FUELLING THE ATHLETE

This resource was created by Michael Naylor, Head of Performance Nutrition, UK Sports Institute in collaboration with the GetPRO Professional nutrition team

This resource is for use under professional supervision

WHERE DOES ENERGY COME FROM?

CARBOHYDRATE

4 kcal/g

PROTEIN

4 kcal/g

FATS

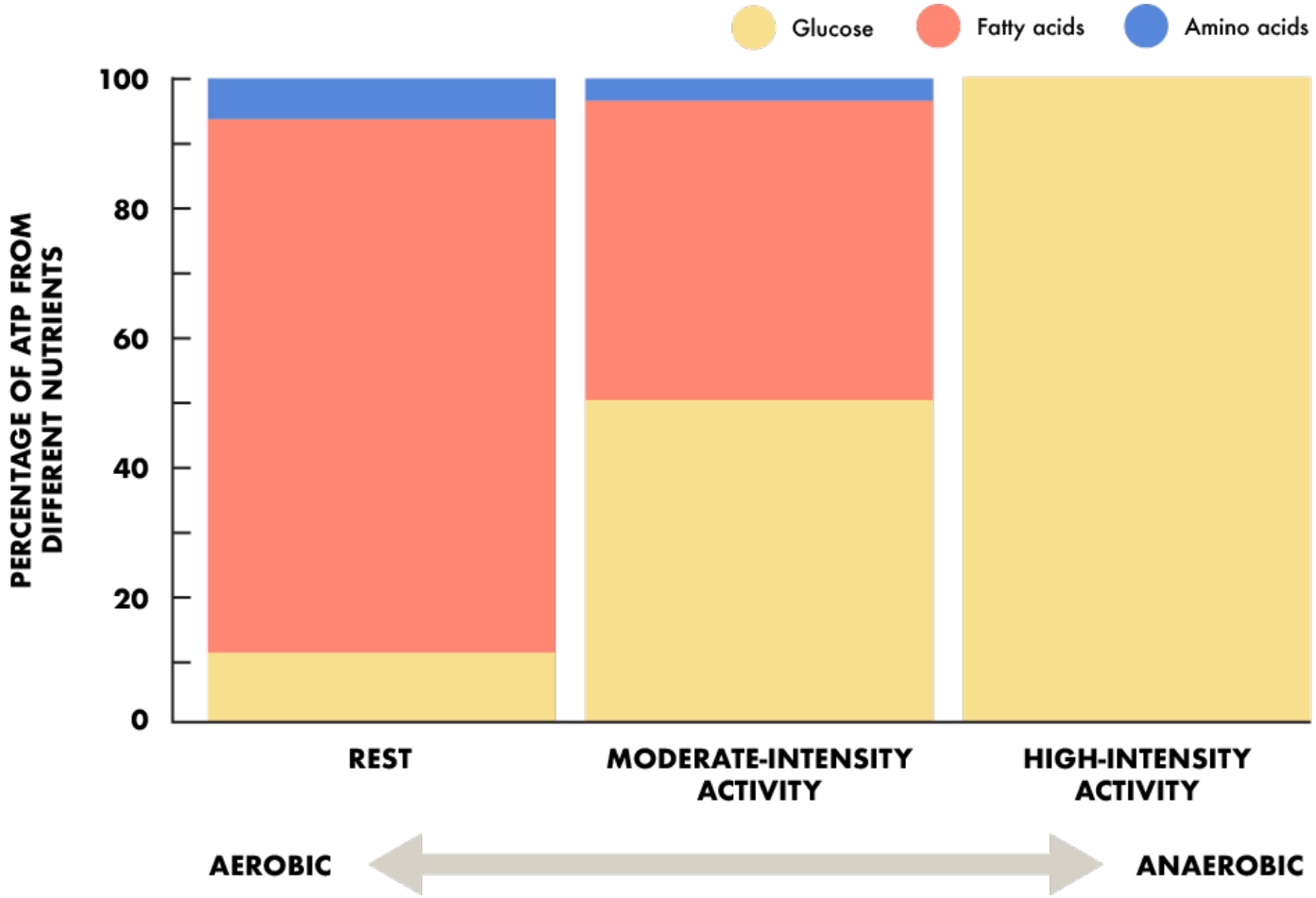
9 kcal/g

DID YOU KNOW?

Protein is primarily used by the body for building and repairing tissues, and not for movement!

WHERE DOES ENERGY COME FROM?

Carbohydrates tend to be the preferred energy source for athletes, because it is the only fuel source that can produce ATP without oxygen. This means, that any exercise above 60% VO2 max, carbohydrates are the predominate fuel source.



CARBOHYDRATE STORAGE

Carbohydrates are primarily stored in the body as glycogen, however stores are limited to around 500g. Glycogen serves as a reserve of energy and is a readily available source that can be mobilised quickly when needed. Think of it like a race car, when the driver puts their foot down on the accelerator, the car (glycogen) responds almost immediately!

DID YOU KNOW?

Even at rest, approximately 60% of glucose found in the blood is metabolised by the brain?

Glycogen storage location	Function	Storage Capacity
 **Liver**	Glycogen in the liver maintains blood glucose levels, particularly during fasting periods, such as sleeping or between meals. When blood glucose levels drop, glycogen stored in the liver is broken down into glucose and released into the blood stream to maintain energy.	100-120g
 **Muscles**	Muscles glycogen reserves are primarily used to provide energy for muscle contraction during physical activity. Muscle glycogen is not able to regulate blood glucose, but instead acts locally to provide energy for the working muscles.	300-400g

Murray B, Rosenbloom C. Nutr Rev. 2018 Apr 1;76(4):243-259

CARBOHYDRATE RECOMMENDATIONS FOR DIFFERENT EVENTS

Type of Activity	Minutes per day	Carbohydrate	Potential sports
Light intensity training e.g., walking, light jog, yoga – can easily talk or sing	<60	3-5 g/kg/bw	Weightlifting, shooting, archery
Moderate intensity training **e.g.**, jogging or cycling – can talk but unable to sing	>60	5-7 g/kg/bw	Weightlifting, swimming, running, team sports
Moderate to high intensity training e.g., interval training, a football match, swimming at a modest effort – can only carry out brief conversations	60-180	6-10 g/kg/bw	Team sports, triathletes, running, cycling
Moderate to high intensity training e.g., very hard interval training, high intensity football/ rugby match, ice hockey, swimming (cannot speak during the effort)	>180	8-12 g/kg/bw	Running, triathletes, ultra endurance athletes, cycling

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WHY GLYCOGEN IS IMPORTANT IN SPORT

ENERGY SOURCE

Adequate stores can delay fatigue and help maintain performance during prolonged or high intensity exercise.

MAINTAINS BLOOD GLUCOSE LEVELS

Liver glycogen is essential for maintaining stable blood glucose levels during exercise, preventing hypoglycemia.

OPTIMISE PERFORMANCE

Sufficient glycogen stores ensure that muscles have an adequate supply of energy to sustain high intensity or prolonged exercise. Depleted glycogen stores can lead to fatigue, reduced power output, and decreased endurance capacity, negatively impacting performance.

RECOVERY AND ADAPTATION

Carbohydrate consumption following exercise helps restore glycogen stores in the muscle and liver, promoting recovery, muscle repair and adaptation to the training stimuli.

Murray B, Rosenbloom C. Nutr Rev. 2018 Apr 1;76(4):243-259

REAL FOOD EXAMPLES OF CARBOHYDRATE AMOUNTS

BAGELS
45.3g per bagel

BAKING POTATO
39.6g per 175g

FRUIT SMOOTHIE
13g per 100ml

GREEK 0% YOGHURT
3g per 100g

MEDIUM SLICED BREAD
16.8g per slice

ORANGE JUICE
9.3g per 100ml

OATS
24.2g per 40g oats

BASMATI RICE
59.9g per 75g dry

CLASSIC VEG MIX
5.2g per 100g

SEMI SKIMMED MILK
9.6g per 200ml

FUSILLI PASTA
57g per 80g dry

BANANA
19.3g per 100g (medium banana)

CARBOHYDRATE PERIODISATION

LIGHT TRAINING DAY

(4g/kg/bw)

70 X 4 = 280g Carbohydrate

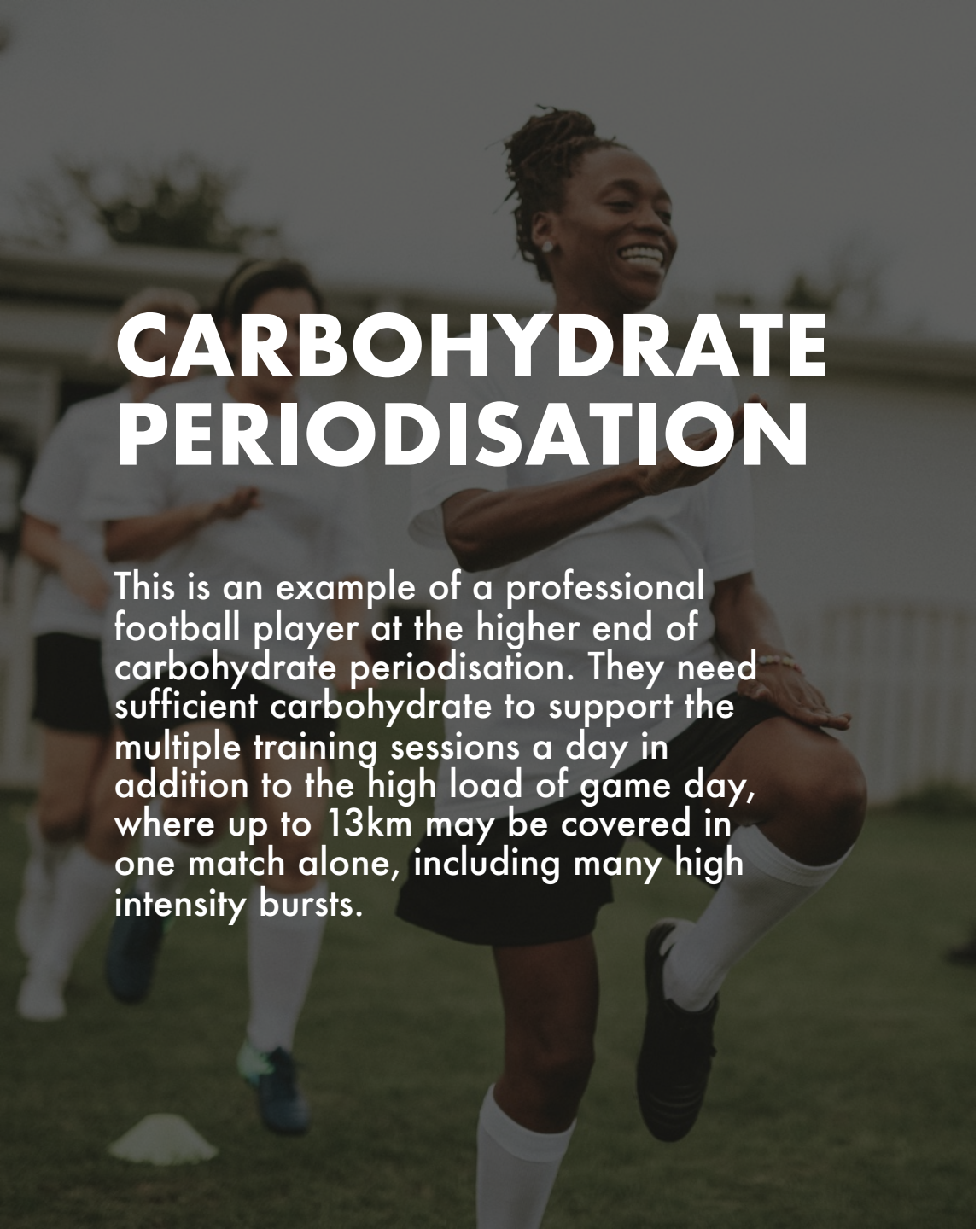
MODERATE TO HIGH TRAINING DAY

(or pre intense day) (6g/kg/bw)

70 X 6 = 420g Carbohydrate

EQUATION: WEIGHT (KG) X CARBS RECOMMENDED FOR DAY (G)

Anderson L *et al*. Journal of Sports Science. 2022: 999-1018.



CARBOHYDRATE PERIODISATION

This is an example of a professional football player at the higher end of carbohydrate periodisation. They need sufficient carbohydrate to support the multiple training sessions a day in addition to the high load of game day, where up to 13km may be covered in one match alone, including many high intensity bursts.

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	TYPICAL LOADS	BREAKFAST	DURING TRAINING	LUNCH	SNACK(S)	DINNER
MD+2	No training	MEDIUM 0.5-1.0g/kg	NO TRAINING	MEDIUM 1.0g/kg	MEDIUM 0.5-1.0g/kg	MEDIUM 1.0g/kg
MD-4	75-80min TD 5000m HSR <100m PM resistance training	MEDIUM 1.0g/kg	NO CHO	HIGH 1.5-2.0g/kg	MEDIUM 0.5-1.0g/kg	MEDIUM 1.0g/kg
MD-3	80-90min TD 6500m HSR 300-600m	MEDIUM 1.0g/kg	NO CHO	HIGH 1.5-2.0g/kg	MEDIUM 0.5-1.0g/kg	MEDIUM 0.5-1.0g/kg
MD-2	<70min TD <4500m HSR <100m	LOW 0.5g/kg	NO CHO	HIGH 1.5-2.0g/kg	MEDIUM 0.5-1.0g/kg	MEDIUM 0.5-1.0g/kg
MD-1	<60min TD <3000m HSR <50m	HIGH 2.0g/kg	HIGH 60g/h	HIGH 2.0g/kg	HIGH 1.5g/kg	HIGH 2.0g/kg

		BREAKFAST	PRE-MATCH MEAL	DURING GAME	POST-MATCH
MD	90min TD 11km HSR 1000m	HIGH 2.0g/kg	HIGH 2.0g/kg	HIGH 60g/h	HIGH 1.2g/h for 3h

		BREAKFAST	DURING TRAINING	LUNCH	SNACK(S)	DINNER
MD+1	Starters (>60min) Recovery session	HIGH 2.0g/kg	HIGH 60g/h	HIGH 2.0g/kg	HIGH 1.5g/kg	HIGH 2.0g/kg
	Non-starters (<30min) 70min TD 6500m HSR 1200m	MEDIUM 0.5-1.0g/kg	NO CHO	MEDIUM 1.5-2.0g/kg	MEDIUM 0.5-1.0g/kg	MEDIUM 0.5-1.0g/kg

MD: match day, TD: total distance, HSR: high speed running, CHO: carbohydrate

LOW CHO INTAKE | MEDIUM CHO INTAKE | HIGH CHO INTAKE

Anderson L *et al*. Journal of Sports Science. 2022: 999-1018.

PRE-EXERCISE NUTRITION

The closer to exercise, opt for high carbohydrate, high GI* foods that are in lower saturated fat, fibre + protein as these foods take the body longer to digest!

2 - 4 HOURS
pre-exercise

Tomato pasta with chicken

1 - 2 HOURS
pre-exercise

Porridge with honey + banana

30 - 60 MINUTES
pre-exercise

Banana / white bread with jam

*GI/ Glycaemic index = a measure of how quickly a food causes our blood sugar levels to rise

DURING EVENT NUTRITION

High Gi foods first when practically possible

Gels / Carb drinks when food less practical

How much Fuel?

Duration	Carbohydrate per hour (g)
Up to an hour	Mouth rinse or nothing
1-2 hrs	30g carbohydrate
2hrs +	60g per hour
2.5hrs +	90g per hour

SUMMARY

Energy comes from the carbohydrates, fats and protein in our diet.

Sufficient carbohydrates are essential when it comes to performance.

Glycogen stores are limited (~500g) highlighting the importance of topping up stores if exercising at high intensities or for long durations (>80mins) , when the aim is to maximise performance.

Periodising carbohydrate doesn't mean no carbohydrate! The amount you need is dependent upon your individual goals and activity levels.

The closer you are to exercising, opts for foods higher in GI and lower in fibre, fat and protein to limit gastrointestinal issues.

Glycogen is king when it comes to performance!

QUIZ

1) How many calories are in a protein per gram?

2) What two parts of the body is glycogen primarily stored?

3) During high intensity activity, what is the predominate fuel source?

4) Name 3 predominately carbohydrate sources

5) Can you explain what carbohydrate periodisation means?

6) In terms of optimising performance and reducing gastrointestinal issues, should low or high GI foods be prioritised 60 minutes before high intensity exercise?

7) If exercising for over 2.5hrs, how many grams of carbohydrate does the literature recommend consuming per hour?

8) Fill in the did you knows of the quiz!

A) Protein is primarily used by the body for …… and ….. and not for movement

B) Did you know? Even at rest, approximately 60% of glucose found in the blood is metabolised by the ….. ?

REFERENCES

1. Murray B, Rosenbloom C. Fundamentals of glycogen metabolism for coaches and athletes. Nutr Rev. 2018 Apr 1;76(4):243-259.
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About the author: Michael Naylor is a leading health & performance nutritionist with over 15 years' experience in elite sport. In his role as Head of Nutrition for the English Institute of Sport he provides expertise to 25 of Team GB's Olympic and Paralympic sports.

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THANK YOU