Putting Fuel in the Athletes Tank

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Aims

- To provide an understanding of the different fuel sources used by the body, and how different lengths and intensity of training influence the bodies fuel preference.
- To understand which foods provide the bodies preferred fuel source, and recommendations around carbohydrates, protein and fluids in particular.
- To consider how these nutritional recommendations can be incorporated into a runners diet to help optimise their performance in training and events.

Content

- Energy systems
- Carbohydrates
- Protein
- Fluids
- Extra considerations around races – 5km, 10km, half and full marathons
- Workshops
- Useful resources

The eatwell plate

Use the eatwell plate to help you get the balance right. It shows how much of what you eat should come from each food group.

Department of Health in association with the Welsh Assembly Government, the Scottish Government and the Food Standards Agency in Northern Ireland

http://www.nhs.uk/change4life/pages/healthy-eating.aspx
http://www.nhs.uk/Livewell/Goodfood/Pages/Healthyeating.aspx

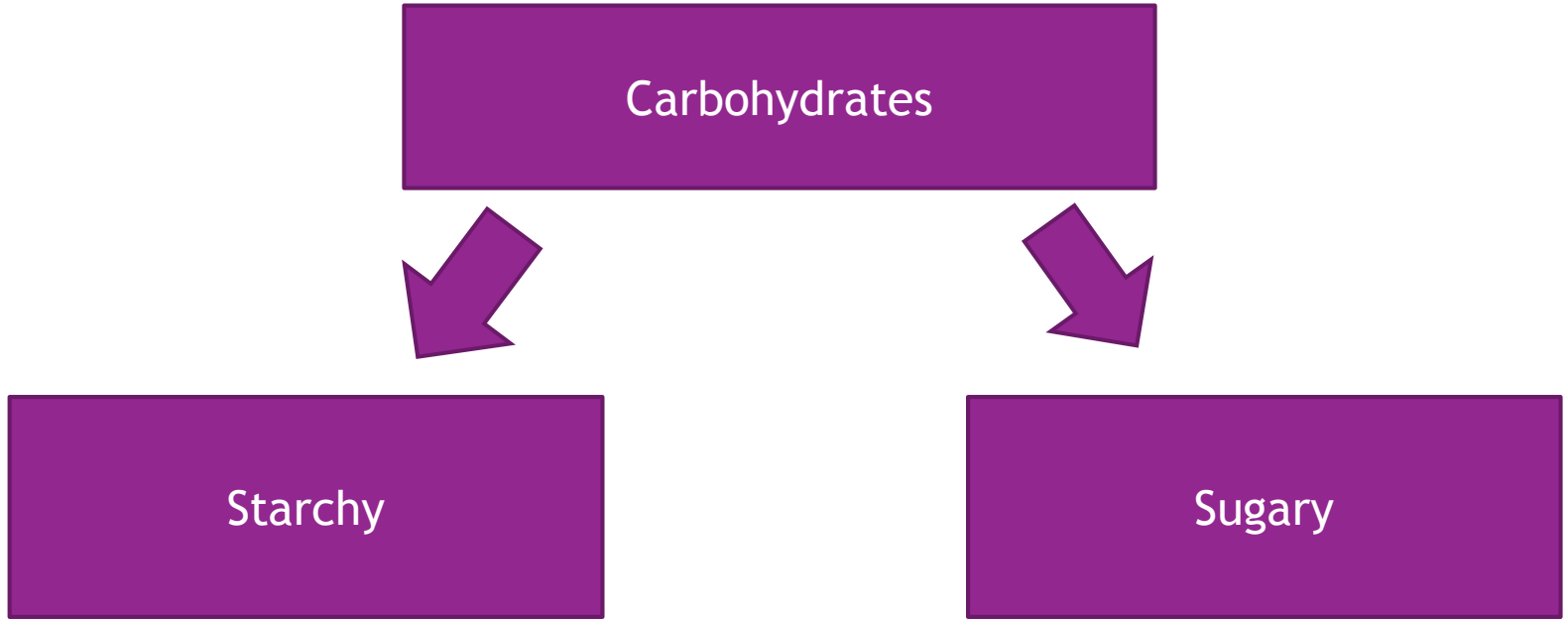
Fuel for the body

What is the bodies main source of energy?

Carbohydrates

Game time!

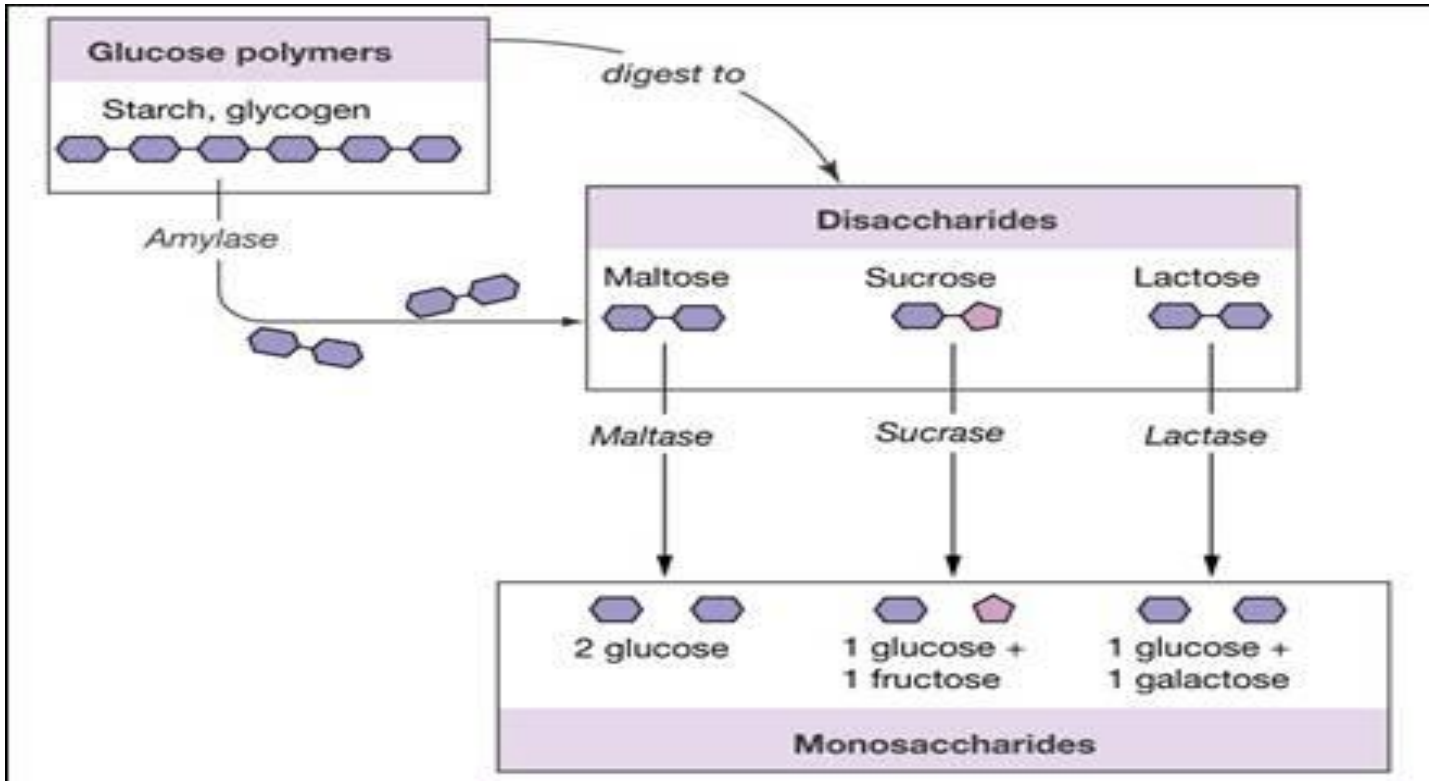
Carbohydrates

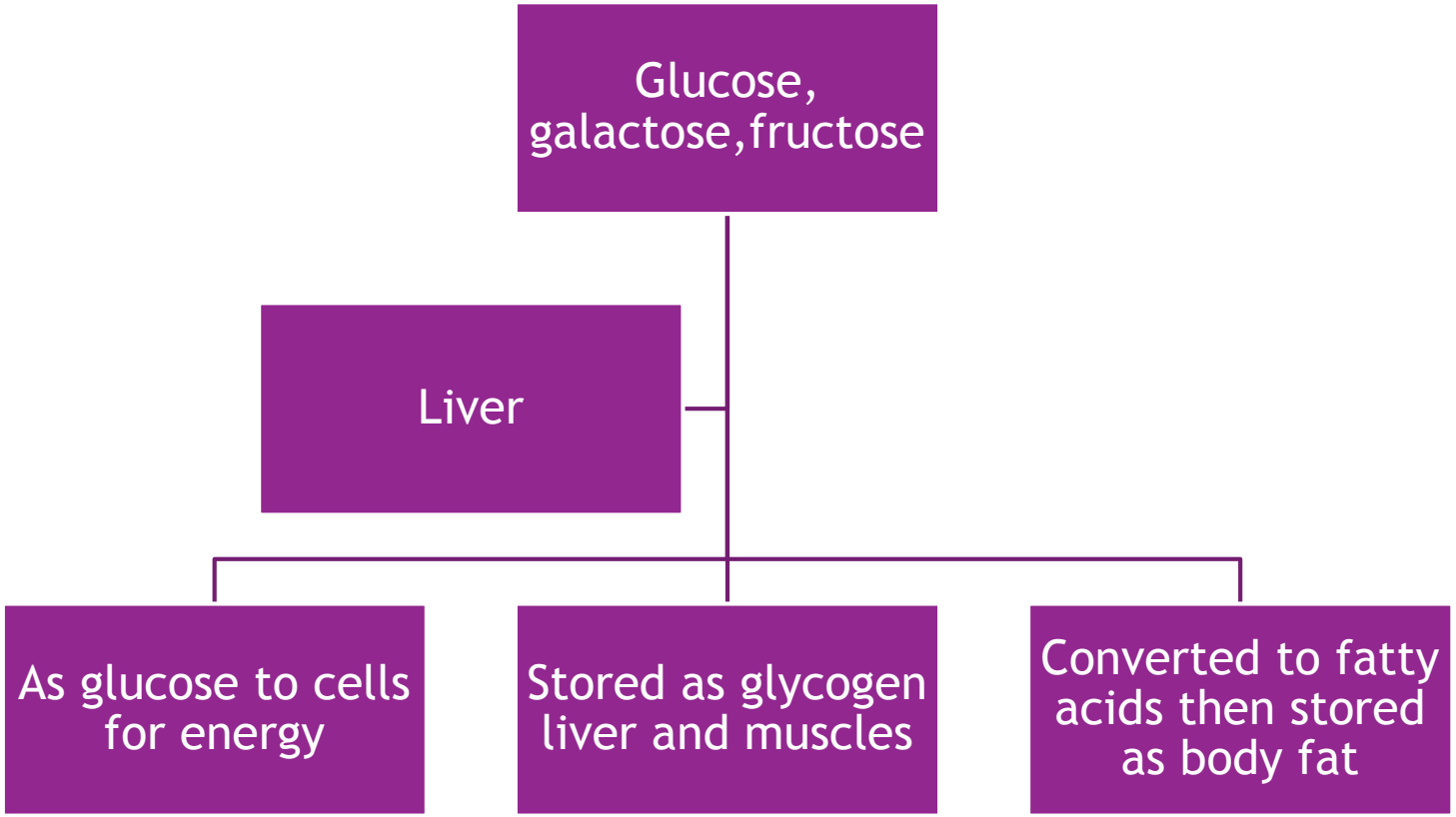


Starchy carbohydrates – main energy source

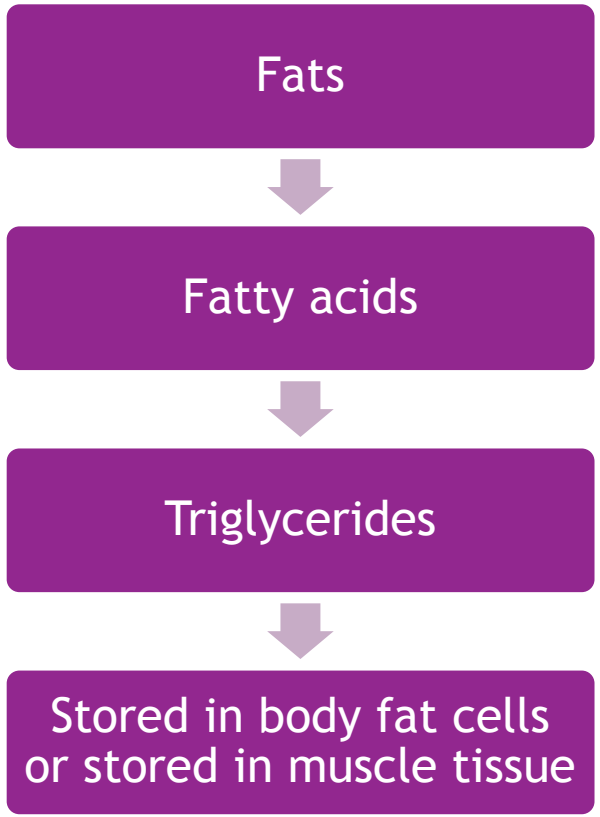
Sugary carbohydrates – natural sugars and added sugars

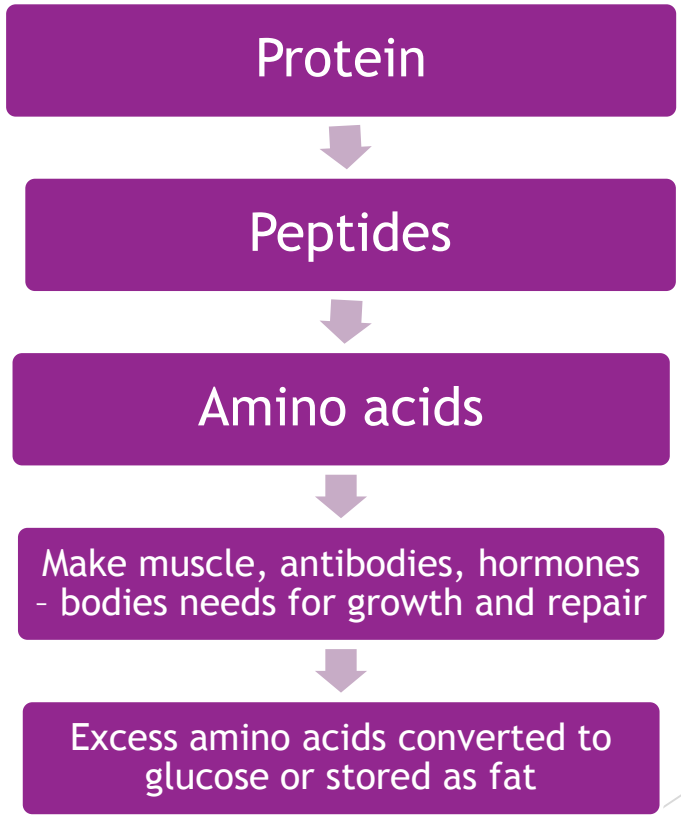
Sugars and starches are ultimately digested to monosaccharides to be absorbed into the blood




Glucose, galactose,fructose
Liver
As glucose to cells for energy
Stored as glycogen liver and muscles
Converted to fatty acids then stored as body fat

Fats and Protein





Energy Systems

- 3 main energy systems
- These work simultaneously
- These allow the body to cope with different demands on exercising muscle – different types of exercise
- All produce ATP (adenosine triphosphate)
- ATP broken down in cells to produce energy
- No ATP = no muscle contraction

Phosphocreatine System

- Produces energy quickly for short periods of time
- 20 metre sprint/lift/throw
- Anaerobic – no oxygen needed
- Creatine Phosphate in the muscle, converts ADP back to ATP
- Limiting factor - the muscles have limited stores of creatine phosphate

Glycolysis

- Meets sudden high demand for energy
- 400 or 800m sprints/weight training/all out 90 second activity
- Anaerobic – no oxygen required
- Primarily uses carbohydrate from glycogen stored in muscle (breaks it back down to glucose)

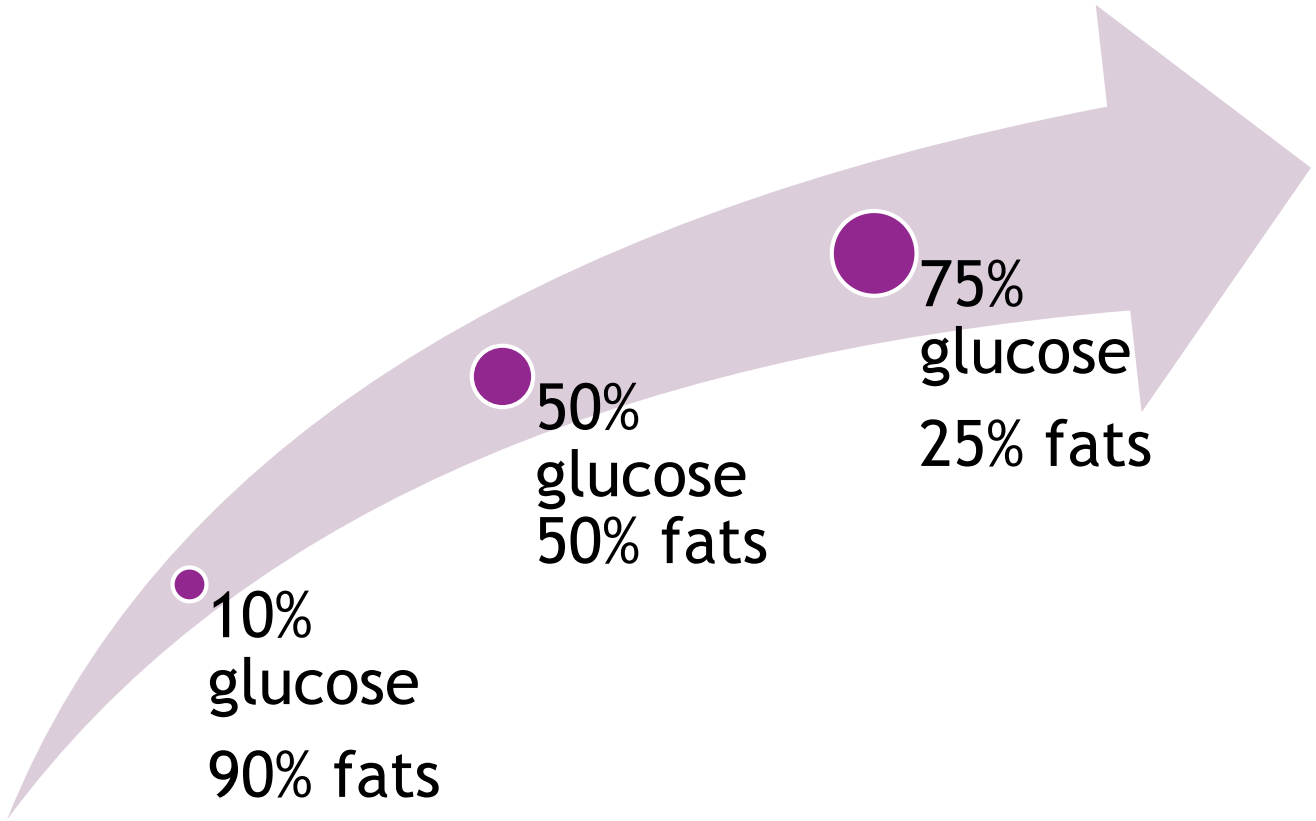
- Glucose (no oxygen) → 2ATP + Lactic acid

- The build up of lactic acid can eventually cause fatigue

Oxidative formation of energy

- Aerobic – endurance – from 5km to marathons to ultra marathons - how long you can go for depends on how fit you are
- Carbohydrate, fat and protein can be used by the body
- Can not produce ATP as rapidly as the anaerobic systems but can yield 32ATP from 1 glucose molecule
- Protein – not usually a major energy source. Used a little more by body when active for prolonged periods of time (3-5hours)
- Fat (as free fatty acids and muscle triglycerides) and glucose (from blood glucose and the breakdown of muscle glycogen) are the predominant substrates used in the aerobic formation of energy

Lower intensity exercise uses more fat
As exercise intensity increases the body uses more glucose



Oxidative formation of energy – fuel choice

- **Exercise intensity** – to maintain intense exercise for longer periods, the muscles preferred fuel is glucose/glycogen
- **Exercise duration** - Exercising aerobically for longer periods the body will gradually use more fat and less carbohydrate, to conserve stores. Stored glycogen may last a couple of hours at marathon speed
- **Your fitness** - The fitter you are the more efficiently your muscles use fat and the longer you can work out (glycogen stores can last longer)
- **Your diet** – level of carbohydrate in diet will effect muscle and liver glycogen stores – start with a half empty tank you will compromise intensity and duration compared to starting on a full tank

Running distances and different types of energy source used

- 5-10km – muscle glycogen main source of fuel by aerobic glycolysis
  - unlikely to deplete glucose stores
  - Start with full tank of fuel to maintain optimum level of intensity throughout the run
- Prolonged (around 2 hours or more)– half and full marathons – muscle and liver glycogen and fats used
  - muscle and liver stores of glucose likely low by 2 hours, potentially resulting in muscular fatigue
  - Glucose needs to be topped up to avoid fatigue
  - Without sufficient glucose, the body can not produce energy from fat metabolism as efficiently and intensity can not be maintained

Carbohydrate storage based on different diets, 70kg male subject, 20% body fat

Taken from Powers and Howley, 2007

Storage Site	Carbohydrate (CHO)		
	Mixed diet	High CHO diet	Low CHO diet
Liver glycogen	60g (240kcal)	90g (360kcal)	<30g (120kcal)
Blood and extracellular fluid glucose	10g (40kcal)	10g (40kcal)	10g (40kcal)
Muscle glycogen	350g (1400kcal)	600g (2400kcal)	300g (1200kcal)

So plenty of carbohydrates it is!!

- When these stores run low, you run low on energy and you will struggle to sustain high intensity levels of exercise
- We need the muscles and liver to be jam packed full of energy before training so you can get the best out of each session

Guide to carbohydrate requirements for different activity levels. Amounts estimated from this guide will likely need adjustment based on trial and error and individual performance.

Level of Activity	Expected carbohydrate requirements
Regular activity (3-5hrs per week) (i.e. includes up to 3 x less than 1 hour low intensity runs plus general daily activity)	4-5g/kg body weight per day
Regular activity (5-7 hours per week)	5-6g/kg body weight per day
Moderate duration/low intensity training (1-2 hrs per day) (i.e. 1-2 hrs per day (at least 6 days per week) of any higher intensity activity such as swimming, cycling, running, football etc)	5-7g/kg body weight per day
Moderate to heavy endurance training (at least 2-4hrs per day) (i.e. at least 2 hours per day of high intensity activity such as swimming, cycling, running, football etc)	7-12g/kg body weight per day

Based on information from Fuelling Fitness for Sports Performance (2004) Dr Samantha Stear in Association with the British Olympic Association.

For example – Steph

- 60kg
- 3-4 runs of 40-90min each a week, and a 45min swim session, cycles at least 15min to work and back each day
- 5-6g carbohydrate per kg = 300 - 360g carbohydrate a day

Carbohydrate content of some common foods

1 medium slice bread	15g
1 tablespoon rice	10g
1 tablespoon pasta	10g
2 shredded wheat/2 weetabix/6tblsp cornflakes/5tblsp shreddies/50g rolled oats	30g
1 medium size banana	25g
1 tablespoon raisins	20g
200ml (1/3 pint) milk	10g

Carbohydrates - Before

- Eat regularly through the day and base meals on a starchy carbohydrate
- Low glycaemic index a few hours pre training e.g. include granary bread, pasta, basmati rice, sweet potato, pulses, cereals
- Consider fibre/fat/protein content pre training – some find can cause discomfort

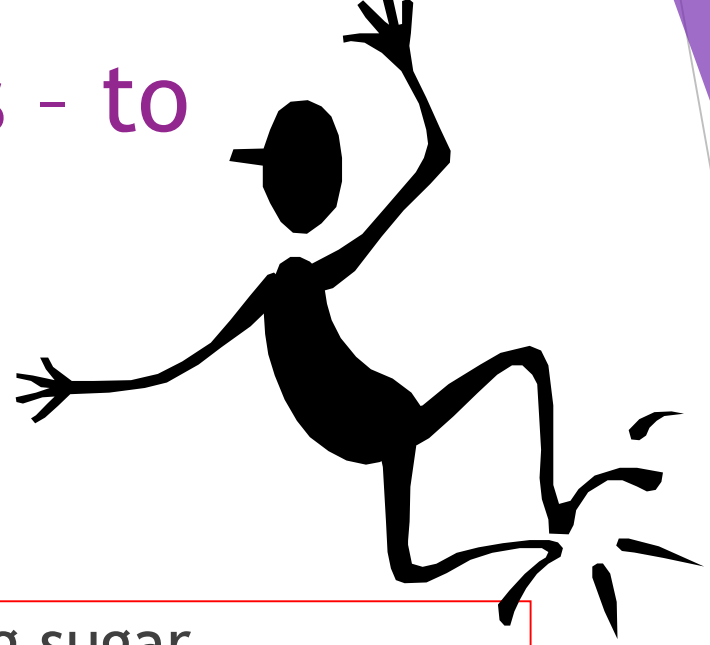
Carbohydrates - During

- General recommendation:
  - Active for <1hr – individual preference. Water adequate.
  - Active >1hr and brings about fatigue, carbohydrate can improve performance
    - Suggest 15-30g per hour under 16yrs
    - 30-60g per hour over 16yrs age
  - * Highly dependent on toleration, some people may only manage or need 15g/hour or less.

Carbohydrate During

15g Carbohydrate	30g Carbohydrate
250ml Isotonic sports drink – purchased or homemade	500ml Isotonic sports drink – purchased or homemade
2 jaffa cakes	4 jaffa cakes
Approx 5 jelly beans or 3 jelly babies	Approx 9 jelly beans or 6 jelly babies
Gels (Varies between gels) approx ½ sachet	Gels (varies between gels) approx 1 sachet
5 x Dextrose/Lucozade tablets	10 x Dextrose/Lucozade tablets

Homemade Isotonic drinks – to make 1L



- 500ml no added sugar fruit juice
- 500ml water
- pinch salt

- Dissolve salt in the water warmed up, then add the fruit juice. Cool in fridge. Throw away any unused after 24hrs

- 50-70g sugar
- 1L warm water flavoured with no added sugar squash
- Pinch salt

- Dissolve salt and sugar in the warm squash. Store in fridge. Throw away any unused after 24hrs

Carbohydrate – After training

- Highest level of muscle recovery first few hours post activity.
- Start within 30min of finishing activity (1-1.2gCHO/kg/hr first 2-4hrs)
- <8 hours between training/activity then this more crucial.
- ≥24hours between training/event, this is not as important as long as you get your daily requirement in.
- E.g. banana/malt loaf on way home and normal meal high in carb once home

High carbohydrate, low fat meal ideas

- Chicken and vegetable Fajitas (Use only a small amount of olive or rapeseed oil to stir fry, hold off on the sour cream, use salsa and a sprinkle of cheese.)
- Chilli with rice (use lean mince, or substitute Quorn or soya mince)
- Pasta with tuna and tomato based sauce
- Risotto (try pea and prawn, salmon and broccoli, mushroom or chicken and serve with salad)
- Jacket potato/potatoes and beans
- Baked fish with jacket potatoes and vegetables
- Chicken and vegetable stir fry with rice or noodles
- Fish, meat or lentil curry using a tomato based low fat sauce with rice.
- Spaghetti Bolognaise

Carbohydrates Summary

- Base meals and snacks mainly on starchy carbohydrates and spread through the day
- Low glycaemic index meal/large snack 2-4hrs pre training (tops up stores in muscles and liver)
- Carbohydrate only required during training if for longer than one hour
- Optimise recharging of muscles by having carbohydrate within 30min of finishing training

Which foods are high in protein?

Which foods are high in Protein?

Why Protein?

- Proteins broken down to amino acids to be used as building blocks for growth and repair in the body – including muscle growth

- HOWEVER REMEMBER
  - Muscle mass is determined by training, not an excess of protein intake.
  - Excess protein in the diet to your individual needs will not lead to further muscle gain but would be used for energy or converted to and stored as fat.
  - Taking an excess in protein could mean that other essential foods are pushed out of the diet, such as carbohydrates. If carbohydrate stores are inadequate to provide sufficient energy during activity, muscle protein may be used as fuel.

Protein recommendations in adults

Activity Level	Recommendation
Endurance - recreational	0.8-1.0g/kg
Endurance – Moderately trained (5 x per week training, not elite)	1.0-1.2g/kg
Endurance athlete	1.2-1.4g/kg

Can be higher with strength and power athletes/resistance training/aiming for fat loss/weight gain. Up to max 2g/kg body weight

Range of protein recommendations based on reviews (Tarnopolsky 2008, Phillips 2004, Tarnopolsky 2004, Fielding & Parkington 2002, Phillips, Moore & Tang 2007), and the joint position statement on Nutrition and Athletic Performance (ACSM 2009)

For example – Steph

- 60kg
- 3-4 runs of 40-90min each a week, and a 45min swim session, cycles at least 15min to work and back each day
- 5-6g carbohydrate per kg = 300 - 360g carbohydrate a day

- Protein 1.0g-1.2g/kg = 60- 72g protein per day

Protein content of some common foods

2 slices beef/pork/lamb	20g
1 small chicken breast	30g
Average fish fillet/100g tinned tuna	25g
300ml milk	10g
Matchbox size cheese	10g
Small pot yogurt	6g
2 medium eggs	15g
½ tin baked beans	10g
3 tablespoon cooked lentil	10g
100g Quorn product	15g

Protein recommendations under 18yrs

- Evidence/studies based on adults
- General rule 1 -1.2g/kg

- Sam at 55kg = 55-66g per day

Protein – basic guidance

- Including 2 portions of high protein food and 3 portions of dairy per day as per healthy eating guidelines will easily meet protein requirements.
- Protein at regular intervals during the day.
- Include at post exercise meal/snack ensuring adequate carbohydrate
- 15-25g protein in 1:3-4 ratio with carbohydrate
- (i.e. 15 g protein with 45-60g carbohydrate)

Example Plan
Steph 300-360g carbohydrate,60- 72g protein

- Breakfast
  - 3 weetabix and 200ml milk, handful raisins
- Snack
  - Pear

- **Lunch**
  - Cheese sandwich
  - (3 slices medium)
  - Carrot sticks
  - Pot yoghurt
  - Apple

Example Plan cont.

This is just one example and is not exhaustive. Taste preferences, training programmes and other factors need considering for an individual plan.

- Afternoon snack
  - Tuna roll and flapjack
- Session at club – water only if for up to 1 hr
- After training –
- If dinner within 1 hour then just have dinner
  - Chilli con carne with rice (4 tablespoons)
  - Side salad
  - Medium banana and custard
- Supper
  - 2 crumpets with spread

Total approx 325g carb and 70g protein

Illustrative purposes only – overall energy requirements, fats, and full dietary needs not necessarily met

In late after training? Eat a supper/snack if you can manage it and then continue to top up carbohydrates with breakfast Ideas for small post training suppers/snacks:

Supper/snack	Approx. Carbohydrate and high biological value protein
Milkshake : Shop bought flavoured 400ml plus handful of raisins Homemade- (250ml milk with milkshake powder and 25g skimmed milk powder) plus 2 x digestive biscuits	16g protein, 55g carbohydrate 18g protein, 60g carbohydrate
2x egg scrambled on 2 x bread and a drink 200ml fruit juice with 200ml water	15g protein 55g carbohydrate
Tuna sandwich and a medium banana	15g protein 55g carbohydrate
2x Weetabix with 200ml milk and a fruit yogurt	15g protein 50g carbohydrate

Fats – will make up approx. 30-35%of your energy intake

- Provide fat soluble vitamins- A,D , E,K
- Provide essential fatty acids:

- Omega – 3
  - Oily fish
  - Linseeds,pumpkin seeds
  - Walnuts
  - Oils such as rapeseed and soyabean

- Omega -6
  - Seeds such as sunflower and sesame
  - Nuts
  - Oils such as sunflower, corn, sesame, rapeseed
  - Polyunsaturated margarine

Why Fluids?

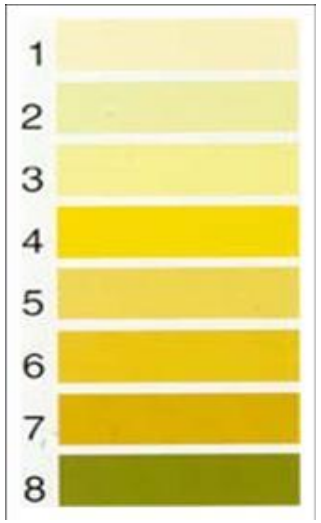
- We get fluids from food and drinks.
- An inactive person may only need 1.5 litres fluid per day from drinks. Add in some activity and sweating and the requirement for fluid can increase dramatically.
- Individual fluid needs vary from person to person, and are affected by length and intensity of training, and weather conditions

Why Fluids?

- If you feel ‘thirsty’ it is likely you are already dehydrated.
- Dehydration can have a detrimental effect on your physical and mental performance.
- Signs of dehydration during training could be nausea, light headedness and poor concentration.

How do I know if I am drinking enough?

- An easy indicator of if you are drinking enough is the colour of your urine.
- If it is dark and small in volume you are probably not drinking enough
- You are aiming for pale urine, and for there to be plenty of it when you pee.



Top 5 tips for fluids

1. Do not wait until you feel thirsty. Aim to drink fluids regularly through the day.
2. If 2-4 hours prior to training your urine is dark, ensure you drink plenty, aiming for your pre training pee to be pale and plentiful. This would mean you are starting off hydrated.
3. During the session aim to drink small volumes frequently. (Drinking too big a volume at once can cause stomach discomfort)
4. If the activity is for more than 1 hour and causes fatigue, carbohydrate as well as fluid can optimise your performance. An Isotonic drink (4-8g carbohydrate per 100ml) would be a good choice to replace fluids and carbohydrate.
5. Post activity having water and food will usually restore hydration. For rapid rehydration a sports drink (homemade or purchased) might be chosen.

Race preparation

- 5km and 10km
  - Start hydrated
  - Carbohydrate loading not needed
  - Ensure meeting carbohydrate intake in the week building up to event
  - Look to increase to 7-10g carbohydrate/kg within the 24 hours prior
  - Including pre competition meal 2-4 hours prior of 1-4g/kg body weight
- General rule, alters for individual and level of training

Race Preparation

- Half and full marathons
  - Start hydrated
  - Likely to benefit from carbohydrate loading for the 3 days prior
  - 8-10g carbohydrate/kg body weight
  - Including pre competition meal 2-4hrs prior, 1-4g carbohydrate/kg

- General rule, alters for individual and level of training

Pre competition breakfast possible requirements taken 2-4hrs pre race

If it is 4 hours before you might aim to get in nearer the top of the range by having a meal 4 hours before followed by a snack 2 hours before. If it is only 2 hours before then aim for the lower end. Some trial and error based on what the individual can manage comfortably before an event, and the time of day. (i.e. morning event, may only be able to manage 2g/kg)

Body weight of athlete	Carbohydrate based on 1-4g/kg
50kg	50-200g
60kg	60-240g
70kg	70-280g
80kg	80-320g
90kg	90-360g

High carbohydrate breakfast ideas for pre competition (carbohydrate rounded to nearest 5g)

Breakfast (approx. weights)	Approximate carbohydrate	Total carbohydrate per meal	Add a little extra?
Porridge with milk (cooked weight 220g) with a handful of raisins 200ml fruit juice Medium slice toast with margarine and thick spread jam	50g 20g 25g	95g	Honey to porridge – 15g carb
Bagel with margarine 2 x Weetabix with 200ml milk Large banana	35g 40g 30g	105g	Glass of fruit juice – 20g carb
Porridge with milk (220g), honey, raisins 2 x crumpets with jam Small bottle fruit smoothie	65g 50g 30g	145g	A fig roll – 15g carb
60g cornflakes with 200ml milk 2x toast with margarine and thick jam 30g dried apricots 250ml fruit juice Pack 4 breakfast biscuits	65g 50g 15g 25g 30g	185g	1 slice malt loaf – 20g carb

Magic Milk

- Growing evidence for milk/milkshakes as recovery drink
- Taken immediately post training to aid rehydration, provide carbohydrate, improve lean muscle and help with muscle damage
- Ideal snack if will be 1-2hrs post training before meal taken

These are only recommendations

- Do not make any big changes to diet for the first time on a race day.
- Certain foods, portion sizes or recommendations might not suit all

Activities

- 1. What does 50g of carbohydrate look like?
- 2. Advice please!
- 3. Small changes big difference
- 4. Fantastic Fluids!

Food		Change		
	Carb		Carb	Energy saving
Porridge and full fat milk	33g	Semi skimmed milk	33g	40
Slice of toast with margarine and jam	20g	Scraping of low fat margarine	20g	30
Egg mayonnaise sandwich	32g	Light mayonnaise	32g	60
Packet crisps (25g)	13g	Packet Rice cake snacks (26g) (106kcal)	20g	30
Fruit corner yogurt (150g)	20g	Light yogurt (175g)90kcal	14g	60
Mars bar	35g	Malt loaf (180kcal)	40g	50
Chicken korma and boiled rice	70g	Made using onion base, reduced amount of oil and low fat yogurt instead of cream	70g	150
Totals	223g		229g	420kcal

Packed lunch and snack ideas

- Bread/bagettes/rolls/pitta/wraps with fillings such as:
  - Ham and tomato
  - Tuna with a small amount of reduced fat mayonnaise
  - Peanut butter and banana slices
  - Peanut butter and jam
  - Chicken or turkey slices
- Cold cooked pasta, rice or couscous with sauce and beans, chicken or fish
- Include some vegetables or salad. (Healthy addition to pack up, low carbohydrate)
- Low fat yogurt or rice pudding
- Fruit e.g. banana, apple, raisins, dried apricots
- Nuts and seeds (healthy addition to pack up, but high in fats, some carbohydrate)
- Fig rolls
- Jaffa cakes
- Cereal bars /breakfast biscuits
- Fruit loaf/malt loaf/banana bread
- Scones
- Teacakes
- Semi sweet biscuits e.g digestives
- Banana and custard
- Fruit in jelly or yogurt

Action	Example - Fred 90 min training run	Daisy - 75 min training run
Pre training body weight After your last loo visit, before warm up, naked if possible, or underwear only.	90kg	66kg
Weigh drinks bottle empty and then with fluid in, or measure how much fluid is in it	500ml in drinks bottle	600ml
Post training weight. Less than ten minutes after training finishing weigh again. Naked and towel dried if possible.	89kg	65.5kg
Weigh drinks bottle/measure remaining fluid	100ml remaining in bottle (Drank 400ml)	0ml
Sweat loss (litres) = bodyweight before exercise (kg) - bodyweight after exercise (kg) + fluid consumed during exercise (litres)	Sweat loss = 90 – 89 + 0.4 = 1.4 litres	66-65.5 + 0.6 = 1.1litres
Requirement to replace lost fluid 1.2-1.5 litres per kg lost	1.68 – 2.1 L = 1680- 2100ml	1.32 - 1.65 litres = 1320-1650ml
Amount left to drink to rehydrate	1280 - 1700ml (already drank 400ml during training)	720-1050ml (drank 600ml in run)

https://www.bda.uk.com/foodfacts/sportsfoodfacts

BDA The Association of UK Dietitians

Food Fact Sheet

Sport

Nutrition plays a pivotal role in supporting the training and competition demands of athletes – recreational or elite – in any sport. Good food choices help make sure you have enough energy, which in turn helps training and aids recovery.

Five goals of sport nutrition

1. **Mix it up** – Eat a varied and well-balanced diet that supplies the right amount of energy and essential nutrients.
2. **Fuel up** – Eat plenty of carbohydrate-rich foods such as cereals, grains, bread, pasta, rice, fruit and vegetables.
3. **Strive for five** – Eat at least five portions of fruit and vegetables a day; fresh, frozen, dried, canned all count.
4. **Refuel** – Start refuelling with carbohydrate foods and fluids as soon as possible after exercise.
5. **Think fluid** – Ensure you are well-hydrated by drinking throughout the day as well as before, during and after exercise, as appropriate.

Fuel up – carbohydrates

No matter what your sport, carbohydrates are vital for the best performance. Exercising muscles rely on carbohydrate as their main source of fuel. The amount you need will depend on your training programme and dietary goals. In general, the more intense the training programme, the more carbohydrate you need to

high carbohydrate low fat snack. The most effective refuelling occurs within 0-30 minutes after exercise. More specifically, aim to consume 1g carbohydrate per kg body weight within the first two hours after exercise. If you are doing only light exercise then 50g carbohydrate should be enough. Your main meal (2-4 hrs after exercise) should also contain plenty of carbohydrate rich foods.

Foods containing 50g of carbohydrate

2 medium- large bananas	15 dried apricots
600ml isotonic sports drink	2 slices thick sliced bread
500ml fruit juice	1 large bowl (60g) breakfast cereal
2 carbohydrate gels	150-160g cooked pasta/ rice
3 (25g) cereal bars	1 large potato (250g)

Estimated carbohydrate needs for athletes based on activity level

Activity or timing	Recommended intake (per kg body weight each day)
3 - 5 hours a week	4 – 5g
5 – 7 hours a week	5 – 6g
1 – 2 hours a day	6 – 8g
2 + hours a day	8 – 10g

*Although general requirements can be provided, carbohydrate intakes should be fine tuned with individual consideration of total energy needs, specific training needs and feedback from training performance.

What about protein?

Protein is required for building and repairing muscle and plays an important role in how the body responds to exercise.

One of the biggest myths is that eating large amounts of protein equates to big biceps! Strength athletes do have higher protein requirement (1.2-1.7g per kg body weight per day) than endurance athletes (1.2-1.4g per kg body weight per day) who have slightly higher requirements than the general sedentary population (0.8-1.0g per kg bodyweight per day). However providing energy requirements are met, a healthy

Suggested practical resources to help implement change

- BDA Factsheet
- Chris Cheyette and Yello Balolia (2013) Carbs and cals . Chello Publishing Ltd.
- Dr Samantha Stear (2004) Fuelling Fitness for sports performance. Published by The Sugar Bureau. In association with The British Olympic Association.
- Anita Bean (2013) The Complete Guide to Sports Nutrition. Bloomsbury Publishing Plc, London.

- My Fitness Pal App
- Carbs and Cals App