Exercise Metabolism II

I. Maximal Oxygen Consumption – VO2max
   A. General
      1. Definition: maximal capacity to transport and utilize oxygen
      2. Measured by incremental or graded exercise tests
      3. VO2 max determined by:
         – Maximum ability of cardiorespiratory system to deliver O2 (trained)
         and/or
         – Maximum ability of muscles to take up and use oxygen (untrained)
   B. VO2max – trained vs. untrained subjects
      1. VO2max is (usually) best expressed as ml/kg/min (not ml/min)
      2. VO2max increases with aerobic exercise training (to a point)
      3. This increase in VO2max is associated with increased mitochondrial density,
         increased Kreb’s cycle enzymes, increased capillarity, increased maximum
         cardiac output, etc.
   C. VO2max – average and elite values
   D. Relationship Between VO2max and Lactate Threshold
      1. Lactate threshold is often expressed as a percent of VO2max
      2. ~30% of VO2max is walking
      3. In untrained people, the lac threshold is at ~50-60% of VO2max
      4. In trained people, the lac threshold is higher
      5. Both VO2max and lac threshold are used to evaluate aerobic and endurance
         capacity, fitness

II. Sources of Fuel During Exercise (review)
   • Carbohydrate
     – Blood glucose
     – Muscle glycogen
   • Fat
     – Plasma FFA (from adipose tissue lipolysis)
     – Intramuscular triglycerides
   • Protein
     – Only a small contribution to total energy production (only ~2%)
     • May increase to 5-15% late in prolonged (at least > 1 hr) exercise
   • Blood lactate
     – Gluconeogenesis via the Cori cycle

III. Fuel Selection During Exercise
   A. Estimation of the % of metabolism from CHO vs. fat
      1. Fuels vary in the amount of O2 used and CO2 produced during their
         metabolism
      2. Respiratory exchange ratio (RER) = VCO2/VO2
3. From the RER, the % fat and CHO used for metabolism can be estimated
4. Resting RER is ~0.75 – 0.80

B. Caveat to the use of RER to estimate % fat or CHO metabolism
   1. RER = respiratory exchange ratio – at the mouth
   2. RQ = respiratory quotient – the VCO2/VO2 at the muscle
   3. RER does not necessarily equal the RQ
   4. During steady-state in humans RER may equal RQ
   5. RER will not equal RQ during non-steady state or hyperventilation

C. Exercise Intensity and Fuel Selection
   1. Low-intensity exercise (<30% VO2max) Fats are primary fuel
   2. High-intensity exercise (>70% VO2max) CHO are primary fuel
   3. “Crossover” concept
      Describes the shift from fat to CHO metabolism as exercise intensity increases
   4. Fat Burning: High or Low Intensity Work?

D. Exercise Duration and Fuel Selection
   1. During prolonged exercise, CHO metabolism gradually decreases while fat metabolism gradually increases
   2. Increased rate of lipolysis
   3. Interaction of Fat and CHO Metabolism During Exercise
      “Fats burn in the flame of carbohydrates”
      Glycogen is depleted during prolonged high-intensity exercise