# Fitness

Chapter 14

## 1° Components of Fitness: Improved Physiological State that leads to Improved Health and Longevity

1. Cardiovascular Ability: body's ability to take in oxygen, deliver it to cells, use it at a cellular level to create energy for physical work – endurance, strength, power
2. Muscular Ability: analysis of muscular capability – endurance, strength, power
3. Flexibility: ability of a joint to move through a specific range of motion
4. Body Composition: proportion of fat-free mass to fat mass

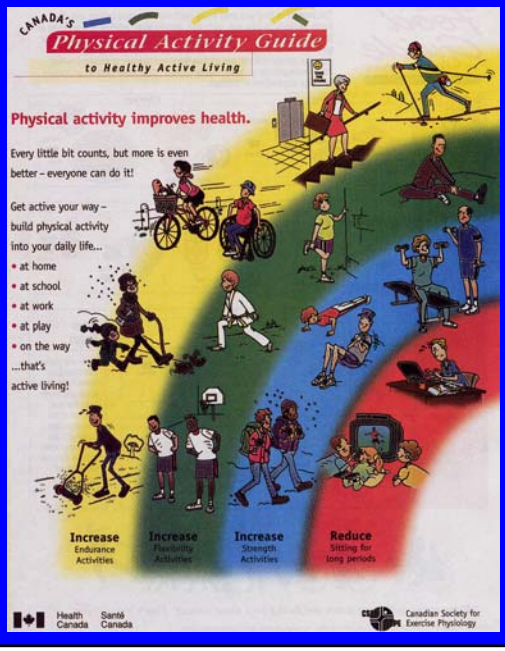
## 2° Components of Fitness

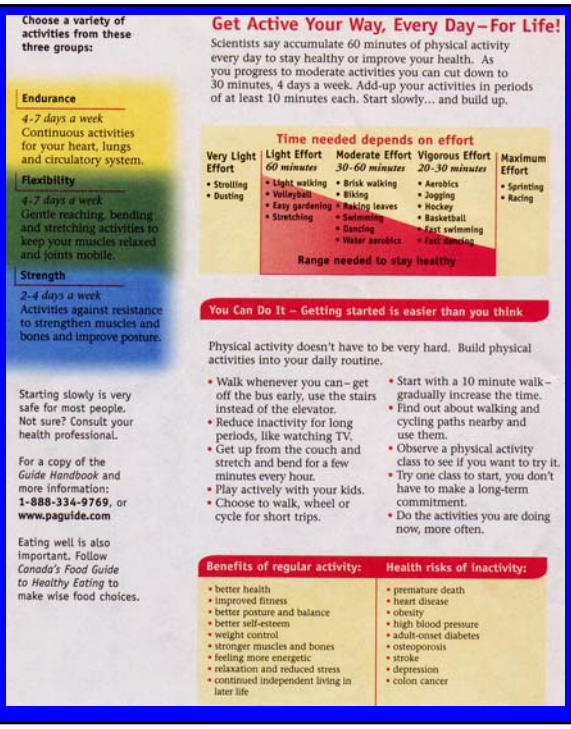
1. Balance
2. Coordination
3. Speed
4. Reaction Time
5. Agility
6. Mental Capability ***

## Benefits of Fitness

- Improved sleep
- Nutritional health
- Improved body composition
- Optimal bone density
- Decreased mortality
- Decreased risk of injury, promotes joint stability and strength
- Increases BMR
- Immunity (moderate intensity)
- Circulatory system health
- Decreased risk of disease (CVD, cancer, type II diabetes)
- Assists in stress management
- Decreased depression
- Improved self-image

# Canada's Physical Activity Guide – Fig. I-2



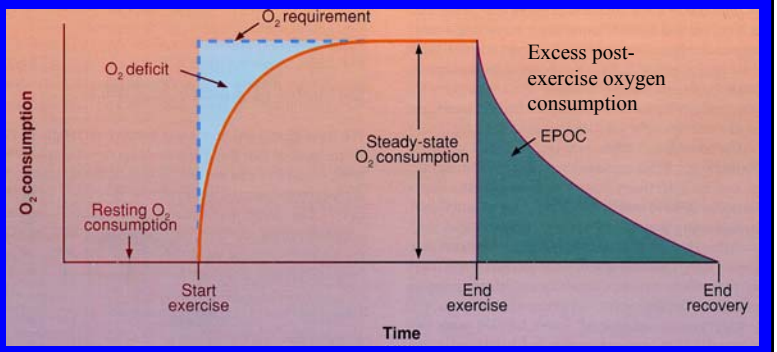



# Progressive Overload Principle

- In order to improve a body system, that system must be worked at frequencies, durations or intensities that gradually increase physical demands
- Small, constant changes
- Rest

# Warm-up

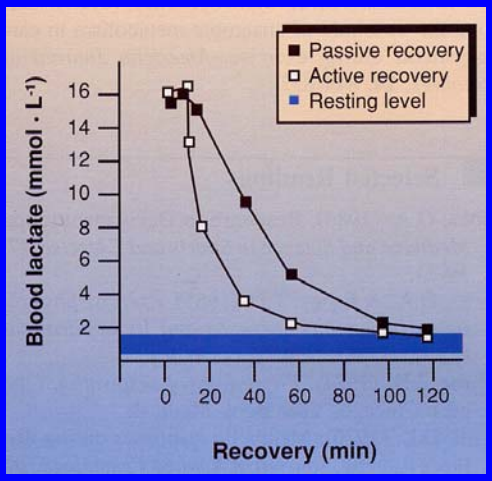
- 3-5 minutes
- Allows body to adjust to blood flow




and prevent early onset fatigue - prevention of early lactic acid build up

- Synovial fluid, temperature, mental, coordination

# Cool-Down

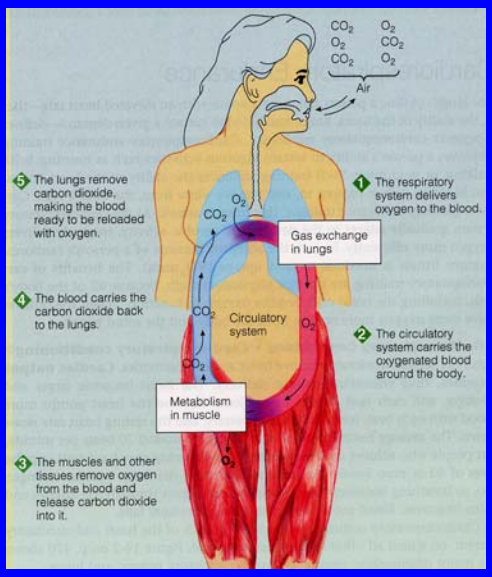



- Active ~ 10 minutes
- Maintenance of blood flow (clearing of waste products, recover from oxygen debt)
- Reduction in intensity and range of motion
- Mental recovery
- Stretching

# Cardiovascular Training Concepts

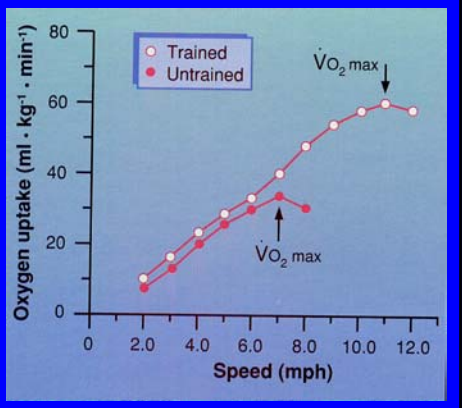
Delivery of Oxygen by the Heart and Lungs to the Muscles – Fig. 14-2

- during exercise- increased oxygen demand
  - increased cardiac output, respiratory rate
  - increased capillary density
  - increased size and number of mitochondria
  - increased aerobic enzyme activity (succinate dehydrogenase, citrate synthase)



# Aerobic Capacity

- $VO_2$ max = oxygen delivery X extraction
  = cardiac output X extraction
  = HR X SV X AV $O_2$ difference
- Limitation: Cardiac Output
- Heart Rate: fitness benefits
- Heart Mass: increased stroke contraction
- Blood Pressure: small increase, advantage with improved fitness?




# Cardiovascular Training Guidelines

| | Beginner | Intermediate | Advanced |
|---|---|---|---|
| Focus | -increase energy<br>-weight reduction<br>-Health benefits | -weight reduction<br>-program variety | -increase $VO_2$ max<br>-sports training and competition |
| Frequency/ week | 1-3 | 3-5 | 4-7 |
| Intensity (max HR) | 40-60% | 60-80% | 70-85% |
| Time (min.) | 15-30 | 20-45 | 40-60 |
| Type | Walking<br>Cycling<br>Swimming<br>Fitness class | Stairmaster<br>Treadmill<br>Fitness class<br>Cycling<br>Cross train | Sports<br>Interval training<br>Challenging terrain<br>Cross train |

# Resistance Training

- Benefits:

  body composition, strength, posture, bone strength, sport performance, decreased injury

- Principles:

  exercise selection

  muscle balance

  muscle order

  rest

  breathing, speed of contraction (slow on eccentric)

  technique (back, body alignment)

  PROGRESSIVE OVERLOAD

# Muscle Fibers

- Slow Twitch (ST) Fibers:

  50% of muscle, slow contraction speed and low strength, slow form of myosin ATPase, steady continuous activity, highly resistant to fatigue, rich in mitochondria and myoglobin, aerobic metabolism

  marathon running

  long-duration swimming

- Fast Twitch Fibers (FTa and b):

  25% a

  25% b of muscle

  faster speed of contraction, highly developed sarcoplasmic reticulum, fast form of myosin ATPase

  a – oxidative-glycolytic, resistant to fatigue, mostly aerobic, jogging

  b – brief maximal efforts, anaerobic, easily fatigued, low in mitochondria and myoglobin, sprinting

## Determinants of Physical Success

- Composition of fiber type determined early in life, first 2-3 years, genetic
- Differentiate according to neuronal innervation
- With age, tend to lose FT and increase percentage of ST fibers
- Indicator of success? Fiber composition, cardiovascular function, muscle size
- Cannot change fiber type, BUT fibers can begin to attain characteristics of other fiber types

## Muscle Growth

- Androgens (testosterone)
- Transient hypertrophy – training induced, edema, 'pumped up'
- Chronic hypertrophy – increase in muscle size with long-term resistance training, hypertrophy or hyperplasia (difference based on training variations, high intensity, low reps = hypertrophy)
- Muscle protein synthesis (post-exercise recovery. During exercise – net protein degradation)
- Atrophy- during immobilization – most apparent in first week (3-4%/day) – takes longer to recover, compared to period of immobilization

## Muscle Soreness

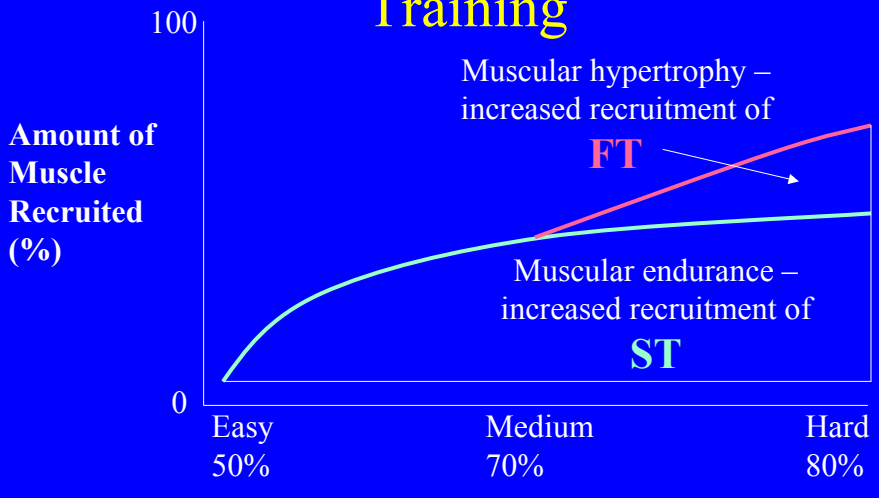
- During exercise and between 12-48 hours following
- Lactic acid (acute)
- Tissue edema ('pumped up', acute)
- Delayed – eccentric, muscle damage
- Inflammatory events…
- To prevent: minimize eccentric contraction early in exercise, start at low intensity and progress slowly over several weeks,

# Results

- 6-8 weeks
- Fewer number of repetitions one can perform before exhaustion, the closer they are to lifting their 1RM (or 100% intensity)

| 1RM 3 6 10 12 15 20 | | | **Reps** |
|---|---|---|---|
| **Power Strength** | **Strength Hypertrophy** | **Muscular Endurance** | **Results** |
| **100%** | **80%** | **70% of 1RM** | **Intensity** |

# Muscle Fiber Recruitment with Training



# Resistance Training Guidelines

| | Beginner | Intermediate | Advanced |
|---|---|---|---|
| Focus | Technique, develop core strength, endurance | Strength, variety, new exercises | Variety, mass focus, maximum results |
| Frequency/ week | 2-3 | 3-4 | 4-6 |
| %1RM | 70% or less | 70-80% | 80-100% |
| Reps | 12-15 | 8-12 | 1-8 |
| Sets | 1-3 | 1-4 | 1-6 |
| Equipment Choice | Machines, stability ball | Machines, free weights, stability ball | Machines, free weights, free body, medicine ball |

# Balanced Fitness Program

- 3 days/week:
  warm up (5 min.)
  aerobic activity (20-30 min.)
  cool down and stretching (10-20 min.)
- 2 days/week:
  warm up (5 min.)
  weight training (30 min.)
  cool down and stretching (10-20)
- Off days: walking, sports, play, stretching

# Energy Systems

- **Carbohydrate and fat**: energy demands
- **Protein**: building and maintenance of lean tissues
- **Vitamins and minerals**: coenzymes/cofactors in metabolism
- **Water**: distribution of fuels, waste transport, heat dissipation

# ATP/Creatine Phosphate System

- Creatine Phosphate → ADP
  Creatine ← ATP

- Very rapid, one ATP/CP
- Stored in muscle – limited supply
- Very high intensity: 1-10 seconds
- Beginning of exercise
- Onset of anaerobic exercise

# Glucose

- Glycogen – liver and muscle
- Glycogen loading – storing glycogen beyond normal capacity
- Can benefit with exercise > 90 min. ***runners

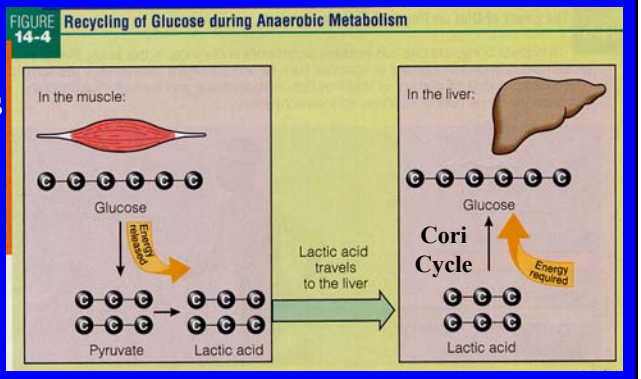
| Before the Event | Training Intensity | Training Duration | Dietary Carbohydrate |
|---|---|---|---|
| 6 days | Moderate (70% $VO_2$max) | 90 min | Normal (5 g/kg body weight) |
| 5 days<br>4 days | Moderate<br>(70% $VO_2$max) | 40 min | Normal<br>(5 g/kg body weight) |
| 3 days<br>2 days | Moderate<br>(70% $VO_2$max) | 20 min | High-carbohydrate<br>(10 g/kg body weight) |
| 1 day | Rest | — | High-carbohydrate (10 g/kg body weight) |

# Anaerobic vs. Aerobic

- Very High Intensity: 20sec. – 3 min., anaerobic glucose metabolism – production of lactic acid
  - ie: ¼ mile run at maximum pace
- High Intensity: 3 – 20 min., aerobic glucose metabolism – entry of pyruvate into TCA
  - ie: cycling, swimming, running

# Lactic Acid – anaerobic breakdown product of pyruvate

- Fatigue
- Predominates at higher intensities – less able to clear
- With improved fitness – better able to tolerate lactic acid build up




# Glucose Depletion

- Training favors fat metabolism (increased mitochondria – improved cardiac output)
- "Hit the wall"…..how can this be prevented?

  - high carbohydrate diet – 8g/kg /70% of kcal from carbohydrates (normal ~ 5g/kg)

  - glucose-rich drinks during activity>60min.

  - carbohydrate-rich foods following activity (within 15 min.)

  - glycogen load prior to event

  - rest!

# Fat

- Moderate activity, >20 min., aerobic
  - ie: hiking, walking
- 20 min. required to increase oxygen delivery to tissues and increase free fatty acid mobilization – favored fuel, lots of it
- 20-30% - athletes – especially endurance!

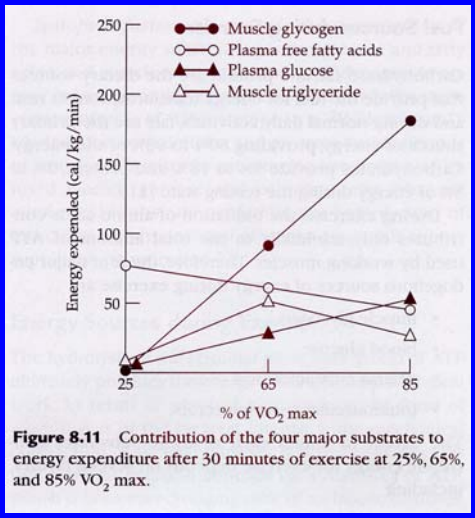



**Figure 8.11** Contribution of the four major substrates to energy expenditure after 30 minutes of exercise at 25%, 65%, and 85% $VO_2$ max.

# Body Fat

- Endurance athletes – important! Energy storage
- "Spot reducing" NOT possible
- For weight loss: walking – best choice
  - moderate aerobic intensity – will favor fat metabolism
  - safe
  - increased compliance

# Intensity and Duration for Maximal Fat Metabolism

- 'Go as hard as you can for as long as you can'
- Fat-burning zone?
- 30 min. walk, 30 yrs old:

**- at 50% of $VO_2$ max – 200 calories expended, (50% fat)** ***therefore, total of 100 fat calories***

*compared to:*

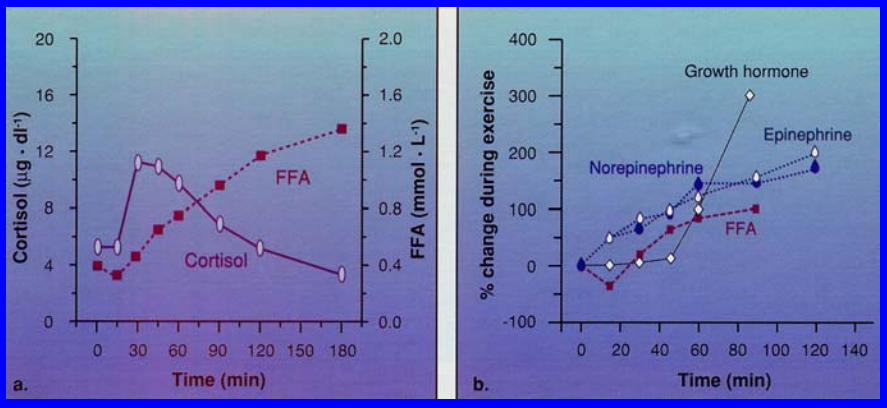
**- at 70% of VO2 max – 310 calories expended, (40% fat)** ***therefore, total of 124 fat calories***

# Hormones – During Exercise

Increased release of:

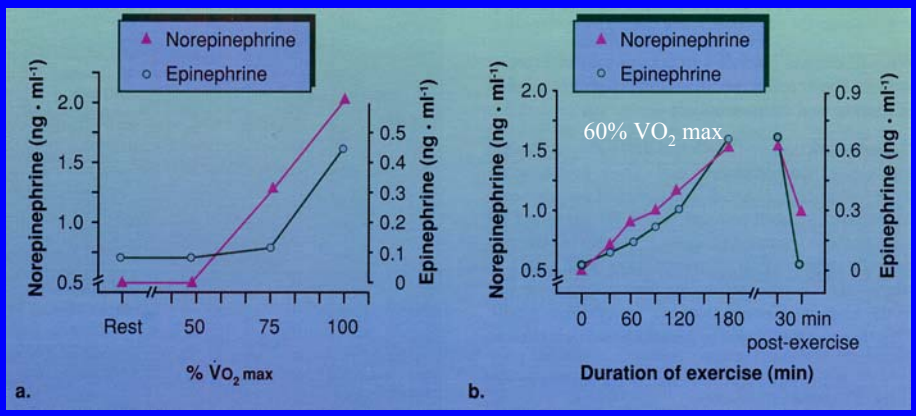
- Glucagon: glycogenolysis, gluconeogenesis
- Epinephrine/Norepinephrine: increased stroke volume, increased release of glucose and fatty acids into blood, vasodilation/constriction
- Cortisol: increased release of glucose, amino acids and fatty acids into blood, anti-inflammatory
- growth hormone: increased release of fatty acids into blood

# Timing



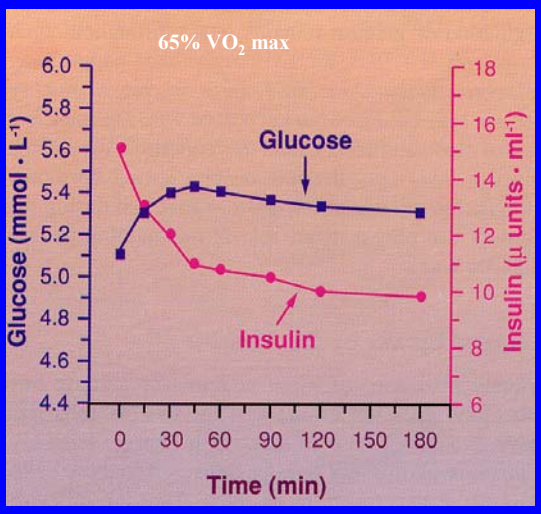

Changes in **a)** plasma levels of fatty acids (FFA) and cortisol
**b)** plasma levels of epi, norepi, growth hormone and fatty acids

# ….at what exercise intensities and durations?



# Insulin

- Decreased release during exercise to prevent increased non-muscle cell glucose up-take
- Muscle cells – increased insulin sensitivity during exercise




# Protein – As Fuel

- Not a major fuel for physical activity
- athletes use more than non-athletes – at most, 10% of total fuel
- Diet rich in carbohydrate will spare protein as *fuel*
- Influenced by intensity, duration, glycogen stores
- ALL athletes require more protein because of increased caloric needs

# Resistance Training – Body Builders

- Less protein as fuel, but increased retention due to muscle growth
- Carbohydrate needs are higher – protein sparing!
- Increased needs can be met with real food
- Supplements:  whey, soy, amino acids
- Timing, Intensity of training *****

# Recommended Protein Intakes for Athletes – Fig. 14-4

American Dietetic Association
Dietitians of Canada

| | Recommendations (g/kg/day) | Protein Intakes 70 kg/154 lb (g/day) | 55 kg/121 lb |
|---|---|---|---|
| | | *Males* | *Females* |
| RDA for adults | 0.8 | 56 | 44 |
| Recommended intake for power (strength or speed) athletes | 1.6–1.7 | 112–119 | 88–94 |
| Recommended intake for endurance athletes | 1.2–1.6 | 84–112 | 66–88 |
| U.S. average intake | | 95 | 65 |

## Calculations – How many grams of protein needed for a body builder???

- Male body builder – strength athlete – 70 kg/154 lb. RDA for adult: 0.8g/kg = 56g protein/day
- Caloric needs:

1540 + 40% = 2156 cal (rest/moderately active)

1540 + 70% = 2618 cal (very active)

- Difference = 462 cal/day + 400 cal/day (activity) = 862 cal/day MORE
- 15% of 862 (protein requirements) = 130 pro cal
  130/4 cal/g pro = 32 g pro EXTRA

- 56 g (rest) + 32 g (active) = 88 g pro/70 kg
  = 1.3 g pro/kg
- Recommended intake for bodybuilder:
  1.6 g/kg/day – 1.3 g/kg/day
  = 0.3 g/kg/day to contribute to muscle repair and building
  = 0.3 X 70 kg = **21 g/day** protein required *on top of* increased metabolic needs
- Research suggests – best time for a protein boost – just before/just after resistance training (up to 3-6 hours)
- Improved muscle repair/anabolism with carbohydrate (1g/kg)
- How much protein? 10-20g

## Pre/Post Exercise Protein/Carbohydrate Choices

- 1 cup hard boiled egg/chopped (17 g pro)
  2 cups orange juice (50 g CHO)
- ¾ cup 2% cottage cheese (23 g pro)
  1 cup white rice (45 g CHO)
- ½ cup water packed tuna (20 g pro)
  3 cups sports drink (3X15 = 45 g CHO)
- ½ chicken breast without skin (27 g pro)
  5 oz. Frozen raspberries (52 g CHO)

## Vitamins and Minerals

- Diet high in nutrient-dense foods – ADEQUATE intake of vitamins and minerals
- Increased free radical production – increase intake of antioxidants?
- Supplements will NOT enhance performance

## Fluids

- 1-2 % loss of body weight in fluids can inhibit performance
- Require ½ cup/100 kcal expended
- Plain, cool water is optimal
- Optimize hydration prior to exercise/event
- 2-3 c 2 hr before activity, 1-2 c 15 min. before activity, ½ c every 15 min. of activity, 2 c after activity for each pound lost
- To replenish electrolytes: regular food

## Optimal Diet for Physical Performance

- Water
- Nutrient density
- Carbohydrate – heavy training (competition): 8-10 g/kg/day ~ dried fruits (raisins), sweet potatoes, juices
- Protein – watch fat intake!!!! The average fit person does NOT require extra protein!!!

## Meals Just Before/After Competition

- Before:

  - high carbohydrate, easy to digest, 500-800 cal, 1-4 hours before event

  - liquid meal/smoothie (apple juice, banana or non-fat milk, banana, vanilla, strawberries)

- After:

  - high carbohydrate (1g/kg) , protein? (10-20 g)

  - preference, tolerance