**Nutrition in Athletes:**
**Carbohydrates, Fats, Proteins, Calories**

**Background**
1. Nutrition is very important for sports performance
   - Often neglected
   - Improves recovery
   - Enhances performance
   - May allow athletes to reach goals more quickly
2. Improper nutrition will prevent athlete from achieving optimal performance
3. During sports and training important to achieve and maintain ideal body weight
   - Provide proper amounts of protein, carbohydrates, fats for optimal performance
   - Promote proper recovery following events and training
4. During physical activity, major source of fuel is muscle glycogen
   - Muscle glycogen and glucose used preferentially during short, intense activity
   - Exercise >2 minutes
     - Glycogen from muscle and liver
     - Fat from adipose, muscle, blood
     - Amino acids

**Caloric Requirements**
1. Institute of Medicine Food and Nutrition Board has issued caloric guidelines as follows:
   - Female athlete >30 years old:
     - Total energy expenditure = $354 - 6.91 \times \text{age (yr)} + \text{PA} \times (9.36 \times \text{weight (kg)} + 726 \times \text{height (m)})$
     - \text{PA (physical activity)} = 1.45
     - \text{kg} = \text{weight (lb)} \div 2.2
     - \text{m} = \text{height (in)} \times 2.54 \div 100
   - Male athlete >30 yo:
     - Total energy expenditure = $662 - 9.53 \times \text{age (yr)} + \text{PA} \times (15.91 \times \text{weight (kg)} + 539.6 \times \text{height (m)})$
     - \text{PA (physical activity)} = 1.48
     - \text{kg} = \text{weight (lb)} \div 2.2
     - \text{m} = \text{height (in)} \times 2.54 \div 100
   - Adjust for older or younger athletes due to varying metabolic rates
     - Males and females 19-30 yo:
       - Add 7 kcal/day for women for every year before age 30
       - Add 10 kcal/day for men for every year before age 30
     - Males and females >30 yo:
       - Subtract 7 kcal/day for women for every year after age 30
       - Subtract 10 kcal/day for men for every year after age 30
     - If <19 yo, use the following guidelines to estimate calories:
       - Boys/girls 7-10 yo: 2,000 calories/day
       - High-school males: 3,000 - 6,000 calories/day
       - High-school females: 2,200 - 4,000 calories/day
Carbohydrate Requirements
1. During exercise, carbohydrate use increases with increased intensity
   o Decreases with increased duration
2. Typical diet:
   o 40-50% of calories as carbohydrates
3. Diets during intense training should include 60-70% carbohydrates
   o Typical daily intake should be 400-800 g (8-10 g/kg body mass)
4. Carbohydrates are stored in liver and skeletal muscles as glycogen
5. Glycogen depletion occurs more rapidly in activities that require near maximal bursts of effort
   o As duration of exercise increases, there is less dependence on carbohydrate substrate and much more dependence on fat
   o Change occurs after about 15 minutes of exercise
6. Requirements are higher during training than competition
   o Much more time is spent training
7. Total daily carbohydrate ingestion is most important
   o Can be complex or simple carbohydrate
   o Requirements may be estimated based on number of hours spent in training
     ▪ 1 hour of training requires 2.7-3 g CHO/lb body weight
     ▪ 2 hours of training requires 3.6 g CHO/lb body weight
     ▪ 3 hours of training requires 4.5 g CHO/lb body weight
     ▪ 4 hours of training requires 5.4-5.9 g CHO/lb body weight
8. Carbohydrate loading may be used for prolonged exercise (>90 min)
   o Begin increased carbohydrate consumption 3-5 days before
   o Consume 400-700 g/day
9. Pre-event consumption
   o Consume 1.8 g/lb body weight within 3-4 hours before exercise
   ▪ Fruit (bananas), dried fruit, fruit juices, bread supplement bars or liquids/gels (e.g., "GU")
   ▪ Could use pancakes, sandwich with lean meat, grains, cereals, pasta
10. During-event consumption
    o Consume 30-60 g/hr
    ▪ Liquids with higher carbohydrate concentrations (sports drinks) or gels such as GU
    ▪ Could also use raisins, bananas, apples, oranges
    ▪ Never try something new during the event
    o Try during training to minimize adverse effects
11. Post-event consumption
    o Consume 0.7 g/lb within 30 minutes of exercise
    o Repeat 2 hr later for training or events lasting >90 min
    o Important for:
      ▪ Optimal recovery
      ▪ Tissue repair
      ▪ Resynthesis of glycogen

Fat Requirements
1. Fat provides a concentrated energy source for low-intensity, longer duration exercise
2. Fat intake should be 20-30% of daily calories
3. Weight (lb) x 0.45 = number of g of fat per day
4. Training increases ability to oxidize fat for energy
   o Allows for glycogen sparing
5. Limit consumption of unsaturated fats to 10% of dietary fats

Protein Requirements
1. Important for muscle growth, repair, and aids in recovery following exercise-induced muscle damage
2. Provides 5% of fuel during activity when glycogen stores are high
3. Provides up to 15% of fuel during activity when glycogen stores are low
4. Muscle mass does not increase simply by increasing dietary protein ingestion
   o Must have proper amounts of protein in diet and must exercise to build muscle
5. Requirements vary depending on sport and athlete
   o Recreational athlete requires 0.5-0.75 g/lb body weight/day
   o Competitive athlete requires 0.6-0.9 g/lb body weight/day
   o Muscle-building or strength-training athlete requires 0.7-0.9 g/lb body weight/day
   o Adolescent/teenage athlete requires 0.9-1.0 g/lb body weight/day
   o Dietary-restricting athlete requires 0.7-1.0 g/lb body weight/day
6. May be difficult to obtain proper amount with solid foods
   o Many athletes use protein supplements to achieve desired amounts
   o Meat only supplies about 100 g protein - not practical
   o Best to consume mixture of protein types
7. Consumption of amino acids (building blocks of protein)
   o No ergogenic benefit

Conclusions
1. Proper attention to nutrition is critically important for optimal sports performance
2. Consuming the right amounts will not enhance athletic ability
   o Proper diet must be accompanied by exercise
3. Proper nutrition not only allows maximal performance but also enhances body's ability to repair and recover from vigorous activity
4. Overloading on any one substance may limit another essential component of diet
5. Proper balance is essential

References

Authors: Christine Manalla, MD, & Kim Edward LeBlanc, MD, LSU Rural FMR, Bogalusa, LA

Editor: Carol Scott, MD, University of Nevada Reno FPRP