CARBOHYDRATES: TYPES & ABSORPTION RELATED TO EXERCISE

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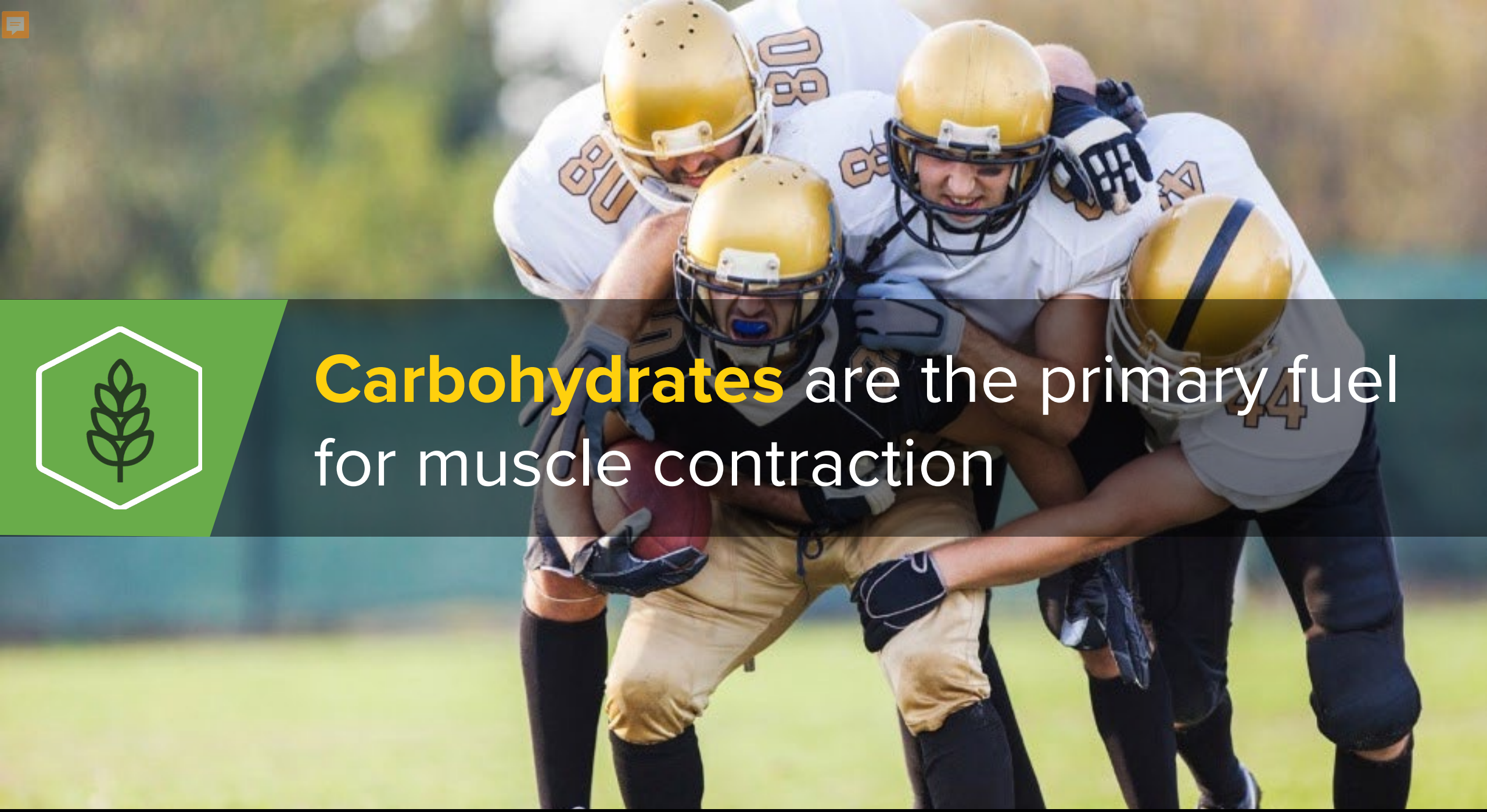
OVERVIEW

- Review the importance of carbohydrates for athletes
- Structure and classifications
- Oxidation rates of different carbohydrates
- Absorption



Carbohydrates are the primary fuel for muscle contraction

INTRODUCTION TO CARBOHYDRATES

CONSUMING CARBOHYDRATES WILL...

- Maintain high rates of carbohydrate oxidation
- Reduce ratings of perceived exertion
- Increase endurance capacity
- Delay the onset of fatigue
- Prevent hypoglycemia

Baker L et. al. *Nutrients*. 2015;7:5733-5763
Jeukendrup, Rollo, Carter. *Sports Science Exchange*. (2013;26(118):1-8

CARBOHYDRATE DEFINED

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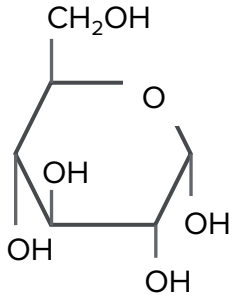
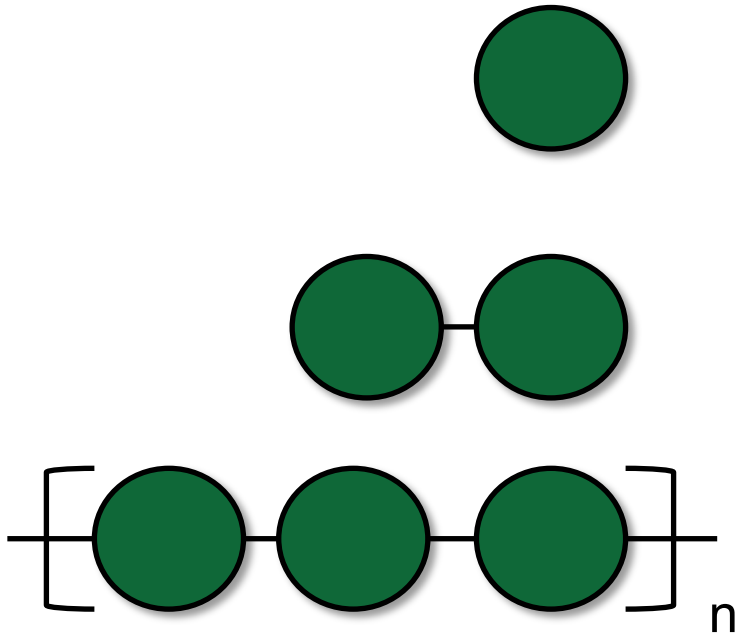


An organic compound made of carbon, hydrogen and oxygen.

A class of food that is rich in sugars, starches, or fibers.

An individual carbohydrate is classified as a sugar, starch, or fiber depending on the structure and number of glucose molecules.

CARBOHYDRATE CLASSIFICATIONS



monosaccharide

disaccharide

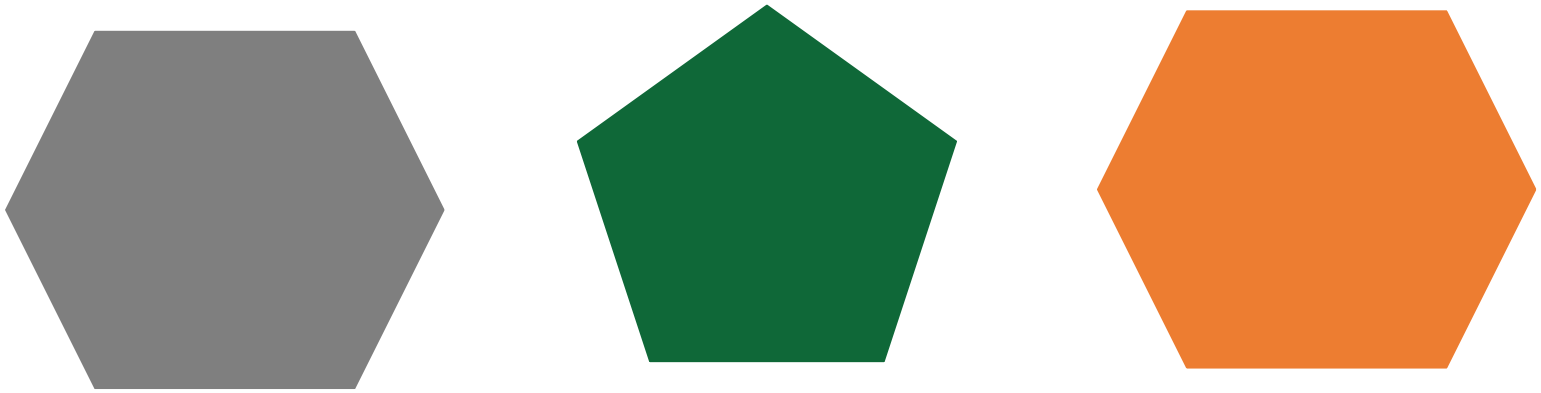
polysaccharide/
glucose polymer

Simple
Carbohydrates
(Sugars)

Complex
Carbohydrates
(Starches/Fibers)

CARBOHYDRATE CLASSIFICATIONS

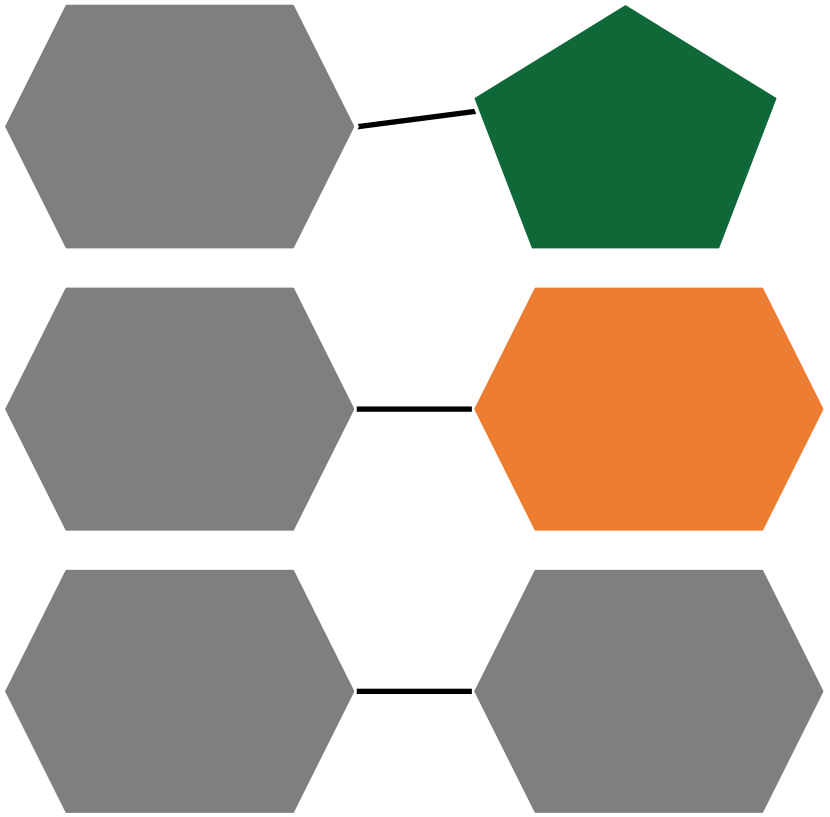
Monosaccharides



glucose fructose galactose

CARBOHYDRATE CLASSIFICATIONS

Disaccharides



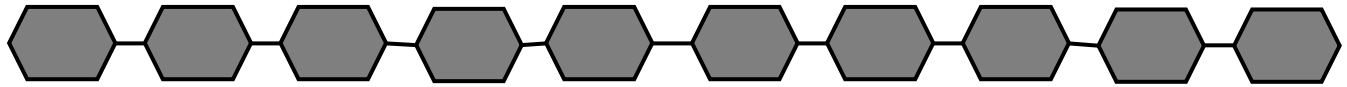
Sucrose

Lactose

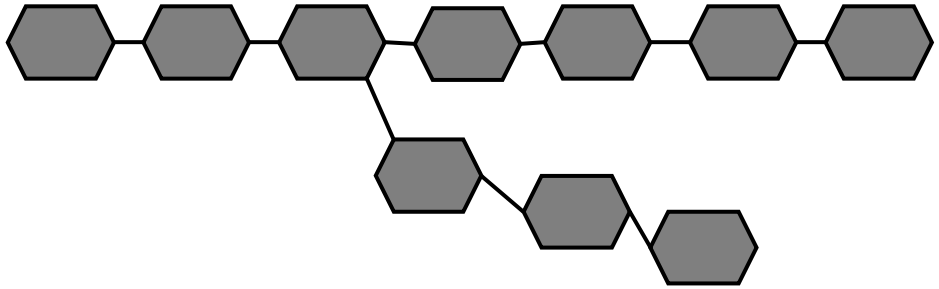
Maltose

CARBOHYDRATE CLASSIFICATIONS

Polysaccharides



amylose

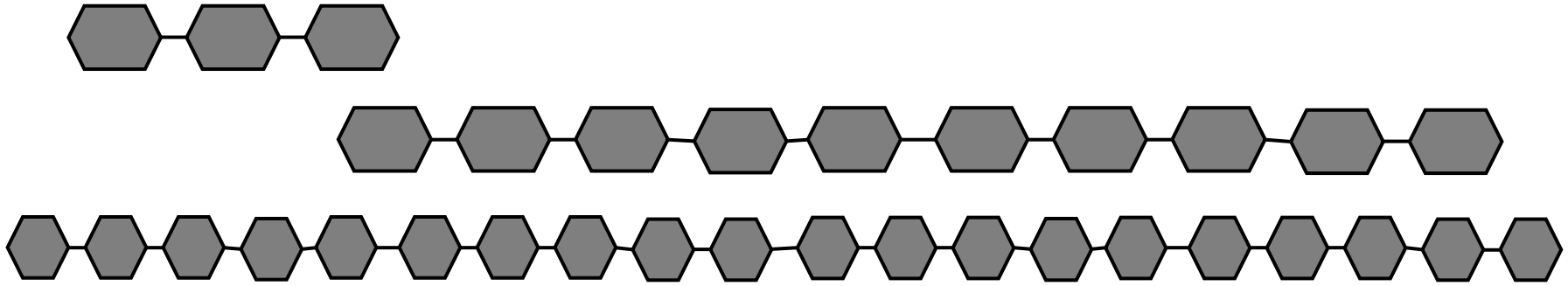


amylopectin

CARBOHYDRATE CLASSIFICATIONS

Maltodextrin

- Group of glucose polymers
- Produced from potato or corn starch
- Same oxidation rate as glucose and sucrose
- Common carbohydrate source in sports nutrition products



CARBOHYDRATE CLASSIFICATIONS

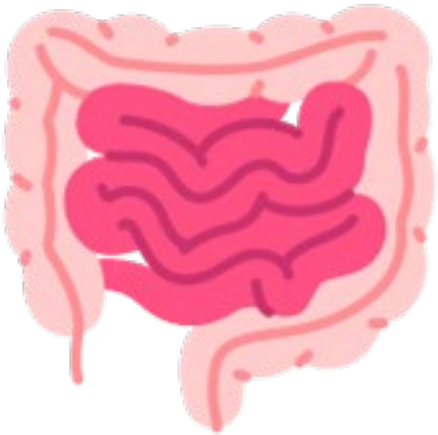
- Glucose
- Fructose
- Galactose

- Sucrose
- Lactose
- Maltose

- Starch
  - Amylose
  - Amylopectin
- Fiber
  - Soluble
  - Insoluble

CARBOHYDRATE CLASSIFICATIONS

INGESTED CARBOHYDRATE



Oral receptors in the mouth detected ingested carbohydrate, can improve exercise performance

Digestion to monosaccharides

Absorption via glucose & fructose transporters

Fuel for brain & muscle

Rollo, I. et al. Sports Med. 2020; DOI 10.1007/s40279-020-01343-3

CARBOHYDRATE CLASSIFICATIONS

Carbohydrates are often classified as “simple” and complex” based on their structures.

But, this *chemical* classification doesn’t reflect the *physiology* of the carbohydrate in the body.

Rather than simple/complex, choice of carbohydrate for athletes *during exercise* should be based on oxidation rate, which is determined by absorption at the intestine.

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Jeukendrup A. *Sports Science Exchange*. 2007;20(106)1-6

CARBOHYDRATE STRUCTURE CLASSIFICATIONS

SIMPLE

- Glucose
- Fructose
- Galactose
- Sucrose
- Maltose

COMPLEX

- Amylose
- Amylopectin

Jeukendrup A. *Sports Science Exchange*. 2007;20(3)1-6

TYPES OF CARBOHYDRATES

FASTER

- Glucose
- Maltose
- Sucrose
- Maltodextrins
- Amylopectin

Rapid Absorption

1.0 g/min (60 g/h)

SLOWER

- Fructose
- Galactose
- Trehalose
- Isomaltulose
- Amylose

Slow Absorption

.06 g/min (35 g/h)

Jeukendrup A. *Sports Science Exchange*. 2007;20(3)1-6

CARBOHYDRATE RECOMMENDATIONS

- ✔ When practicing or competing for an hour or longer
- ✔ Goal = Performance
- ✔ 30-60 g/h
- ✔ Easily digestible, quickly oxidized carbohydrate

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Baker LB, Rollo I, Stein KW, et al. *Nutrients*. 2015;7:5733-5763
Burke LM, Hawley JA, Wong SHS, et al. *Journal of Sports Science*. 2011;29(1):S17-S27
Thomas DT, Erdman KA, Burke LM. *Medicine & Science in Sports & Exercise*. 2016;48:543-568

OXIDATION

A faster rate of carbohydrate oxidation can result in a better performance

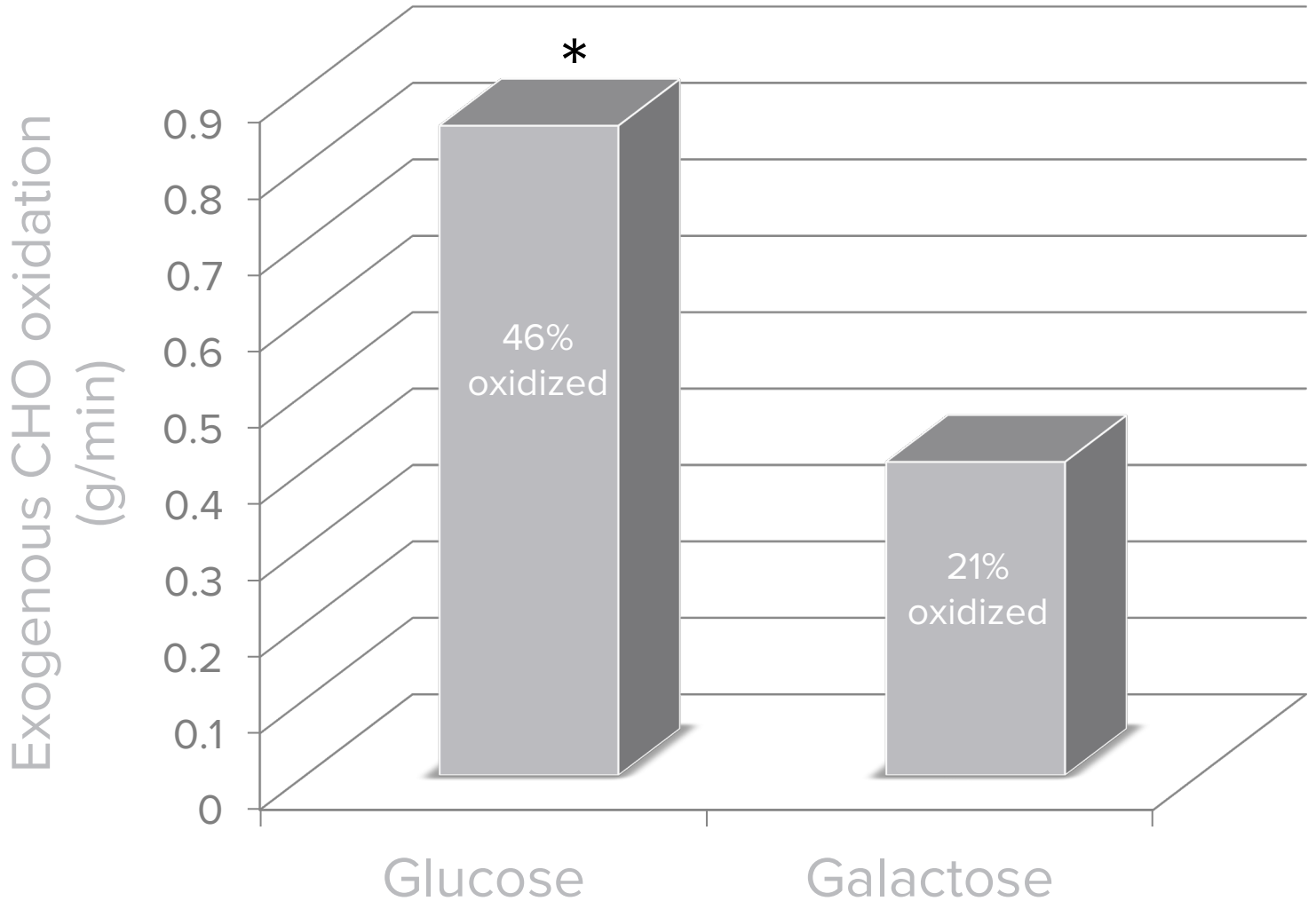
Jeukendrup A. *Sports Science Exchange*. 2013;26(108):1-5
Jeukendrup A. *Curr Opin Clin Nutr Metab Care*. 2010;13:452-457

OXIDATION RATES DURING CYCLING

120 min @ 65% max
60 min rest
30 min @ 60% max

8% ^{13}C-enriched
glucose –or- galactose

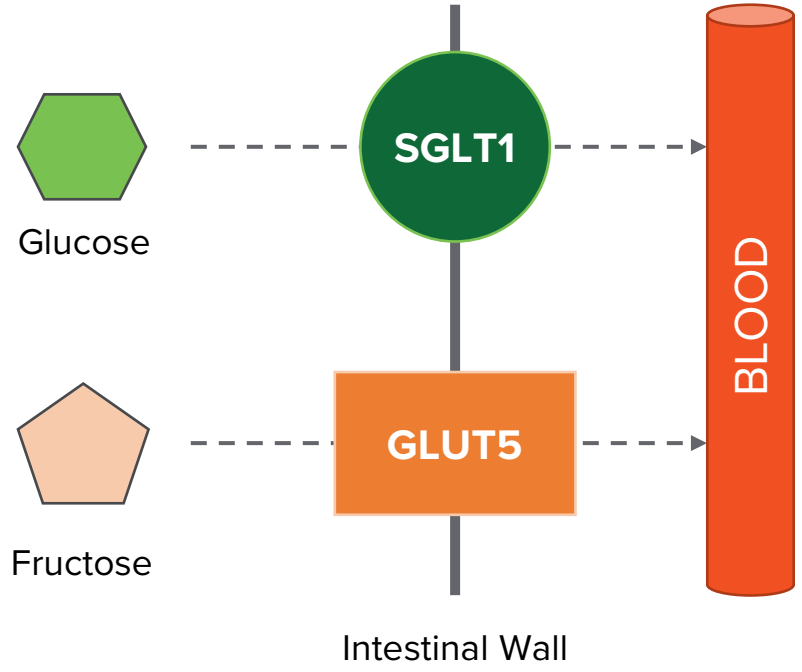
8mL/kg pre
2 mL/kg every 15 min



INTESTINAL CARBOHYDRATE TRANSPORTERS

Intestinal wall has transporters for both glucose and fructose

Making use of both transporters increases carbohydrate absorption and oxidation



INTESTINAL CARBOHYDRATE TRANSPORTERS

Toll Booth Analogy

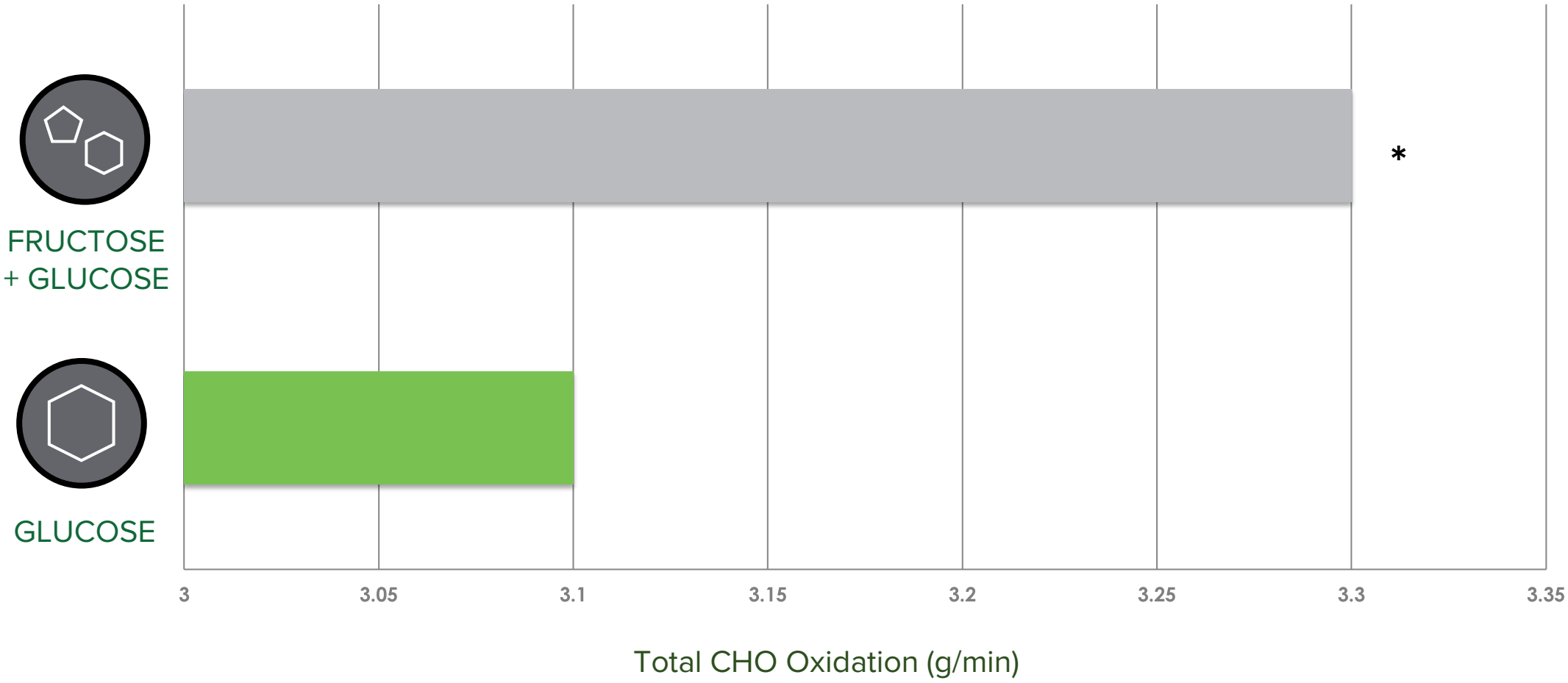
Think of the carbohydrate transporters each as a lane of a toll booth

The more toll lanes that are open, the faster the cars can move through

If less toll lanes are open for use, the cars can get backed up

FRUCTOSE + GLUCOSE COMBINATION

You don't need all "fast" sugars



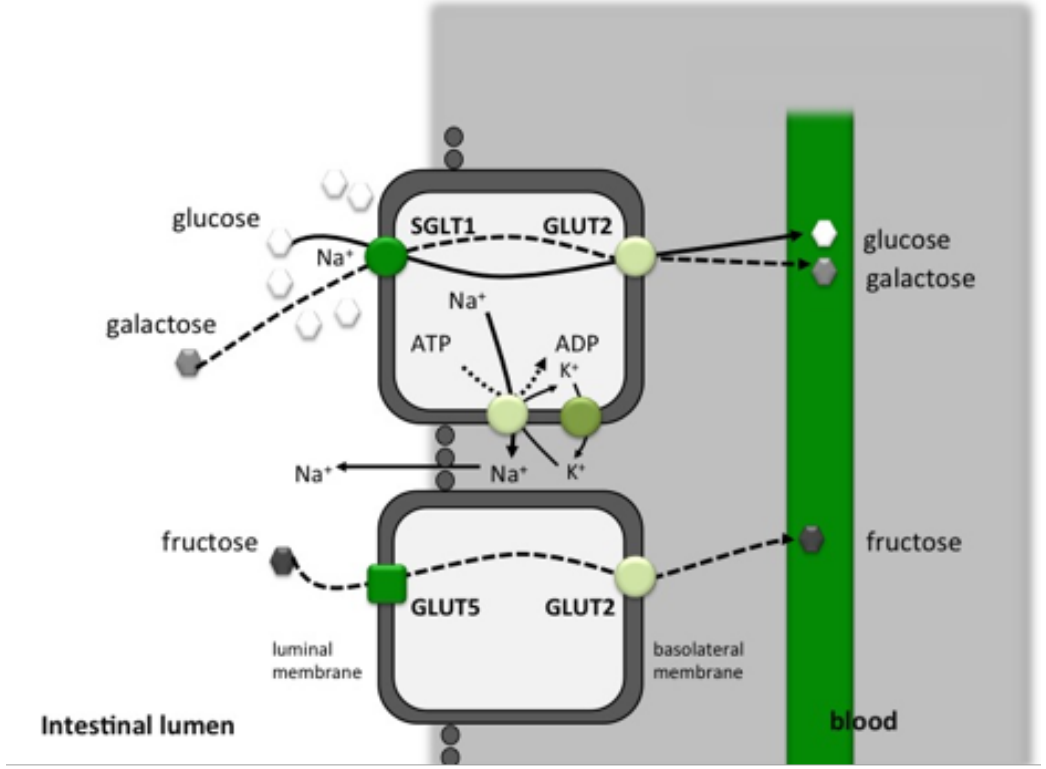
MULTIPLE TRANSPORTABLE CARBOHYDRATES

Endurance activities > 2.5 hours

Aim for 90 g/h, use multiple transporters

The CHO source should be a mix of glucose and fructose in a ratio of roughly 2:1.

60 g/h of glucose (to saturate the SGLT1 transporters) and 30 g/h of additional fructose for oxidation.



SSE#108

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SPORTS NUTRITION PRODUCTS

Common Sugars in Sports Nutrition Products

Dietary Sugar Source		After digestion:
Glucose	⇨	Glucose
Sucrose	⇨	Glucose + Fructose
Maltodextrin	⇨	Glucose
High Fructose Corn Syrup	⇨	Glucose + Fructose
Organic Cane Sugar, Honey, Molasses, Agave nectar, Fruit juice concentrate	⇨	Glucose + Fructose


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SUGAR

Sugar Gets a Bad Rap

Sugar is often demonized and called “toxic”

Many quickly oxidized carbohydrates are sugars

For athletes, it’s important to differentiate the need for a *functional* CHO (sugar) *during* exercise due to fast absorption and oxidation – it won’t provide energy if it’s sitting in the gut causing GI upset!

ALL-DAY CARBOHYDRATE INTAKE

For sports nutrition needs (pre/during/post exercise) the focus should be on quickly oxidized CHO.

Throughout the rest of the day, athletes should focus on nutrient-rich sources regardless of oxidation rate, including *fruits, vegetables, whole grains and legumes.*

25-30 g/d = recommended fiber intake from food.

ARTIFICAL SWEETENERS

KEY TAKEAWAYS

- ✓ Carbohydrates are the primary fuel for muscle contraction
- ✓ Intake during exercise can help improve performance
- ✓ The chemical classification (simple/complex) does not reflect the physiologic response in the body
- ✓ During exercise, consume mostly “fast” carbohydrates – those that are quickly oxidized
- ✓ Multiple transportable carbohydrates

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