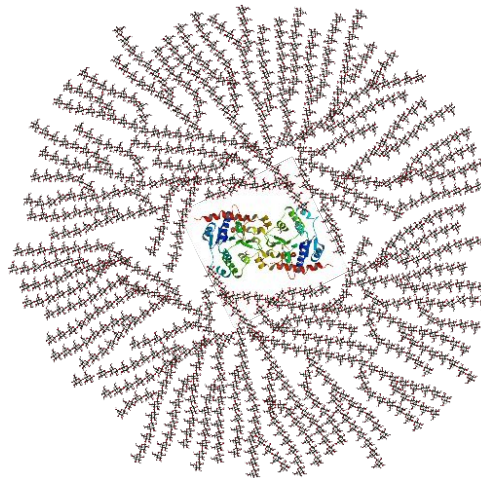


From Walking to Marathons: The Role of Nutrition in Exercise



Liz Lane and Adam Brown
DayCon 2016

Roadmap

Background:

- Metabolism and Exercise

Vignettes

- Endurance Athletes and Carb Loading
- Diabetes and Walking

Roadmap

Background:

- **Metabolism and Exercise**

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- Endurance Athletes and Carb Loading
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Why do we need to eat?



Food

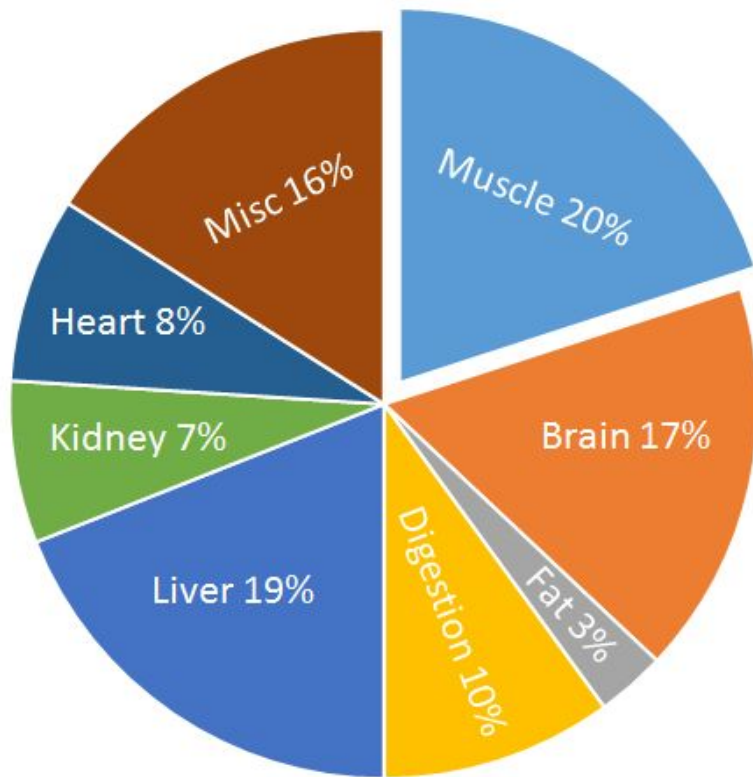


Uses for nutrients

1. Broken down for energy
2. Stored for later use
3. Used as building blocks for biomolecules (ex.building new muscle)

The body requires energy to function

Percent Basal Metabolic Rate



BMR is dependent on 3 variables

- Weight
- Height
- Age

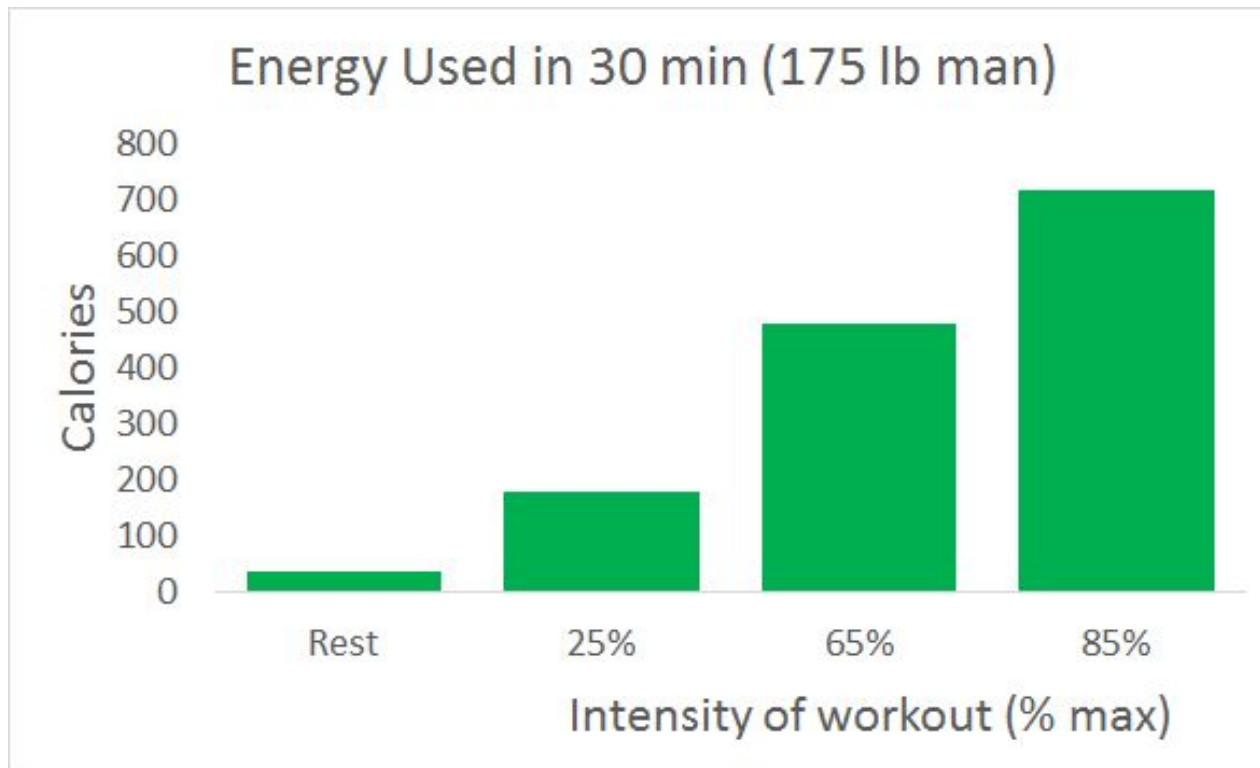
For a 25 year old man

6 feet 175 pounds

BMR=1,651 Calories

<http://www.calculator.net/bmr-calculator.html>

The energy requirement of the body increases with exercise



Romijin et al, 1993

Three types of nutrients in foods



High Protein Foods



Amino acids



High Carb Foods



Sugars



High Fat Foods



Fatty acids

Three types of nutrients in foods



High Protein Foods



Amino acids



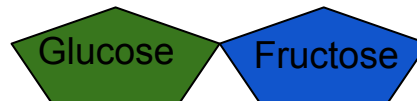
High Carb Foods



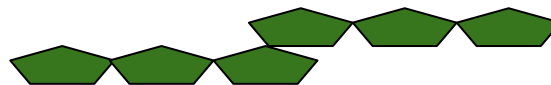
Sugars



Monosaccharides (one sugar)



Disaccharides (table sugar)



Complex carbs (starch)



High Fat Foods



Fatty acids

Three types of nutrients in foods



High Protein Foods



Amino acids



High Carb Foods



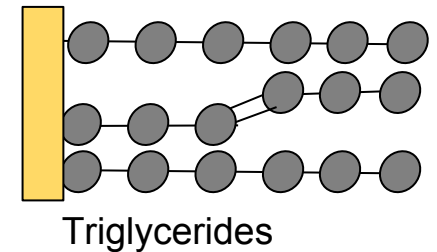
Sugars



High Fat Foods



Fatty acids



Three types of nutrients in foods



High Protein Foods



Amino acids



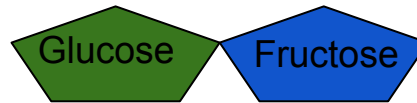
High Carb Foods



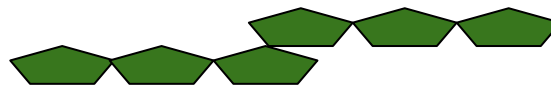
Sugars



Monosaccharides



Disaccharides (table sugar)



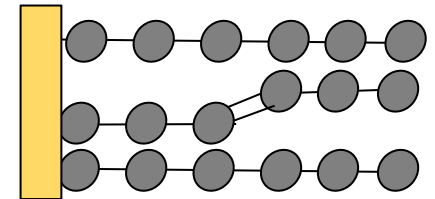
Complex carbs (starch)



High Fat Foods

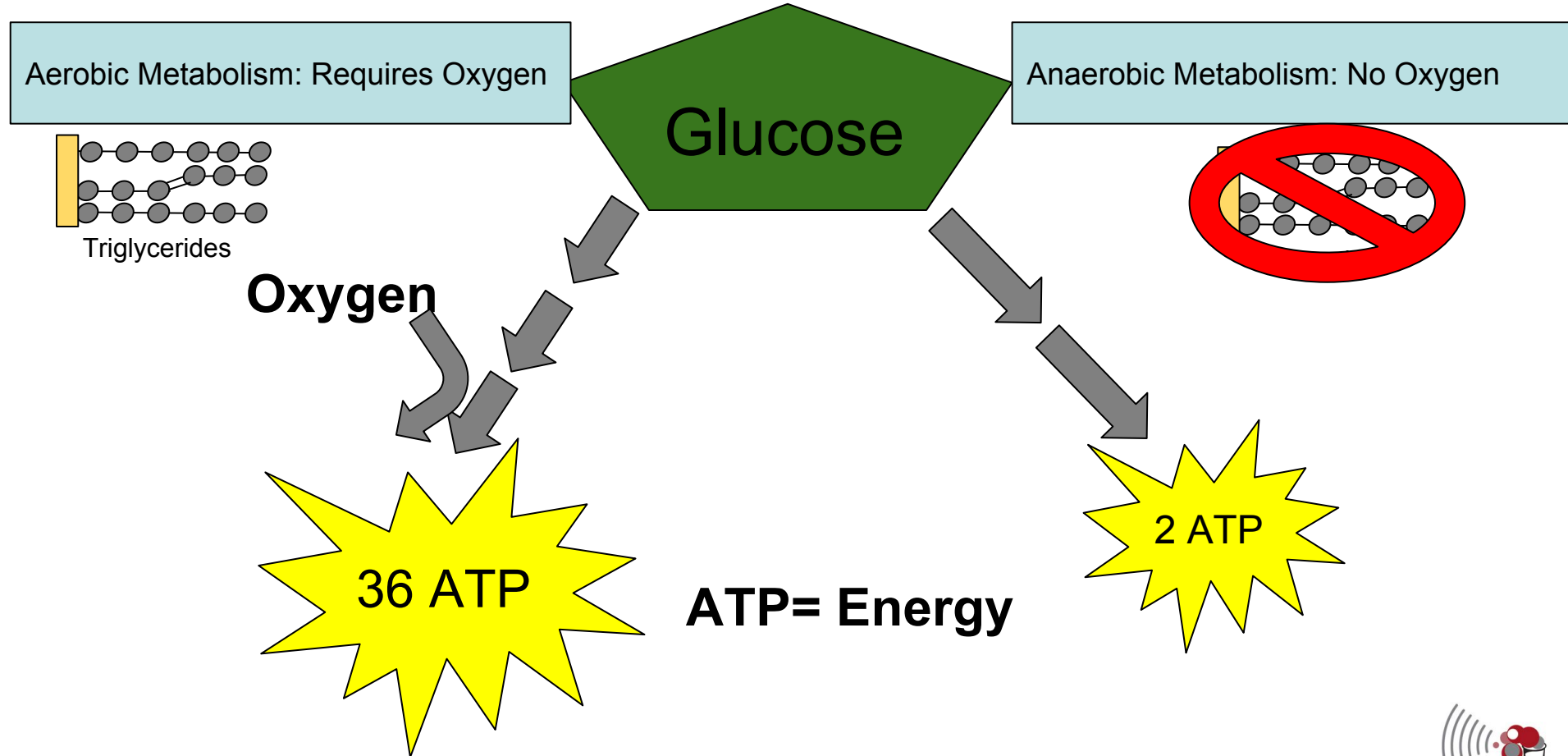


Fatty acids



Triglycerides

How do we get energy from nutrients (the importance of oxygen)?



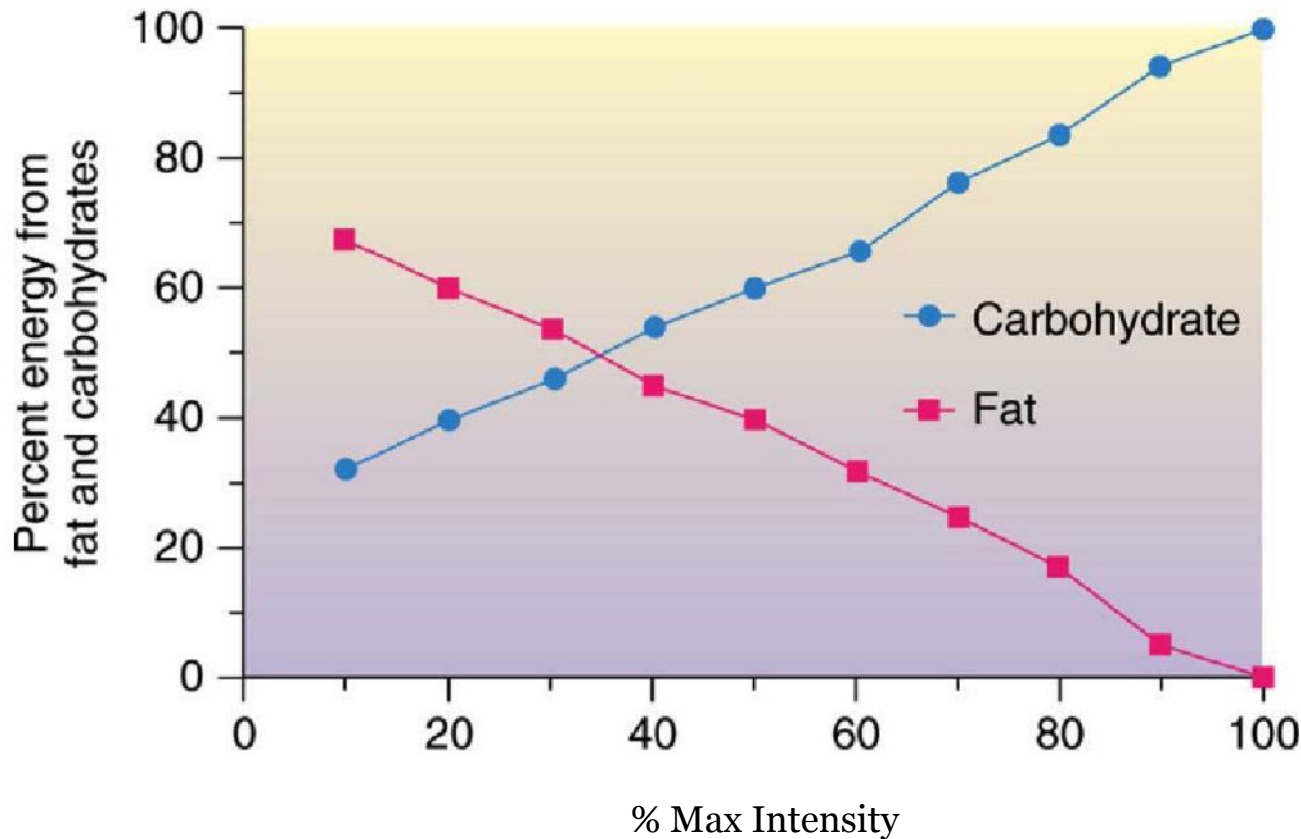
Carbohydrates vs. fats as an energy source



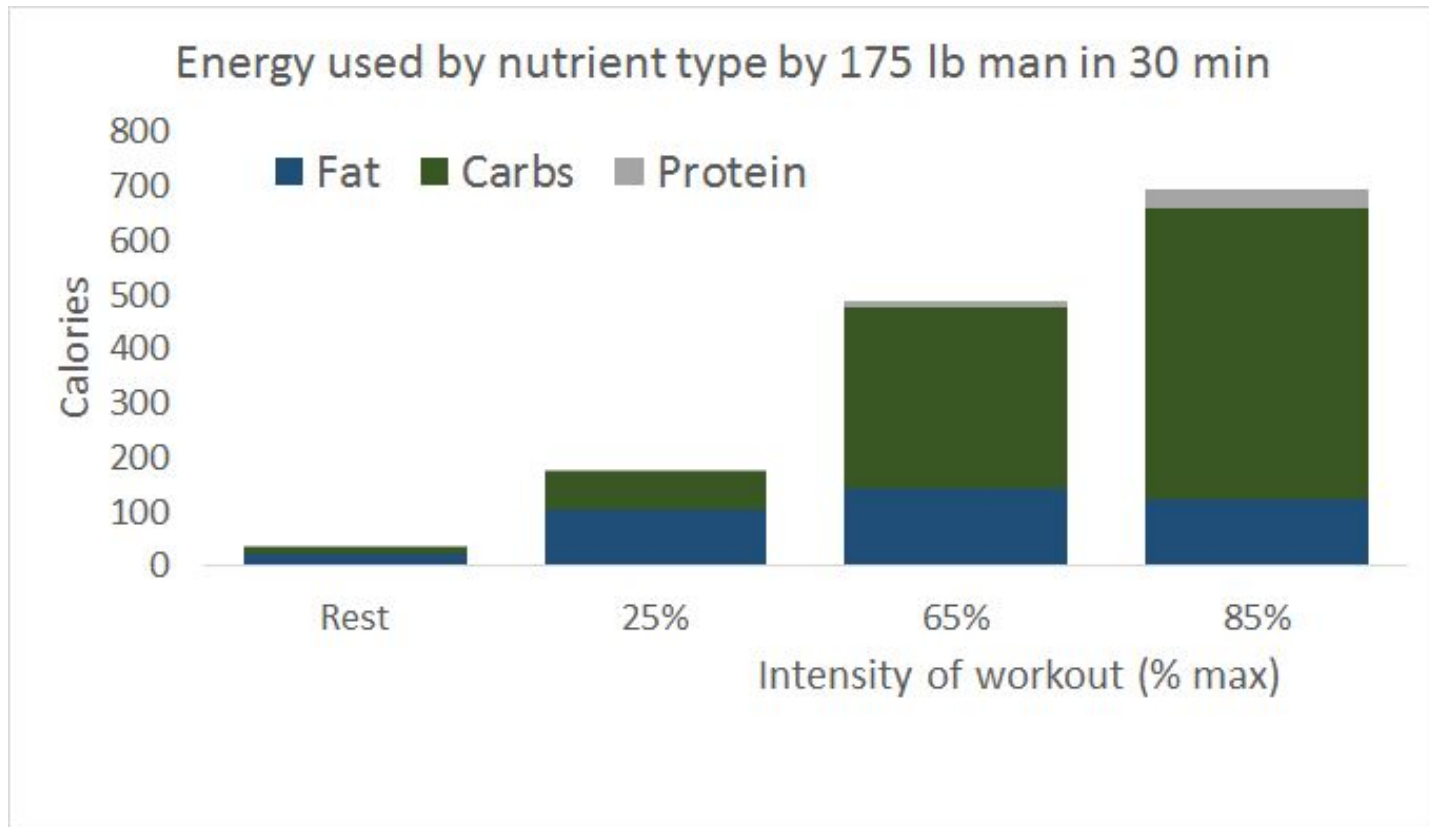
	Glucose	Fatty Acids
ATP Produced Per Oxygen	~6 ATPs	~4.5 ATP

ATP= The main energy source of the cell

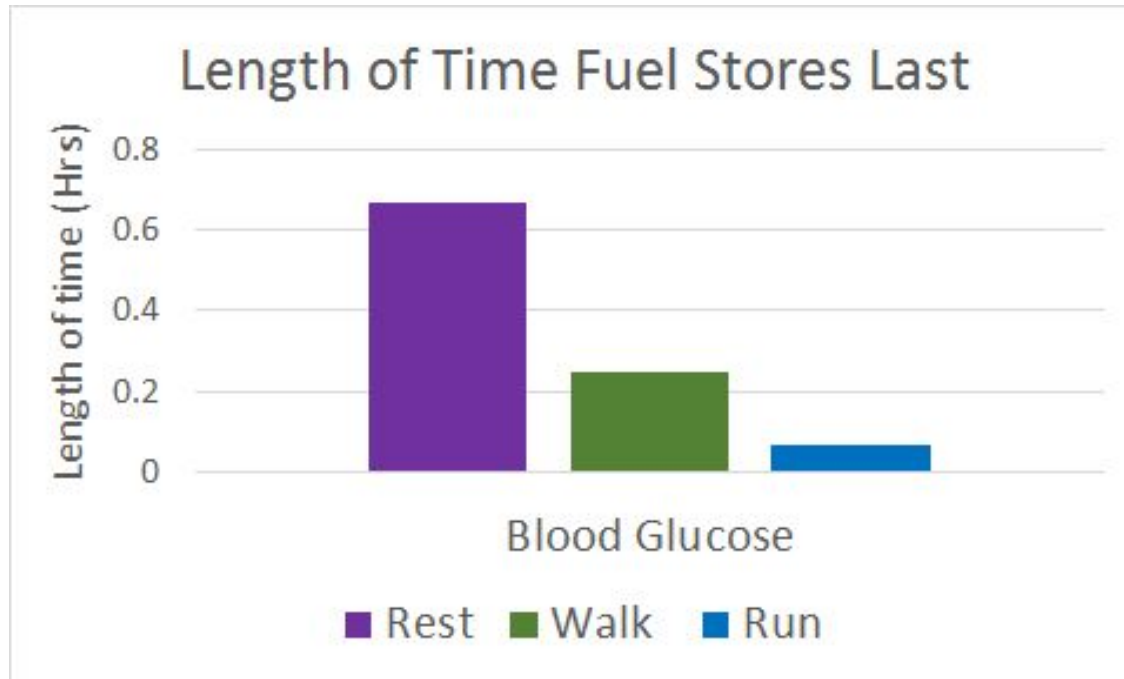
Carbohydrates are the preferred energy source during intense workouts



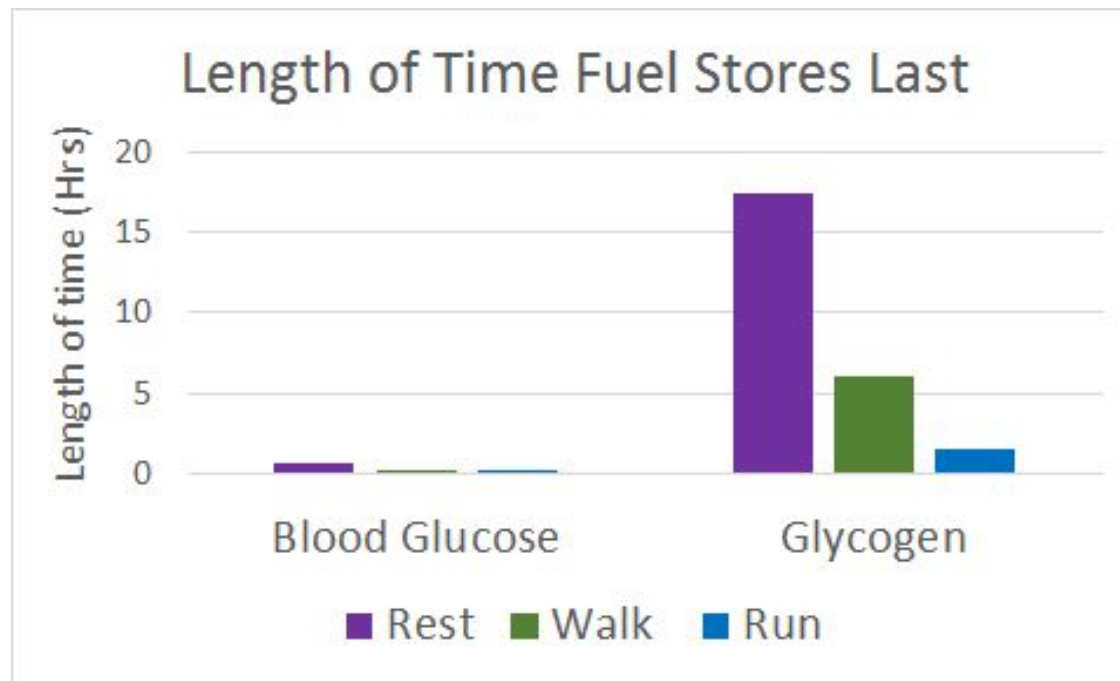
Medium intensity workouts burn the most fat



What happens when blood glucose isn't enough?



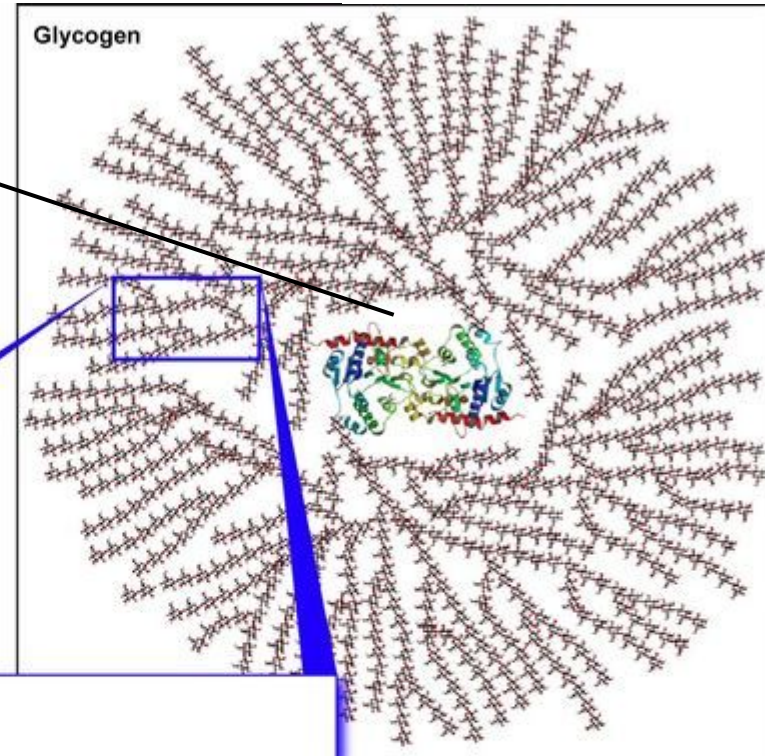
After using up glucose, the body switches to glycogen



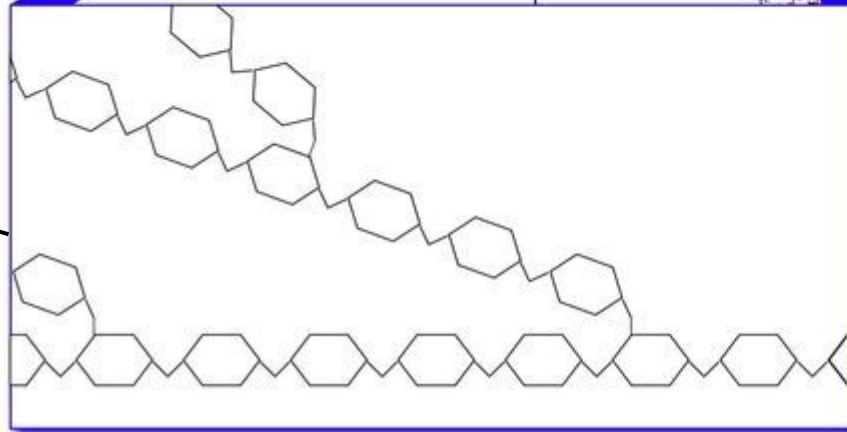
What is Glycogen?

Glycogen is the storage form of carbs and made in liver and muscle when blood glucose is high

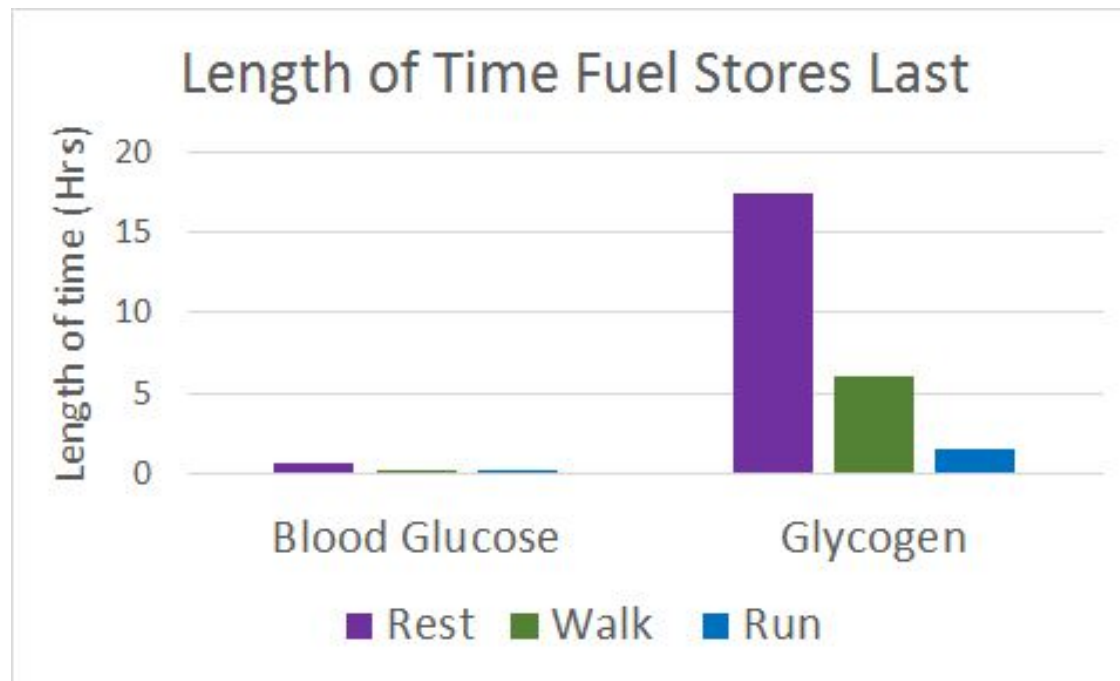
Protein core:
anchor for
glucose
chains



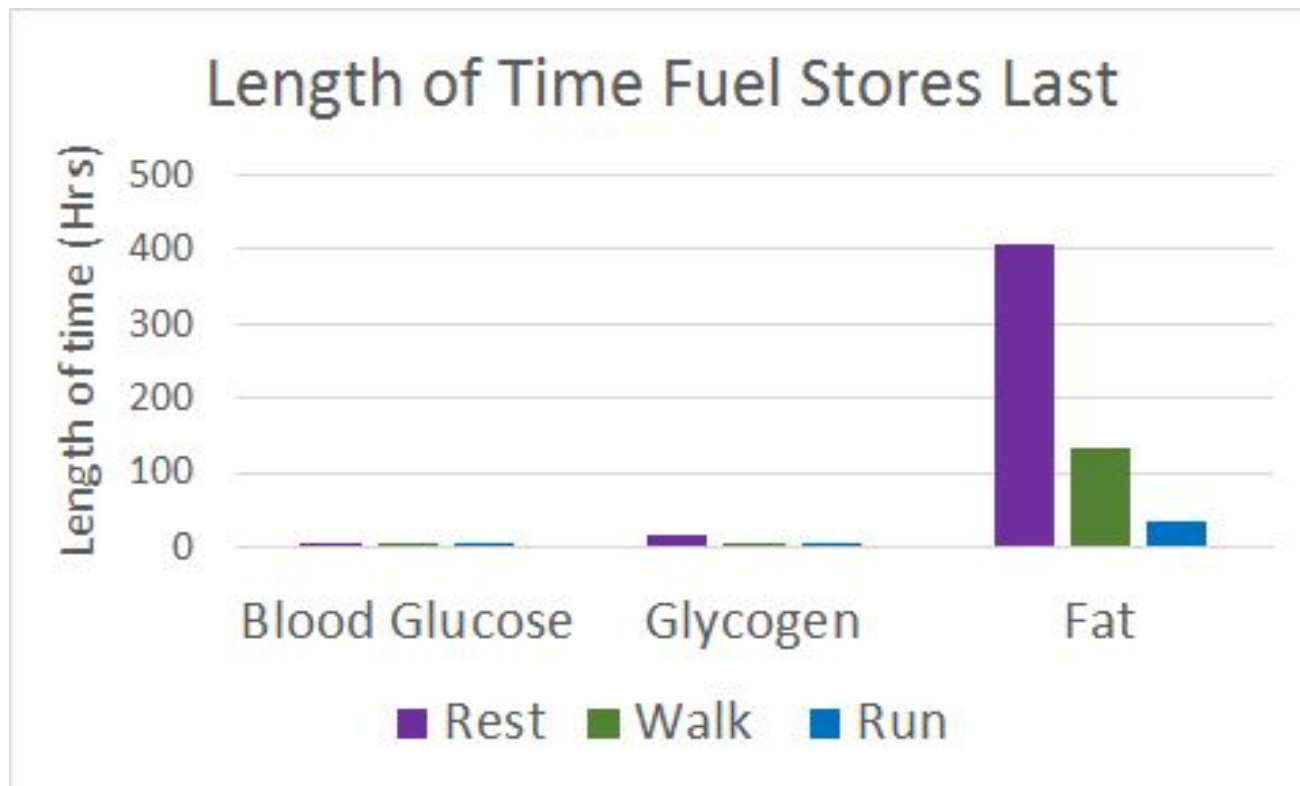
Glucose
monomers
linked
together



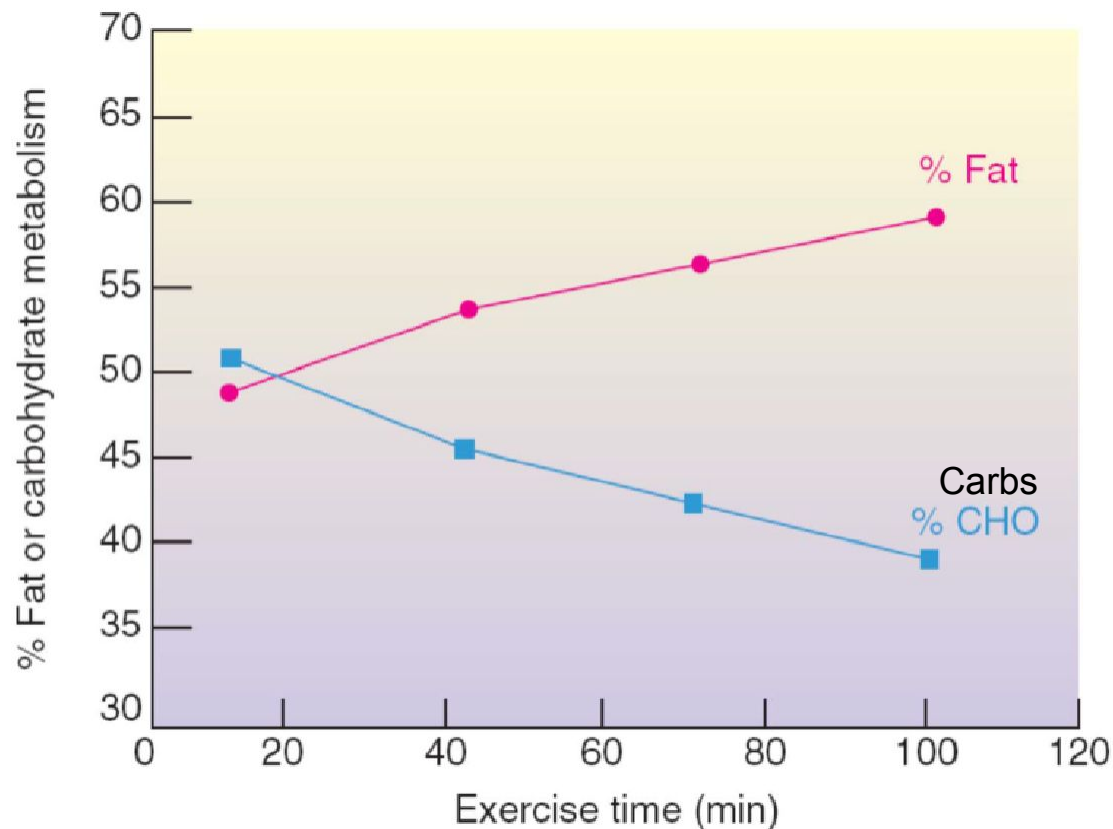
Glycogen is an excellent source of energy but stores are limited



The body has large energy reserves in fat



During endurance exercise the body begins to use more fat for energy



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Questions?

Roadmap

Background:

- Metabolism and Exercise

Vignettes

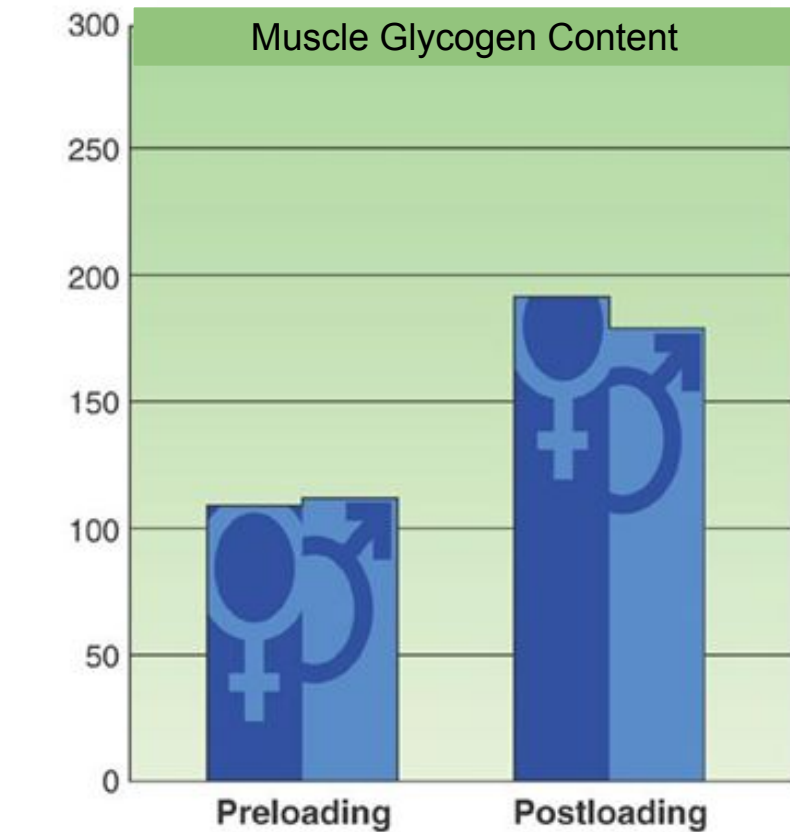
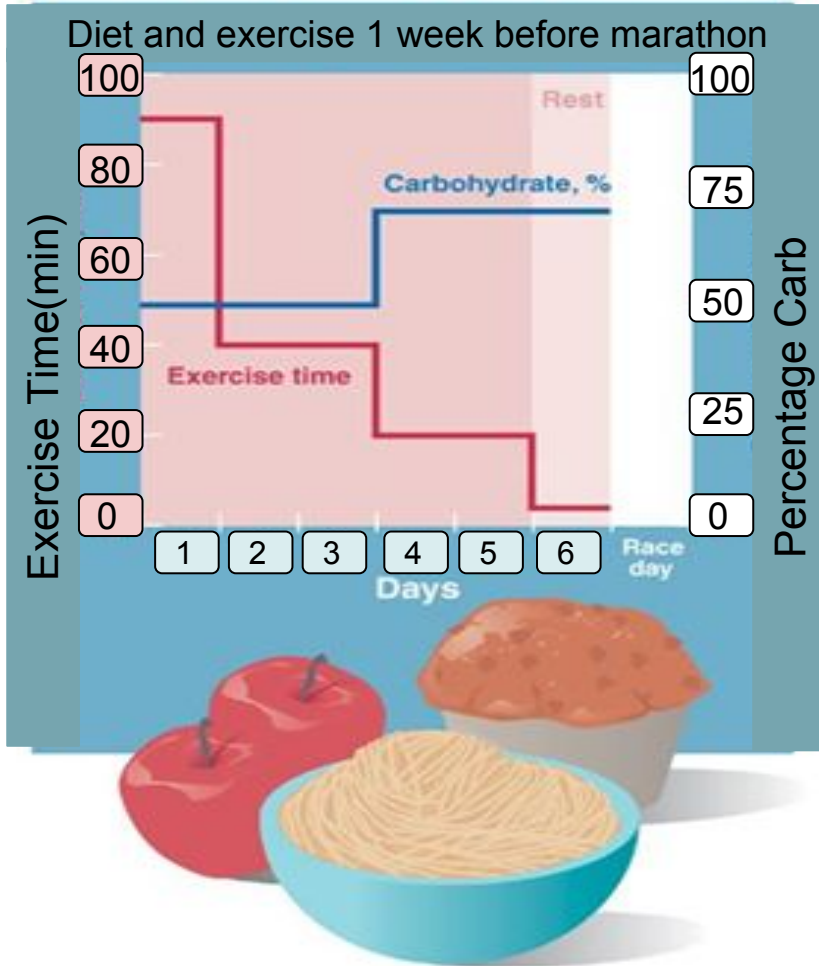
- **Endurance Athletes and Carb Loading**
- Diabetes and Walking

“Hitting the wall” during prolonged exercise

- An athlete “hits the wall” when they use up all their glycogen stores, causing blood glucose to drop
- To avoid ‘hitting the wall’
 - Maximize glycogen stores
 - Replenish carbohydrates during exercise (using energy gels, etc.)

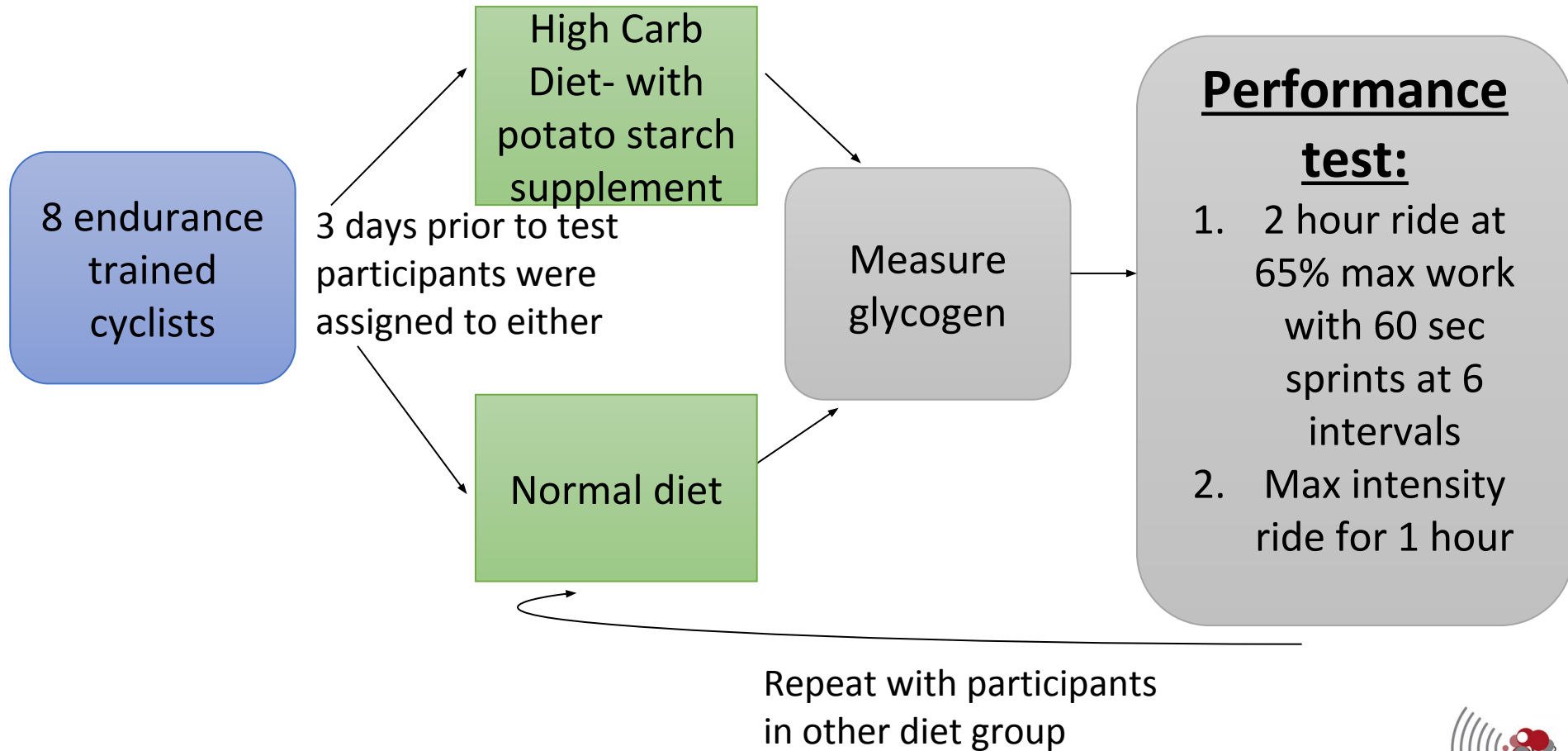


Carb loading isn't just eating pasta the night before a race

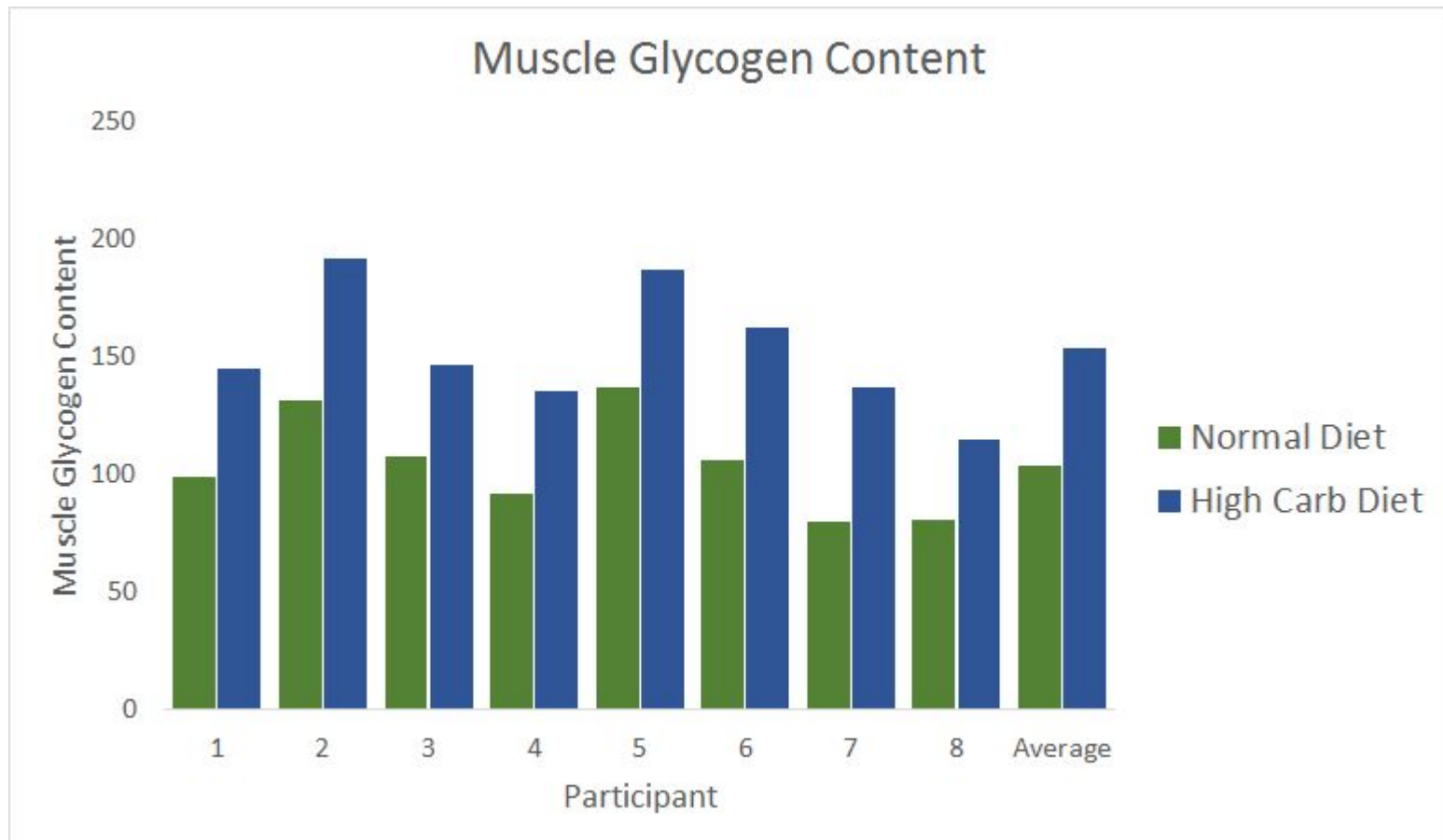


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Does carb loading improve performance for endurance exercise?

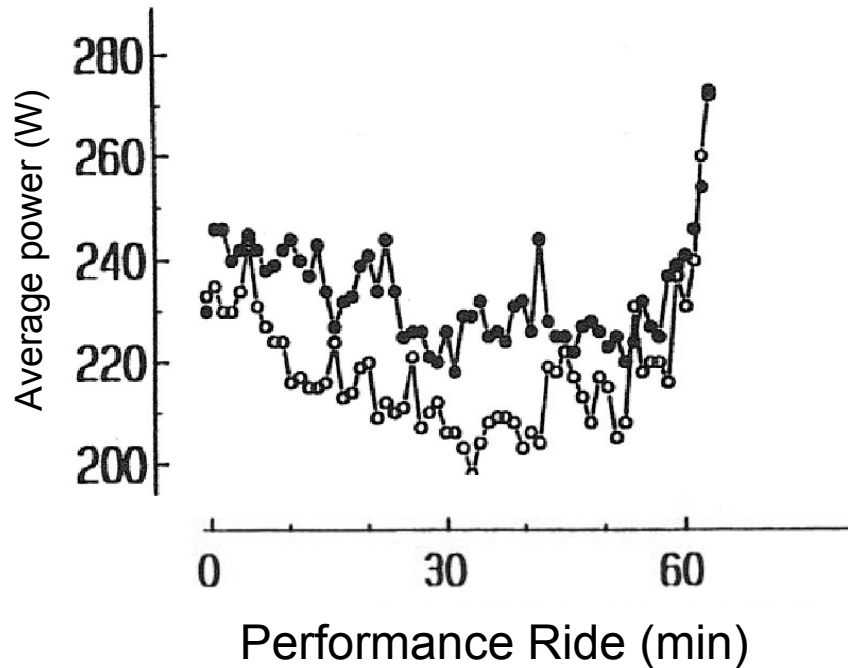


Carb loading for 3 days increases muscle glycogen content



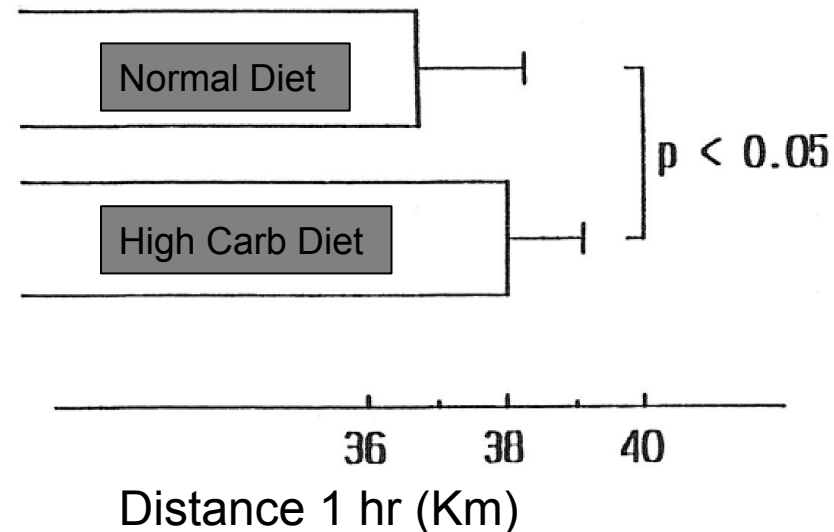
Carb loading for 3 days increases performance in cycling test

Increased power output in performance ride after carb loading



- Normal Diet
- High Carb Diet

Increased distance traveled in performance ride after carb loading



Fact and fiction of carbohydrate loading

- Carb loading is a multi-day process
- The purpose of carb loading is to increase glycogen stores
- A word of caution
 - Carb loading can cause gastrointestinal distress
 - Carb loading can increase the risk of diabetes

Questions?

Roadmap

Background:

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Vignettes

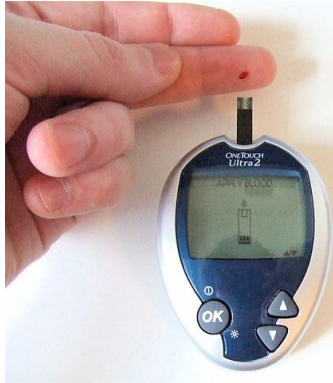
- Endurance Athletes and Carb Loading
- **Diabetes and Walking**

Glucose: a double-edged sword

Glucose is **necessary** for your body during rest and exercise alike, but diabetics have **too much** blood sugar

Too much blood sugar **can hurt many organs**, including the heart, kidneys and eyes

Diabetes and Exercise



- Daily monitoring combined with physical activity improves long-term health¹
- Many diabetics aren't mobile enough for strenuous exercise, so walking is often suggested as an alternative

Walking as Exercise



Walking is often recommended by doctors to improve diabetes and general health¹

What's the right number of steps to take each day?

FEEL GOOD, FITBIT NEWS

JUNE 22, 2010

The Magic of 10,000 Steps

BY FITBIT STAFF

f t g @ in



“Use a pedometer to count how many steps you take each day. Each week aim to increase your daily step count by 1,000 steps until you reach **10,000 steps a day.**”

- American Heart Association

- Governments and Companies most often suggest 10,000 steps/day
- Numbers are the same for diabetics

Where does 10,000 steps per day come from?

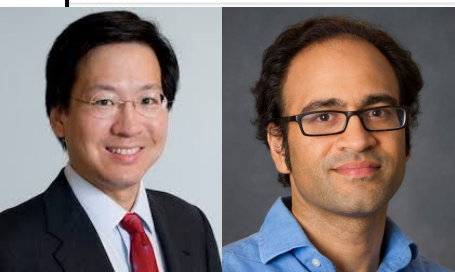
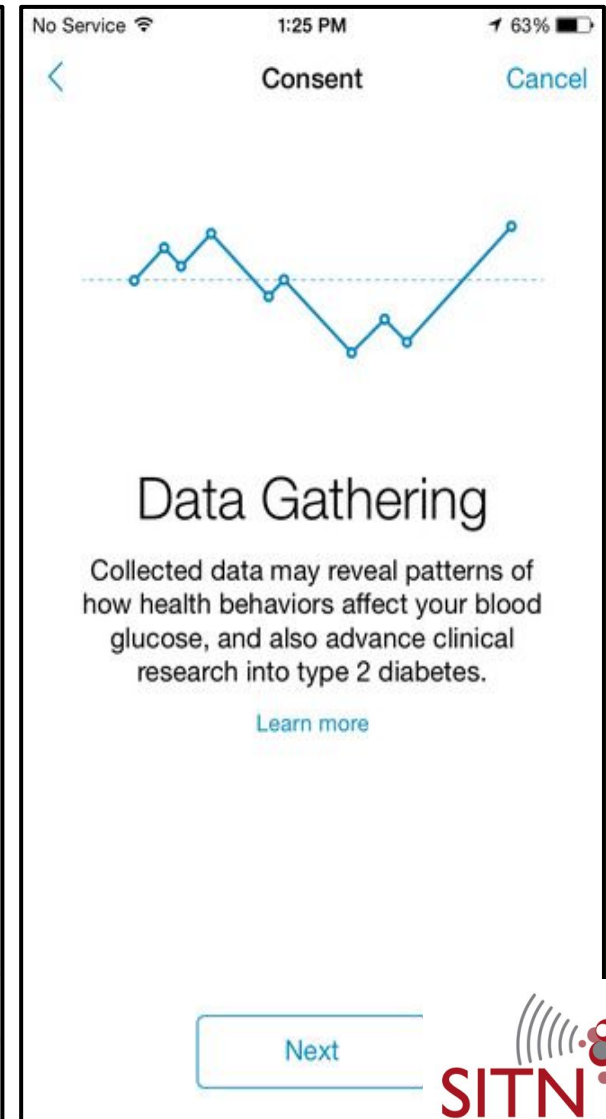
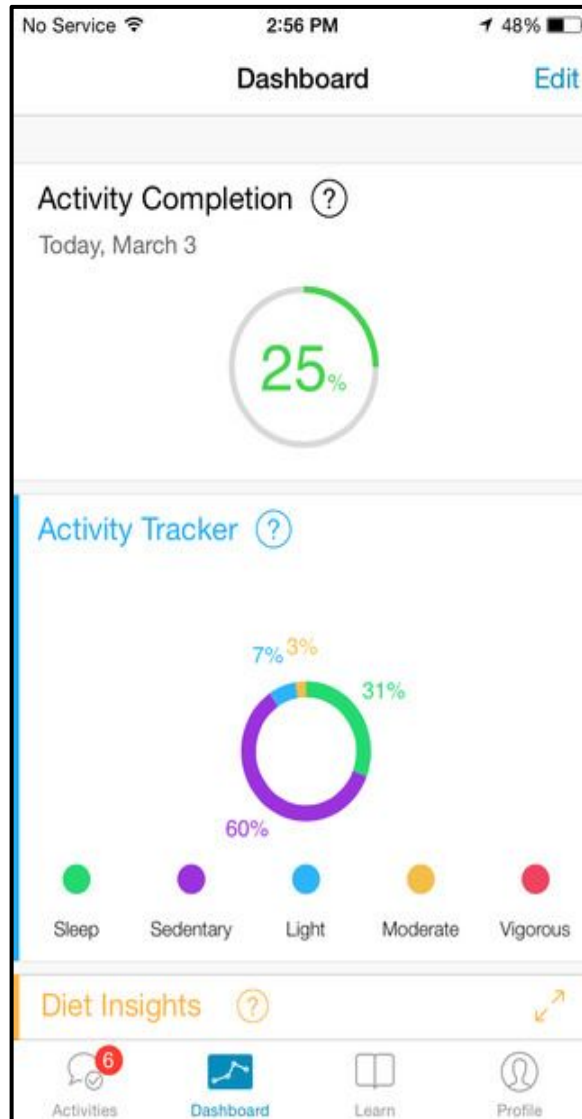
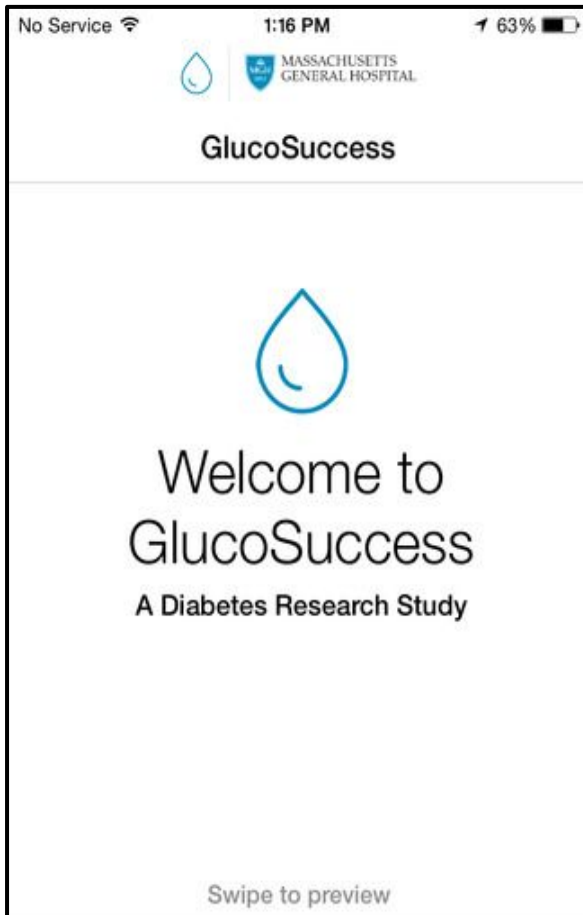


- 10,000 steps a day (manpo-kei) was coined by Y. Hatano in the mid 1960's as a tool to sell pedometers¹

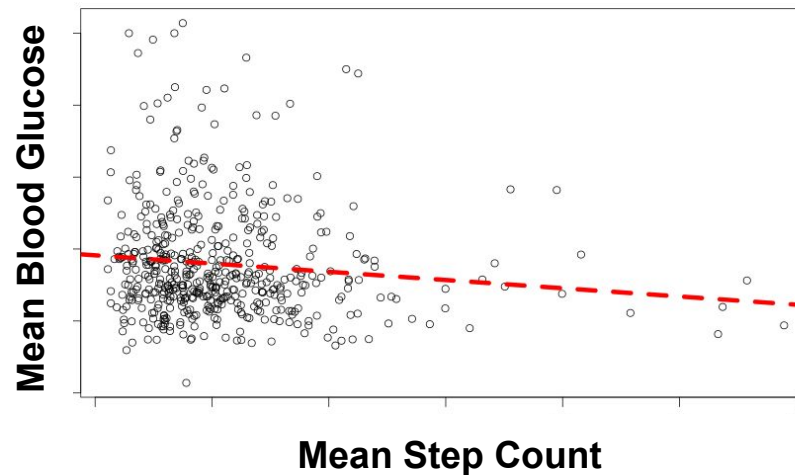
Two Open Questions

1. Does walking directly impact blood glucose in diabetics? If so, at what time scales?
2. Are population-level trends applicable to individual diabetics? Will walking help everyone equally?

The GlucoSuccess iPhone App

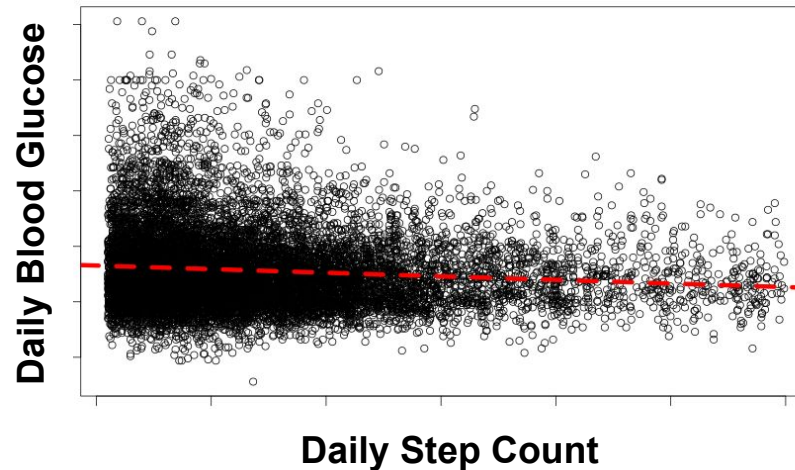


Does Walking Lower Blood Glucose?



- Probably. Among 2,496 diabetics, walking 1K more steps per day was associated with 1 point (mg/dL) lower fasting blood glucose (measured over 9 months)

What about in the short-term?

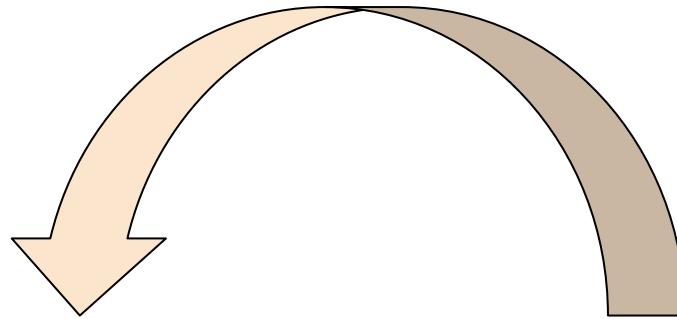


- We looked at day-to-day impact of walking on glucose and found a significant, but small and very noisy relationship

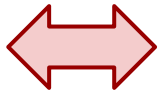
Lessons from GlucoSuccess

1. Overall, blood glucose in diabetics is **probably** tied to daily step count
2. BUT, the relationship is **complex and not generalizable** from person to person
3. 10K a day is nice, but we need more **personalized recommendations**

Walking
Endurance Exercise

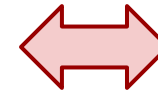


Hitting the Wall

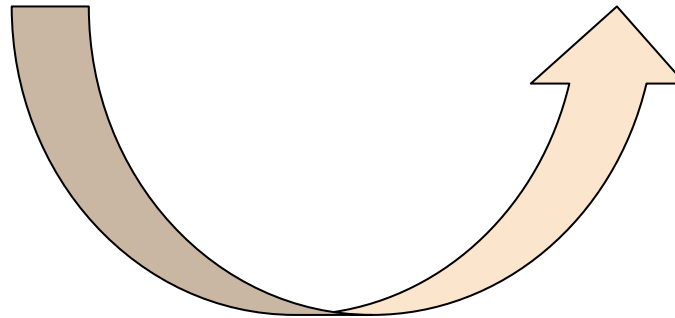


Low Glucose

High Glucose



Diabetes



Carbo Loading
Lifestyle
Disease

Questions?

Thank you!

SITN would like to acknowledge the following organizations for their generous support.

Harvard Medical School

Office of Communications and External Relations
Division of Medical Sciences

The Harvard Graduate School of Arts and Sciences (GSAS)

The Harvard Graduate Student Council (GSC)

The Harvard Biomedical Graduate Students Organization (BGSO)

The Harvard/MIT COOP

Aerobic vs anaerobic metabolism

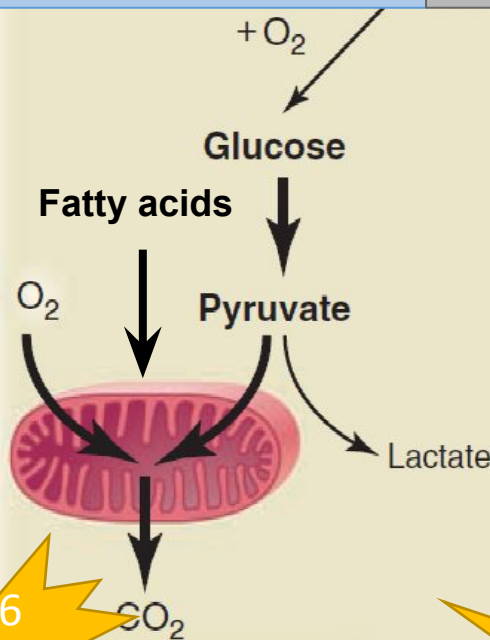
Pros of aerobic metabolism

1. Produces a lot of energy
2. Long lasting

Cons of aerobic metabolism

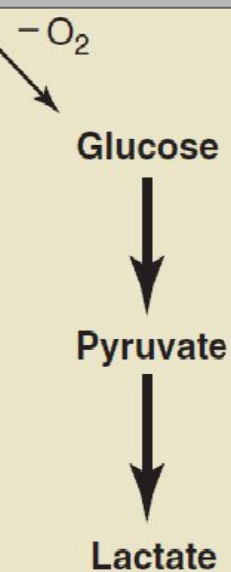
1. Requires oxygen
2. Slower than anaerobic metabolism

Aerobic Metabolism Requires oxygen



36
ATP

Aerobic Metabolism Requires oxygen



2
ATP

Pros of anaerobic metabolism

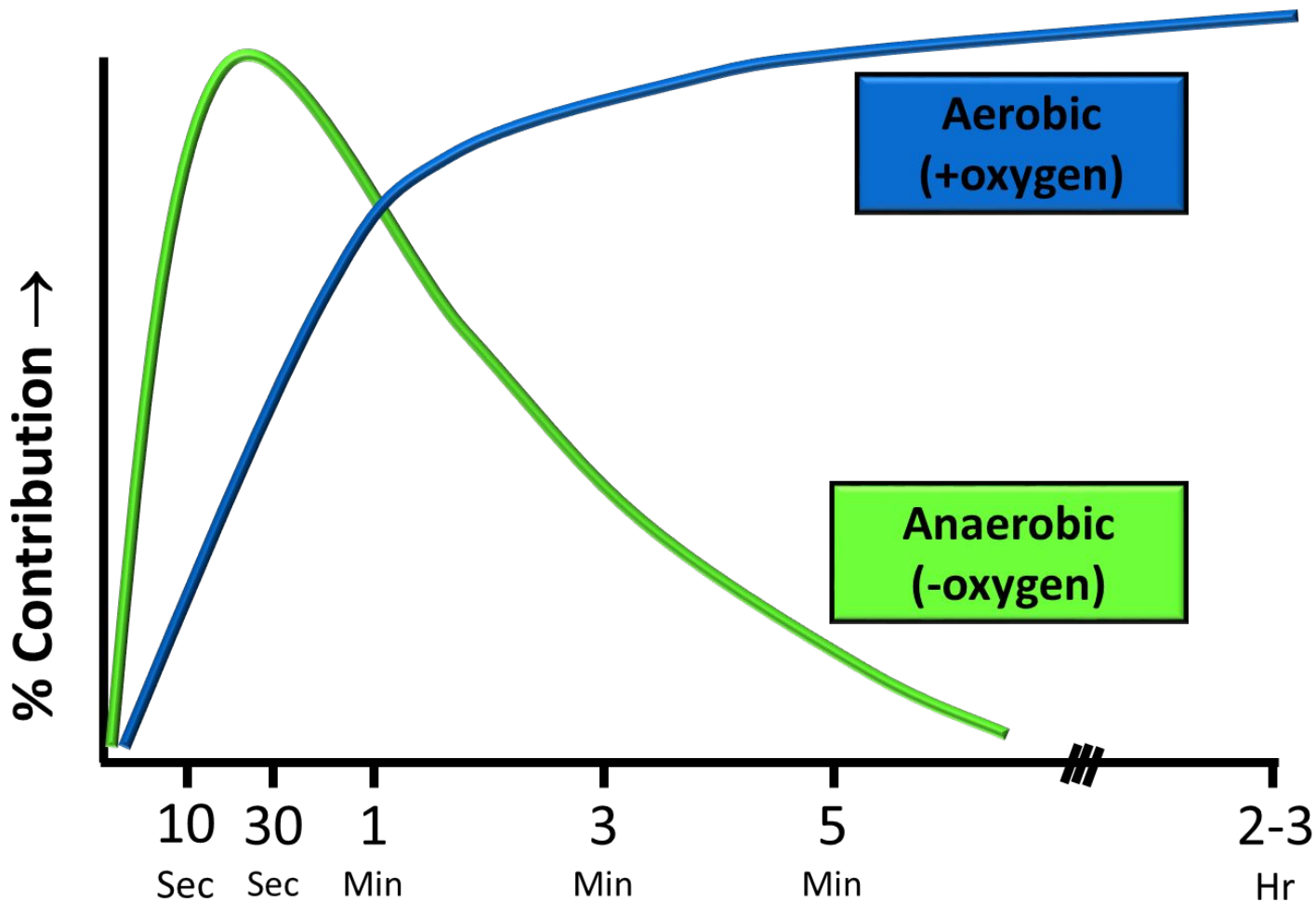
1. Fast
2. Does not require oxygen

Cons of anaerobic metabolism

1. Inefficient
2. Produces toxic by-product
3. Lasts only a couple of minutes

ATP: Main source of energy for the cell

Anaerobic metabolism is brief during exercise



Is 10,000 steps per day supported by science?

“most of the benefit is achieved by **8000 steps per day**”

- Ewald et al., 2014 (J Phys Act Health)

“The findings suggest that **10,000 to 11,000 and 7700 to 8000 steps/d represent the optimal thresholds** [depending on which activity goal you choose]”

- Cao et al., 2014 (J Phys Act Health)

- The verdict is still out, but the evidence suggests that 10K/day isn't a “magic number” of steps

Aerobic metabolism can use both glucose and fats

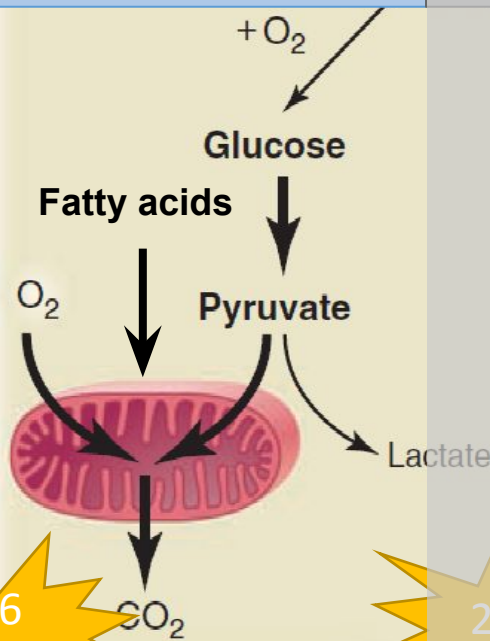
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Aerobic Metabolism Requires oxygen



36
ATP

Aerobic Metabolism Requires oxygen



2 ATP

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