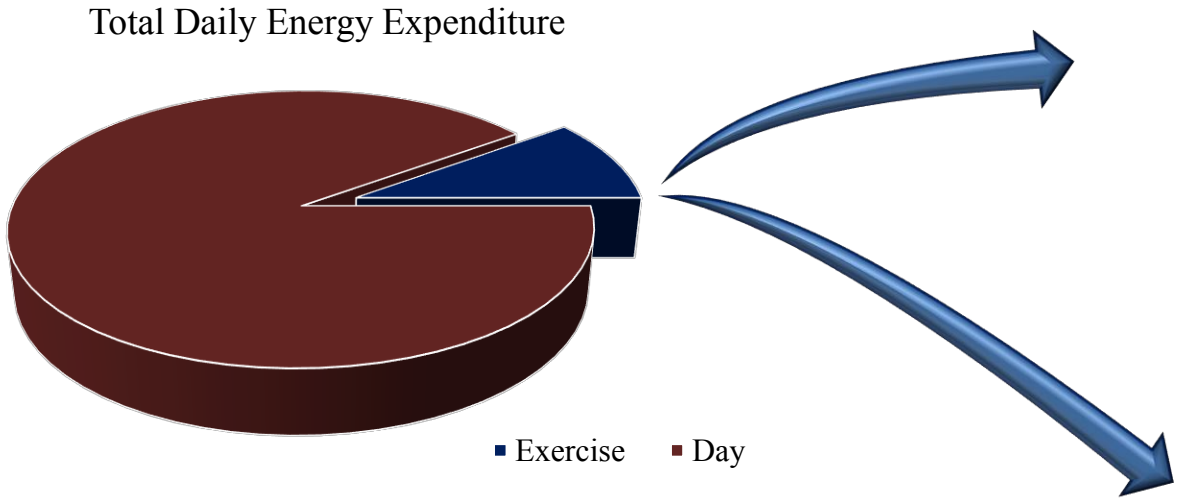
- 0.16 kcal / min / Kg x 75 Kg = 12 kcal / min x 20 min = **240 kcal**


Putting it all
Together -
Application

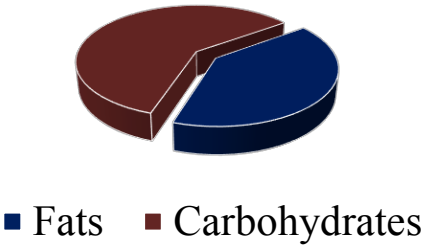
Calories …

Where is your Focus?

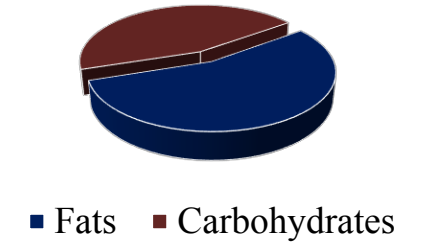
- Do exercise calories really make a difference – NEAT is your solution.



A: Fuel Utilization



B: Fuel Utilization



	Scenario A *	Scenario B *
2,200 kcal	45% Fat = 990 kcal	55% Fat = 1,210 kcal
	55% Carbs = 1,210 kcal	45% Carbs = 990 kcal
Calories may be calories …. but over 365 days = 22.9 lbs. of fat !		

* Assume negligible energy from protein

Calories …

What Matters

- Diet plays a significant role in what you burn as a fuel, both short-term and long-term.
- Gender (hormones) play a significant role in what you burn…

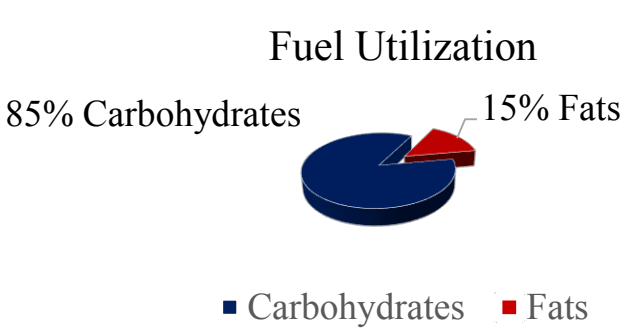
	Females	Males
Rested state	Greater fat utilization, but influenced by diet* and conditioning status.	Greater glucose utilization, but influenced by diet* and conditioning status.
Fasted state	No significant difference in fuel utilization.	
Post-prandial	Women take up and store fat faster than men, but oxidize more glucose immediately relative to men	Following high-carb diets (70%), men = increased glycogen, but not women (immediate glucose utilization v. stored).
During exercise	Higher proportion of fat burned at any given intensity – spares glycogen.	Higher glycolytic capacity for anaerobic work, greater lactate accumulation = longer recoveries.
Post-exercise	EPOC + recovery: Women utilize increased proportion of carbohydrates.	EPOC + recovery: Men utilize increased proportions of fat.

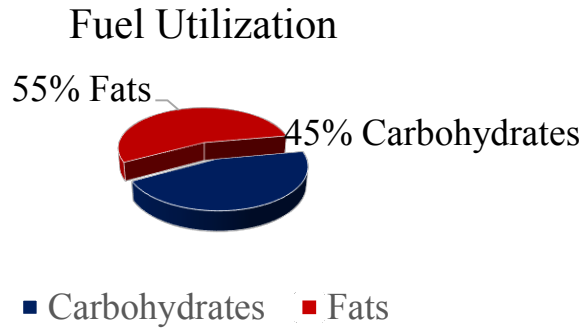
Calories …

What Matters

- Workout Intensity and Fuels:

	High-intensity	Lower-intensity
Workout	10 mph x 30-min (180 lbs.)	4.5 mph x 30-min (185 lbs.)
Kcal	701 kcal	339 kcal
Fuel Utilization	85-90% carbohydrates 10-15% fats	55-65% fats 35-45% carbohydrates
Fat calories	70-105 kcal	186-220 kcal
4x/week	2,800 kcal	1,356 kcal
52 weeks	41.6 lbs.	20.1 lbs.
Diet	Higher carbs (higher caloric intake?)	Lower carbs (lower caloric intake ?)





Closing Remarks ..

Thank You..!!

For Your Commitment to Excellence

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