



# Athletes Need To Know: Sports Nutrition

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# Objectives

- Discuss how macronutrients supply energy for physical activity.
- Understand how to calculate the amount of each micronutrient an athlete should consume daily.
- Able to recognize the importance of timing of macronutrients pre and post exercise.
- Receive a basic understanding of how hydration affects athletic performance and hydration recommendations.
- Knowledge of electrolytes and what is the recommendation for athletes.



# Conflict of Interest

- In compliance with continuing education requirements, all presenters must disclose any financial or other associations with companies to which they have direct link and/or financial relationship that is related to the topic/ content of their presentation.

# Ever Felt Exhausted or “Hit The Wall” in a Game?





# What Are Macronutrients?

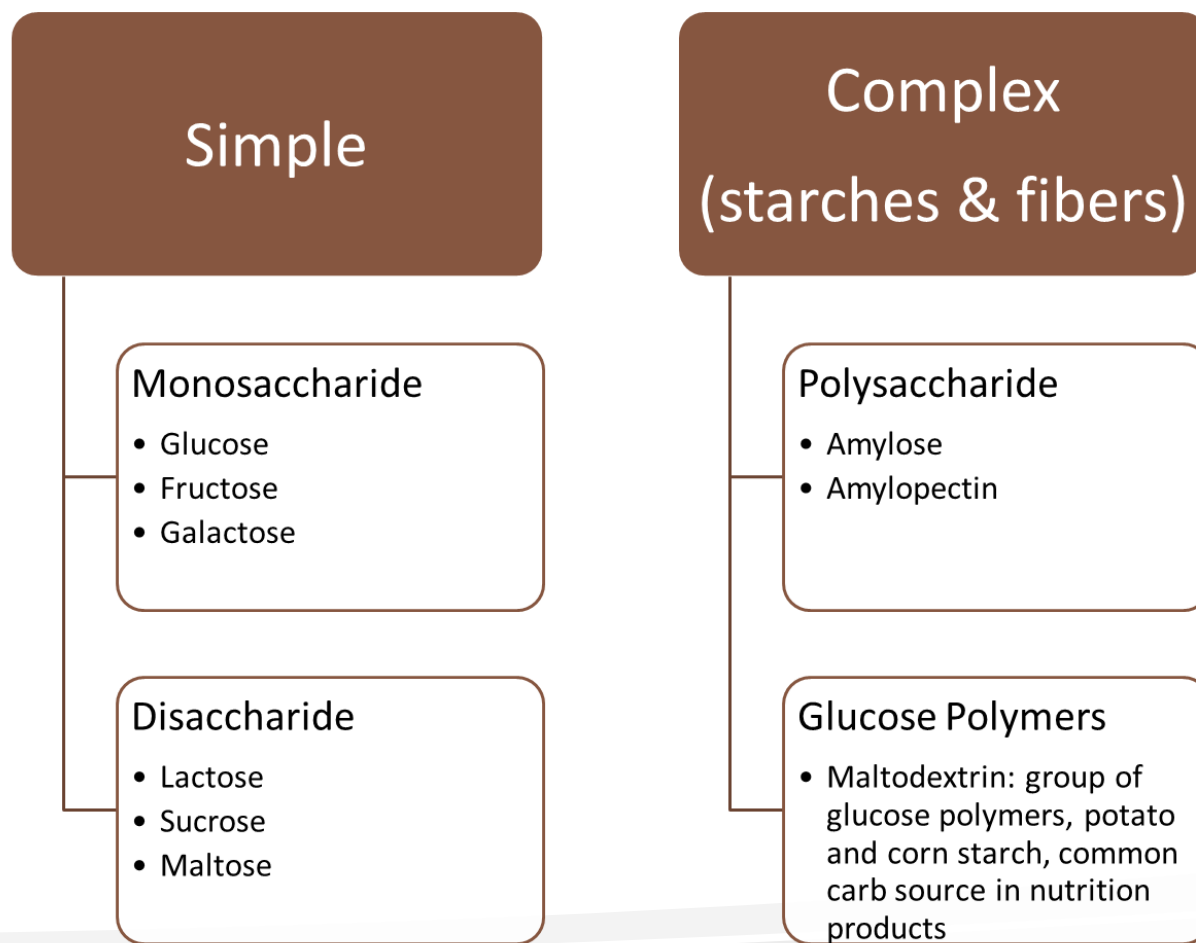
- Macronutrients are a chemical element or substance (such as potassium or protein) that is essential in relatively large amounts to the growth and health of a living organism. (Merriam-Webster, 2022)
- Macronutrients oxidized to release energy as ATP.
  - ATP provides muscle fibers energy to contract.
  - ATP can be stored in the muscle, but amount is limited.
- Nutrients for energy production:
  - glycogen: storage form of carbohydrate (liver, muscle, plasma)
  - fat (adipose tissue): stored as triglycerides in adipose and skeletal muscle



# CARBOHYDRATES



# Carbohydrates





# Rates of Digestion

## Faster (Simpler Carbs)

- Glucose
- Sucrose
- Maltose
- Maltodextrin
- Amylopectin

## Slower (Complex Carbs)

- Amylose
- Fructose
- Galactose
- Trehalose
- Isomaltulose



# Glycemic Index

- Ranks carbohydrate-rich foods by the blood glucose response that occurs after consumption.
- **Lower glycemic index** foods mean a slower release of glucose to blood.
- **Higher glycemic index** foods mean a rapid increase in blood glucose.
- High glycemic index foods include glucose, bread, potatoes, some cereals, and some sports drinks.
- Moderate glycemic index foods include sucrose, soft drinks, oats, and bananas.
- Low glycemic index foods include fructose, milk, yogurt, lentils, pasta, nuts, apples, and oranges.



# Carbohydrate Recommendations

- 1 gram of a carbohydrate= 4 calories
- Carb availability before and during exercise improve endurance performance.
- Replenishes muscle and liver glycogen.
- Provides energy for training.
- Glucose provides fuel for the brain.
- AMDR (Acceptable Macronutrient Distribution Range) 45%—65% of total calories.
- Recommendations are made for athletes based on their body weight and goals for loss, gain, or maintenance and training load.



# Carbohydrate Recommendations

Recommended daily carbohydrate intake ranges from 3–12 g/kg. Adjust with consideration for the athlete's total energy needs, specific training needs (see chart), and feedback from training performance. Carbohydrate intake should be spread over the day to promote fuel availability for key training sessions—before, during, or after exercise.

| Type of Activity                                                       | Recommended Carbohydrate Intake, g/kg |
|------------------------------------------------------------------------|---------------------------------------|
| Very-light training program<br>(low-intensity or skill-based exercise) | 3–5                                   |
| Moderate-intensity training programs, 60 min/d                         | 5–7                                   |
| Moderate- to high-intensity endurance exercise, 1–3 h/d                | 6–10                                  |
| Moderate- to high-intensity exercise, 4–5 h/d                          | 8–12                                  |



# Communicating Carb Recommendations

- Use absolute quantity (g/kg of body weight [BW]) of carbohydrate, rather than percentage of energy from carbohydrate.
- An athlete with high energy (calorie) needs can meet his or her carbohydrate needs with a lower percentage of energy from carbohydrate.
  - For example, 4,000 kcal/d providing 50% of energy from carbohydrate supplies 8 g/kg for a 70 kg athlete—which is adequate to maintain muscle glycogen stores.
- An athlete restricting energy may not provide sufficient carbohydrate to maintain optimal carbohydrate stores for training.
  - For example, 2,000 kcal/d providing 60% of energy from carbohydrate supplies 5 g/kg for a 60 kg athlete—which is inadequate to maintain optimal carbohydrate stores for heavy training.



# Carbohydrate Loading

- Increase in muscle glycogen store to improve performance in endurance events exceeding 90 minutes.
- Not necessary/effective for events under 90 minutes.
- Purpose is to delay fatigue and extend duration of exercise.
- Tips:
  - Low fiber foods (avoid whole grain)
  - Eat frequently
  - Choose liquids such as juices and sports drinks
  - Think of foods that will provide carbohydrates but prevent feeling of fullness
  - Temporary weight gain due to carbs stored in muscle.



# Carbohydrate Loading Guidelines

| Day | Training    | Carbohydrate                                                                                            |
|-----|-------------|---------------------------------------------------------------------------------------------------------|
| 1   | Rest        | 10–12 g/kg/d                                                                                            |
| 2   | Rest        | 10–12 g/kg/d                                                                                            |
| 3   | Competition | Follow carbohydrate guidelines for intake before competition, during competition, and after competition |



# Training with Low Carbohydrate Availability

- Also known as “training low”.
- High carbohydrate diet recommended during heavy training and competition preparation.
- No definitive research on optimal method including whether carbohydrate should be withheld before, during, or after training sessions.
- Suggestions to offset limitations of training low include the following:
  - Undertake training low when sessions are not dedicated to heavy training loads.
  - Consume caffeine before exercise or use a carbohydrate mouth rinse during exercise.
  - Consume 20 to 25 g of protein before, during, or immediately after exercise.
  - Combine with sessions of “training high” (after eating a glycogen-loaded, pre-exercise meal or having carbohydrate feedings during exercise).



# Pre-Exercise Meal Recommendations

Consider both the amount and timing of carbohydrate intake. See the chart for general recommendations.

If you are unable to eat breakfast before early morning exercise, consuming ~30 g of easily digested carbohydrate 5 minutes before exercise may improve performance.

Low glycemic index foods may be beneficial when carbohydrate cannot be consumed during exercise.

| <b>Timing Before Exercise</b> | <b>Carbohydrate</b> |
|-------------------------------|---------------------|
| 1 hour                        | 1 g/kg              |
| 2 hour                        | 2 g/kg              |
| 3 hour                        | 3 g/kg              |
| 4 hour                        | 4 g/kg              |



# Pre-Exercise Meal: <1 Hour Prior

- Example: 1 g/kg: 150lb (68kg) athlete = 68g of carbs
  - 4 oz bagel = ~62g carbohydrates
- Create an individual plan based on performance and tolerance.
- Intake during this window begins to meet the “during” exercise needs of the athlete.
- Consuming CHO during this time period is particularly important if the athlete cannot or will not consume fuel during their training or competition.
- Many athletes do well with 25-30 g of CHO during this time period which is an appropriate amount when considering during exercise recommendations.
- Research shows even if “rebound hypoglycemia” occurs, it does not impact performance.



# Carbohydrates After Exercise

- Carbohydrate intake post exercise enhances muscle glycogen synthesis.
  - Greater blood flow to muscle cells:
    - take up glucose faster and enhances glycogen synthase
- 1-1.2 g of CHO/kg per hour (0.45-0.55 g/lb/hour) every hour for 4-6 hours post exercise.
  - Resume to regular diet after
- 4:1 ratio of carbohydrates to protein
  - Chocolate milk



# Recommended Carbohydrate Intake After Glycogen Depleting Exercise

- When exercise sessions are less than 8 hours apart, start consuming carbohydrate immediately after exercise to maximize recovery time.
- Consume 1–1.2 g of carbohydrate per kilogram per hour for the first 4 hours after glycogen-depleting exercise.
- Early refueling may be enhanced by consuming small amounts of carbohydrate more frequently (every 15–30 minutes) for up to 4 hours postexercise.
- Medium- to high-glycemic index foods may help to maximize glycogen storage for athletes who have limited time to recover between workouts.
- Add a small amount of protein (20 g) to the first feeding to stimulate muscle protein synthesis and repair.



PROTEIN



# PROTEIN

- 1 gram of protein= 4 calories
- Protein is synthesized from amino acids.
- Immune function, hormones, enzymes, cell signaling, structure, and movement.
- >40% of body mass is skeletal muscle.
- Consuming protein regularly is important to ensure there are adequate amino acids to replenish pools.
- Urea is the principal vehicle for excreting unused nitrogen.
- Acceptable Macronutrient Distribution Ranges (AMDR) is 10-35% of total calories come from protein
- RDA is 0.8g/kg/day for adults



# PROTEIN QUANTITY: RESISTANCE EXERCISE

- 0.25 g protein per kilogram of BW in a meal
- Total recommended daily protein intake:
  - distributed throughout the day
  - 1.6–1.7 g/kg/d
- Protein synthesis and breakdown are increased after exercise
- Belief that larger dietary protein intake per meal/throughout the day, the larger the increases in lean mass.
  - Study found that there was no further benefit by consuming 40g of egg protein compared to 20g
- 20g of high quality protein, 5-6 times per day



# PROTEIN QUANTITY: ENDURANCE EXERCISE

- Adequate protein intake still necessary to prevent MPB
- Overall quantity depends on training status, intensity and duration.
- Ingestion of protein with carbohydrate during endurance exercise:
  - may not be beneficial when adequate carbohydrates are consumed
  - can be beneficial during multiday, ultra endurance exercise
  - Maintain nitrogen balance throughout race
- After endurance exercise recommendation:
  - Protein synthesis and breakdown are increased after exercise
  - ~0.25-0.4 g protein per kilogram per meal: (20 g for 80-kg athlete)



| Type of Training | Protein Recommendation, g/kg/d | Example of Total Daily Protein Intake         |
|------------------|--------------------------------|-----------------------------------------------|
| Endurance        | 1.2–1.4                        | 84–98 g for 70-kg (154-lb) endurance athlete  |
| Resistance       | 1.6–1.7                        | 146–155 g for 91-kg (200-lb) strength athlete |

Emphasis should be placed on timing and distribution of dietary protein ingestion over the course of the day (eg, approximately 0.25 g protein per kilogram per meal × 4–5 meals per day) to optimize the skeletal muscle adaptive response in an athlete.



# Recommended Amounts of Protein





## Those at Risk For Inadequate Protein Intake

- Low protein intake can exist with inadequate energy intake.
- Protein deficiency can lead to muscle loss and decrease performance.
- Female runners, male wrestlers, boxers, and other athletes in weight-category sports; ski jumpers; male and female gymnasts; and female dancers can have protein intakes well below the recommended dietary allowance (RDA).
- Vegetarian athletes may also be at risk because plant food sources typically contain lower-quality proteins, which often contain low levels of one or more essential amino acids; also the digestibility of plant protein can be low.



# Maximizing Muscle Hypertrophy

- Consider the postexercise period as a time for rehydration, refuelling (to restore glycogen), repair (of damaged muscle fibers), and remodelling (adaptation to the training stimulus).
- Timing of protein intake is an important variable to consider in optimizing skeletal muscle recovery and hypertrophy.
- It appears optimal to ingest protein in the postexercise period in sufficient doses ( $\sim 0.4$  g/kg b.w./meal) and up to three other meals distributed throughout the day with the aim of achieving a total dietary protein intake of 1.4 to 1.6 g/kg b.w.
- Ingesting a larger dose of protein ( $\sim 0.6$  g/kg b.w./meal) before bedtime appears to augment both acute overnight muscle protein synthesis and muscle adaptations.



# Protein After Exercise

Adding protein in recovery feeding:

- enhances glycogen storage
- stimulates muscle protein synthesis
- inhibits protein breakdown
- enhances net muscle protein accretion

Protein recommendation is  $\sim 0.4$  g/kg or 20-30 g

- 150 lb (68kg) = 20g
- 200 lb (91kg) = 27g

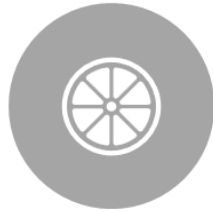




# FUNCTION



FUEL FOR  
CONTRACTING  
MUSCLES



ABSORPTION OF  
FAT-SOLUBLE  
VITAMINS



INSULATION OF  
VITAL ORGANS



CELL MEMBRANE  
STRUCTURE



9 CAL/GRAM



# Fatty Acids – Foods Have Mixture of Saturated and Unsaturated

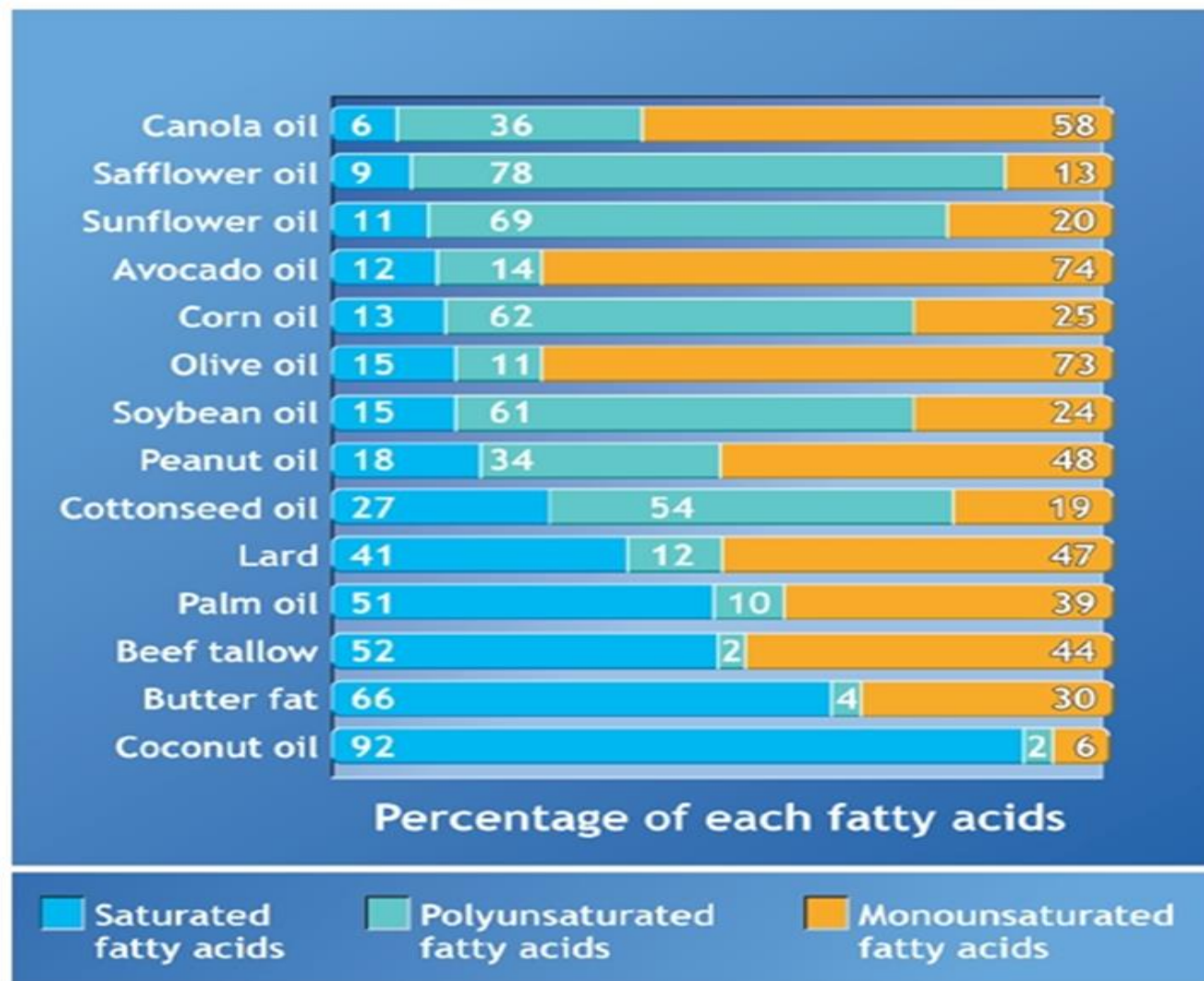
- Saturated fatty acids
  - When the carbon binds to the maximum number of hydrogens (only single covalent bonds between carbon atoms)
  - Occur primarily in animal products
    - Beef, lamb, pork, egg yolk
  - Also occur in plants
    - Coconut oil, palm oil, vegetable shortening



# Fatty Acids

- Unsaturated fatty acids
  - Monounsaturated contains one double bond along carbon main chain
    - Examples include olive oil, canola oil, peanut oil, almond oil
  - Polyunsaturated contain two or more double bonds along main carbon chain
    - Some PUFA's, like alpha-linolenic and linoleic acid, cannot be made by the body but are needed = essential fatty acid

# Composition of Fatty Acids





# DIETARY FAT INTAKE PATTERNS

- AMDR range: 20%–35% of total energy
- Consumption recommendation for endurance athletes  $\leq 1$  g/kg/d of fat
- Athletes may restrict fat intake to lose body weight or improve physique
- Fat restriction may limit intake of key nutrients
- Exact fat recommendation should take body weight goals, chronic disease risk, and specific event into consideration.



# PUBLIC HEALTH RECOMMENDATIONS

## TOTAL FAT INTAKE

- 20%–35% of total energy from fat:
  - meets needs for essential fatty acids
  - decreases coronary heart disease risk

## LIPID COMPOSITION OF DIET

- Limit saturated fat to <10% of total calories
- Emphasis on consuming MUFAs and PUFAs
  - reduce inflammation and maintain vascular function
- Limit *trans* fats to <1% of total calories
- 5-10% of calories from “good” fats



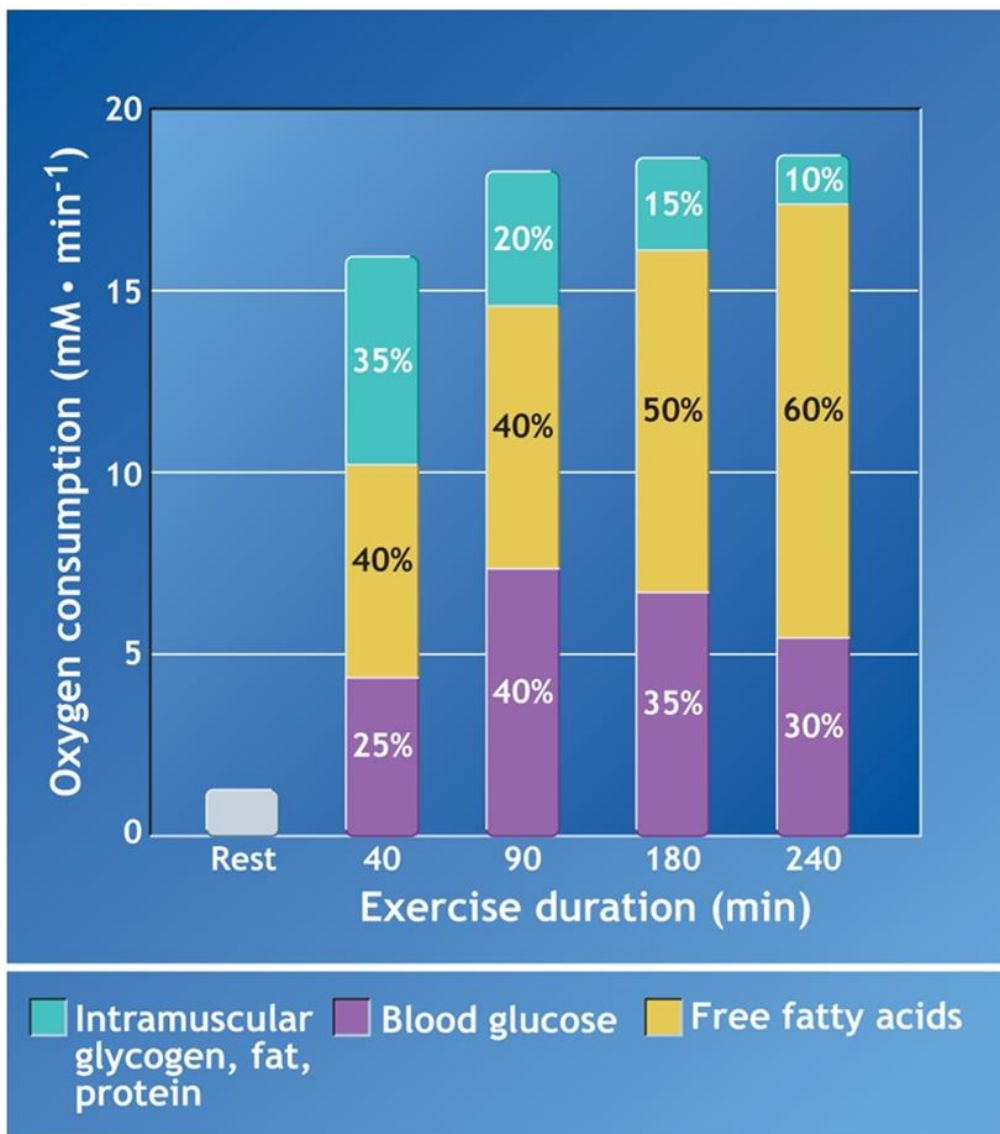
# FACTORS AFFECTING FAT METABOLISM IN EXERCISE

- Most of lipid contribution to energy based on:
  - exercise intensity
  - duration
  - training
- Fat oxidation depends on:
  - Gender (women have a greater FO rate)
  - dietary intake before and during exercise
  - exercise method



# Fat Dynamics in Exercise

- Fat provides 30-80% of energy for physical activity, depending on nutritional status, fitness, exercise intensity, and duration
- Light to moderate exercise
  - ~3x fat use as rest
- Moderate intensity exercise
  - Energy comes from equal amounts of carbohydrate and fat supply
  - When exercise is prolonged more than an hour, fat metabolism becomes more predominant
    - Depletion of glycogen
- High intensity exercise
  - Carbohydrates, primarily muscle glycogen is the source of energy
  - Fat needs more  $O_2$  to release energy, and takes longer





## Review of How to Calculate Your Energy Needs

- Player A is a football player having 4-hour practices: 175lb (79.5KG)
- Carbs:  $12 \times 79.5\text{kg} = 954\text{g}$
- Protein:  $1.7 \times 79.5\text{kg} = 135.15\text{g}$
- Fat: Part 1-  $(954 + 135.15) \times 4 = 4,356.6 \times .20 = 871.3$  Calories
  - Part 2-  $871.3 \div 9 = 96.8\text{g}$

Total Calories Per Day:  $(954 + 135.15 \times 4) + 871 = 5,227 \text{ cal}$



# Hydration & Electrolytes



# Water Basics

- 45%-75% of body weight is water
- Fluid constantly lost from body by
  - Kidneys (urine)
  - Gastrointestinal tract (feces)
  - Respiratory tract
  - Skin
- Recommendations
  - Approx 1liter/day for sedentary adult
  - Approx 3-4 L/d for minimally active adults
  - Approx 7-8 L/d for athletes who train >2 h/d
- Vigorous exercise = 1-2 L sweat lost per hour



# Control of Fluid Balance

- Daily intake of fluid should match or exceed the volume of fluid lost
- Cells tightly regulated movement of electrolytes across the membrane
  - Sodium, chloride, potassium, calcium, magnesium
  - Kidneys aid in maintenance of electrolyte balance
- During physical activity
  - Thirst is an imprecise gauge of immediate fluid needs
  - Difficult to offset the large volume of sweat lost
- Sodium and fluid balance:
  - Maintain proper fluid and electrolyte balance
  - Stimulates thirst
  - Supports cardiovascular function
  - Promotes whole body rehydration by stimulating renal fluid retention

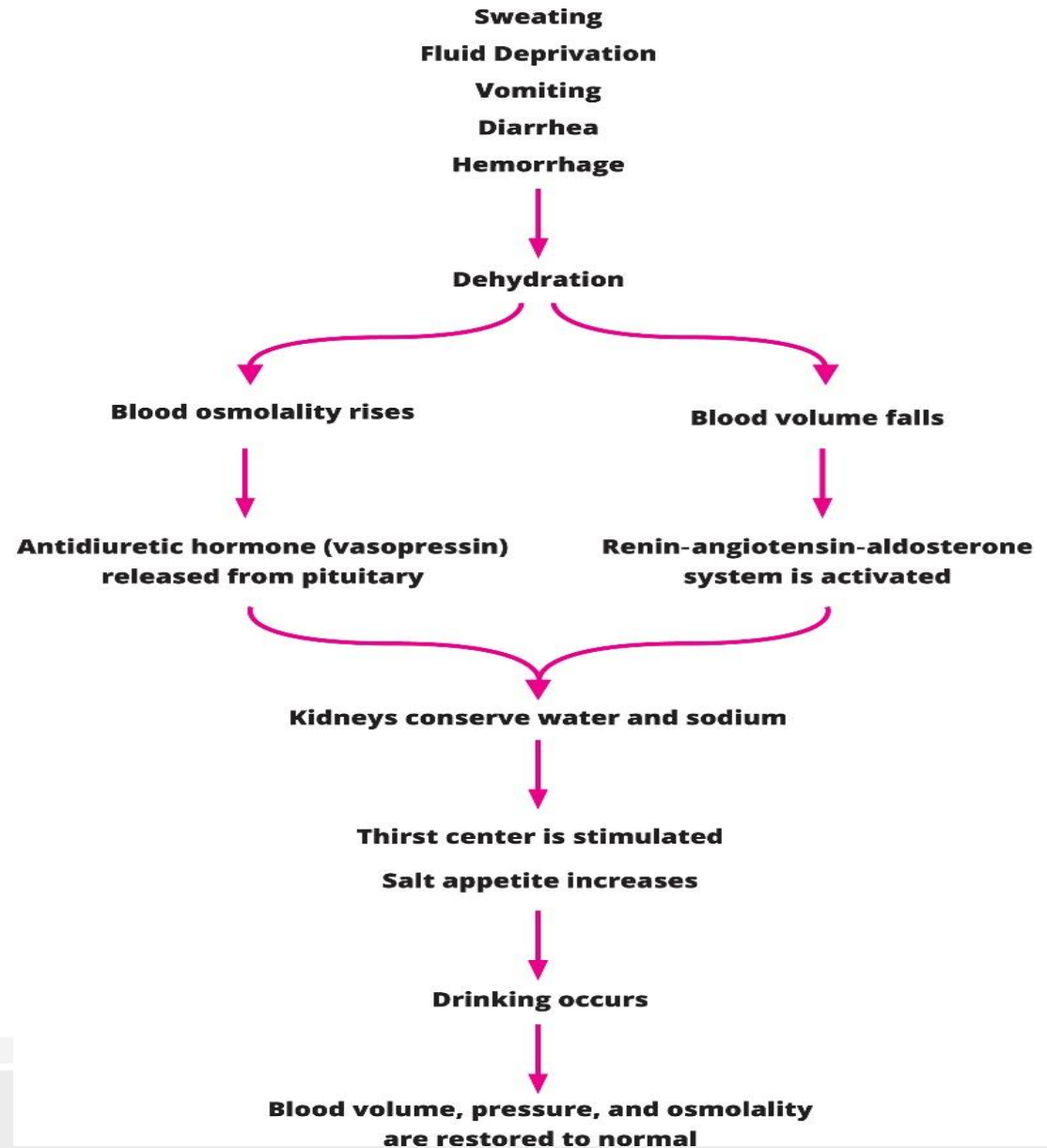


# What Determines Daily Fluid Loss?

- Environmental conditions
- Size of the person
- Metabolic rate
- Physical activity
- Sweat loss
- Diet composition
- Volume of excreted fluids



# Dehydration & Thirst





# Why is thirst an unreliable regulator of fluid needs during exercise?

- Distractions during physical activity
- Fluid may not be readily available
- Physiology of the thirst mechanism:
  - Thirst is not stimulated until until approx 1 liter of fluid is lost
  - Rationale that by the time thirst is perceived, dehydration has already occurred.
- However, drink to thirst may be sufficient when:
  - Exercise under 90 minutes
  - Cooler temperatures
  - Lower intensity



# Fluid requirements for athletes

- Dependent on body size, body composition, activity and environment
- AI (adequate intake) from all sources including food:
  - 16 cups for males
  - 12 cups for females
- Ensuring adequate hydration before exercise
- Ensuring hydration during exercise
  - During exercise 1 cup every 15 minutes
  - Personalize depending on sweat rate
- Composition of sport drinks during exercise
  - 6% CHO solution



# Sodium

- Better maintenance of blood sodium concentration
- Better maintenance of plasma volume
- Critical to include in rehydration – helps with fluid distribution and fluid retention
- Sodium intake usually exceeds needs for average person
  - Sodium recommendation is 2,300mg per day, average intake is 3,200mg (for average US adult)
  - 1,500mg per day rec for those with high blood pressure or at risk for cardiovascular disease



# Potassium

- Potassium is lost in sweat, but the concentration of potassium is much less compared to sodium
- Small fraction of total body potassium
- Potassium is primarily intracellular, includes water inside the muscle and brain cells.
- Potassium recs are 3,500mg -4,700mg per day
  - Potassium is now on the nutrition facts label



# Assessment

- Assess weight change
- Assess urine color and volume
- Whole Body Wash Down technique
- Patch Testing to assess sweat composition
  - <https://www.levelen.com/>
  - Gatorade recently came out with a [sweat patch](#) that links to an app

# Assessment:

## Urine Color & USG

- Use a urine color scale from 1 (very pale) to 8 (very dark)
- Urine color of 5 or greater is indicative of hypohydration
- A urine color of 3 or 4 provides reasonable assurance the athlete is hydrated
- Urine color can be monitored by the athlete or ATC
- Provide urine charts in the bathroom as a visual
- USG is a urine concentration test
- USG test of  $\geq 1.020$ -1.025 indicative of hypohydration
- Use more than one method to assess hydration status (body weight, urine, color or USG)



|   |  |                                                                                 |
|---|--|---------------------------------------------------------------------------------|
| 1 |  |                                                                                 |
| 2 |  | If your urine matches the colors 1, 2, or 3, you are properly hydrated.         |
| 3 |  | Continue to consume fluids at the recommended amounts.                          |
|   |  |                                                                                 |
| 4 |  | If your urine color is below the <b>RED</b> line, you are                       |
| 5 |  | <b>DEHYDRATED</b> and at risk for cramping and/or a heat illness!!              |
| 6 |  | <b><u>YOU NEED TO DRINK MORE WATER!</u></b>                                     |
| 7 |  | <u>If you are taking a multi vitamin your urine color is subject to change.</u> |
| 8 |  |                                                                                 |



# What influences sweat rate?

- Temperature
- Environment & equipment (goalies, hockey, football)
- Humidity
- Training status & intensity

# High rates of sweat secretion

- Necessary during hard exercise
- Limit the rise in body temperature
- If the exercise is prolonged,
  - body-temperature increase leads to progressive dehydration and loss of electrolytes.
  - Some people may lose up to 2 to 3 L/h of sweat during strenuous activity in a hot environment.
  - Even at low ambient temperatures of about 10 °C (50 °F), sweat loss can exceed 1 L/h.
- **“During” Hydration Recommendation: 20-24 oz/lb lost**
  - Average sweat rate is 1 liter per hour





# Effects of Fluid Intake on Exercise Performance

- Pre-exercise hyperhydration: rapid influx of water prior to exercise
- Fluid intake during exercise
  - Oral fluid ingestion during exercise helps restore plasma volume to near pre-exercise levels prevents the adverse effects of dehydration on muscle strength, endurance, and coordination.
  - Helps with absorption of sport foods, reducing GI distress
- Dehydration also poses a serious health risk because it increases the risk of cramps, heat exhaustion, and life-threatening heatstroke.
- Proper hydration
  - Maintains cardiovascular, thermoregulatory function
  - Improves performance during physical activity



# Sodium Replacement During Exercise

- Sodium is extracellular, which is the fluid in the space between cells and plasma (water portion of the blood)
- Sodium chloride added to a beverage:
  - improves palatability
  - helps maintain osmotic drive to drink
  - reduces amount of sodium to supply to intestine
  - maintains plasma volume
  - restores extracellular fluid volume after exercise
  - Decrease urine volume



# Exercise Associated Cramping

- Cause and treatment of exercise-associated muscle cramps is not well understood
- Some cramps may be associated with water and electrolyte imbalances, but not all.
- When water and salt losses are high, drinks containing electrolytes, especially sodium, should be used rather than plain water
- Sodium rich products:
  - Right Stuff
  - Pickle Juice



# Fluid & Electrolyte Replacement

- Record body weight before exercise
  - Record beverage intake during
  - Record body weight post exercise
- Drink at 10–30 minute intervals
- Weight loss may signal inadequate drinking
  - 2% or greater weight loss may impair performance
- Weight gain indicates excessive drinking
- Recommend 0.4–0.8 L/h or about 400–800 mL (12–26 oz)



# Fluid & Electrolyte Replacement

- Plain water less effective
- Sodium
  - Maintains osmotic drive to drink
  - Decreases urine production
- Ingestion of 125%-150% of weight loss required to achieve normal hydration within 6 hours after exercise.
- 20-24 oz per lb body weight lost
- 2% decrease in weight
  - <https://www.gssiweb.org/toolbox/fluidLoss/calculator>

# Sports Drinks

- Sports drinks provide 6% carbohydrate solution
  - Research found that an 8% carbohydrate solution did not empty the stomach as quickly and caused gastrointestinal distress.
  - Equation: grams of carbohydrates/mL
- Appropriate for exercise >60–90 minutes
- Sports drink advantages:
  - improves palatability
  - source of fuel for active muscles
  - stimulates fluid absorption from intestine
- Coconut Water
  - Carbohydrate content ~4%
  - Better hydration than plain water
  - provides high amounts of potassium
  - contains sodium and other minerals



# Hydrating and Rehydrating with Foods

- Sodium loss can be replaced with salty foods
- Soup, pretzels, crackers, breads, pickle juice, beef jerky,
- The Right Stuff, Nuun, Drip Drop, Skratch, Gatorlytes
- Hydrating foods- especially fruit and veggies!





| Position Stand                                                                          | Before Exercise                                                                                                      | During Exercise                                                                | After Exercise                                                                                                                | Electrolyte Replacement                                                                 |
|-----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| American College of Sports Medicine Position Stand: Exercise and fluid Replacement 2007 | Drink 5-7 mL per kg body weight at least 4 h prior to exercise. If needed, drink 3-5 mL per kg body weight 2 h prior | Follow a customized fluid replacement program to prevent excessive dehydration | Fully replace fluid and electrolyte deficits. For rapid rehydration , drink 1.5 L fluid (w/ electrolytes ) per kg weight loss | Consuming snacks and beverages with sodium will help stimulate thirst and retain fluids |
|                                                                                         |                                                                                                                      |                                                                                |                                                                                                                               |                                                                                         |



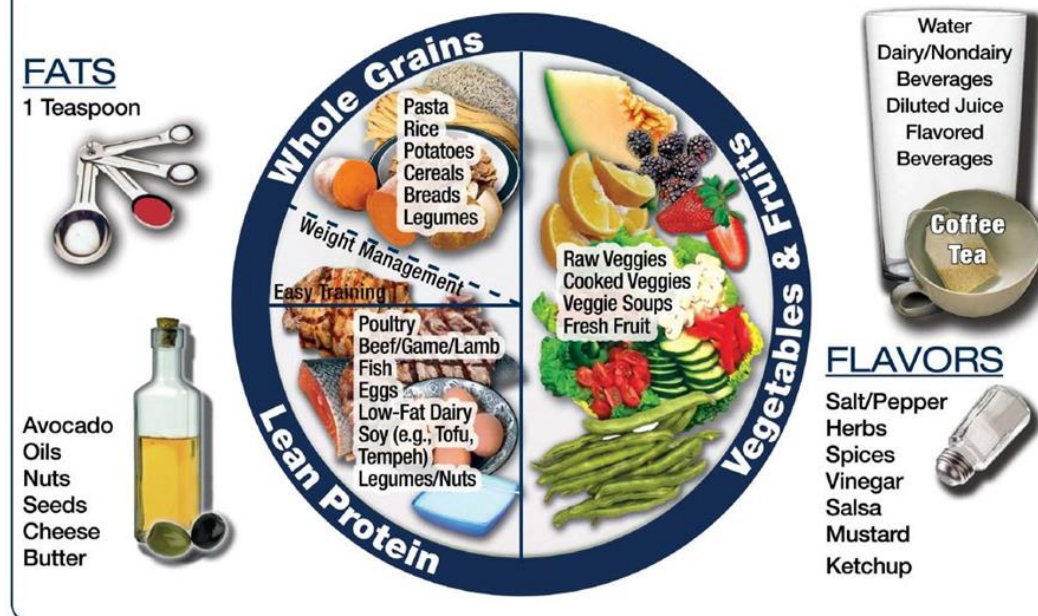
# Hydration Recommendation Summary

- Before: 5-7 mL/kg of fluids with sodium approx. 4 hours prior,
  - If athlete shows signs of dehydration (lack of urine output or dark urine color) an additional 3-5 mL/kg approx. 2 hours prior
- During: Amount of fluid based on sweat rate
- After: 20-24 oz/lb lost

# Athletic Plate: Easy Training or Off Day

## ATHLETE'S PLATE

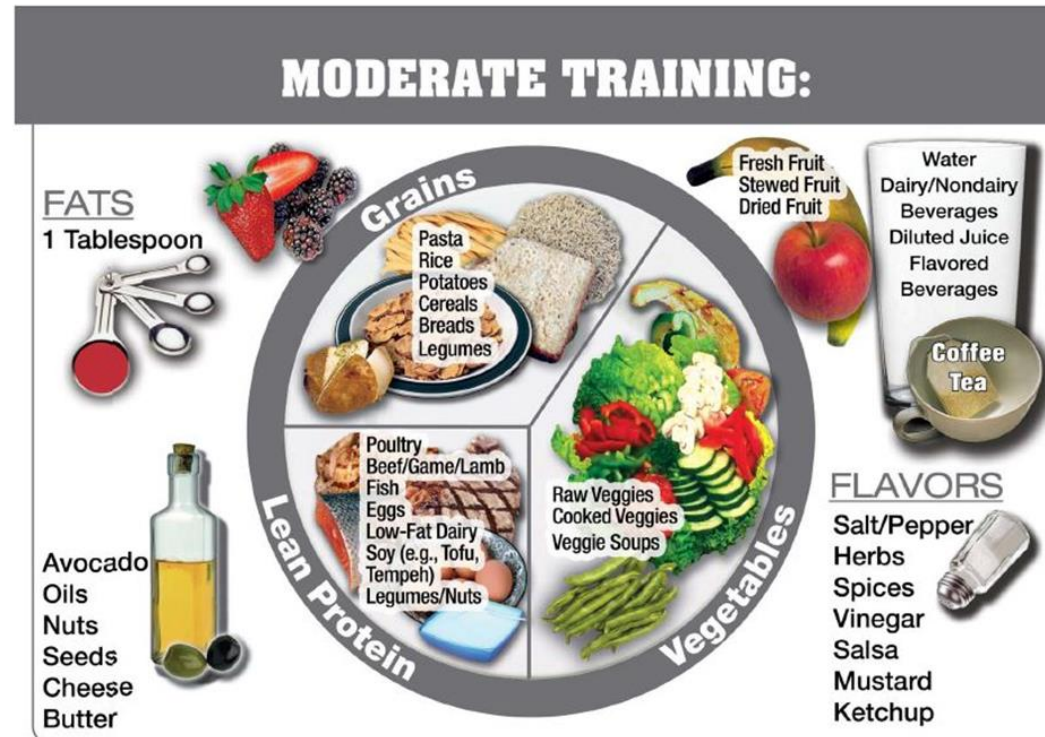
### EASY TRAINING / WEIGHT MANAGEMENT:



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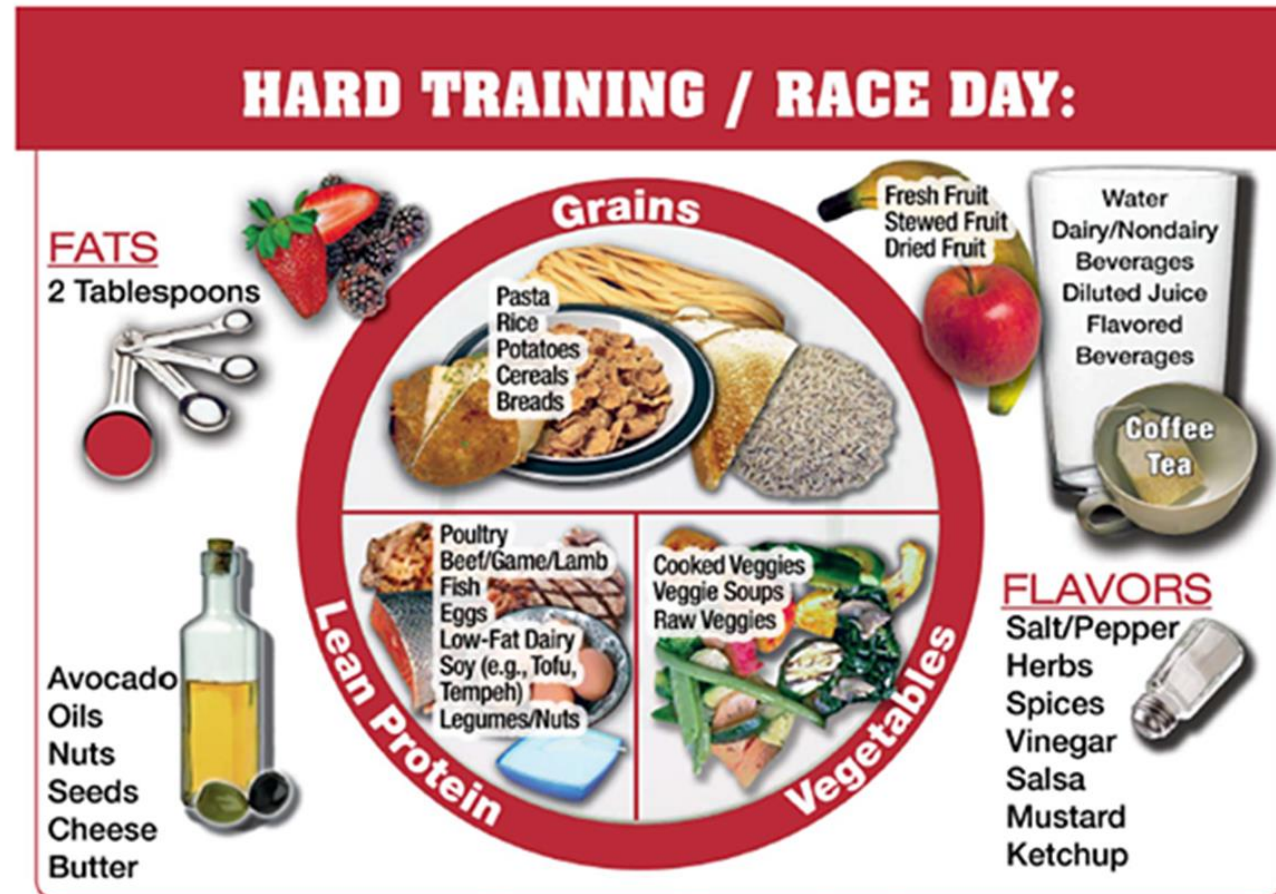
# Moderate Training

## ATHLETE'S PLATE



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# Competition or Hard Training



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# CITATIONS

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QUESTIONS?