

Nutrient Timing: The Future of Peak Performance

Len Kravitz, Ph.D., Univ. of New Mexico, lkravitz@unm.edu, drlenkravitz.com

Great Resources: Ivy, J. & Portman, R. (2004). Nutrient Timing. Basic Health Publications, Inc. (basichealthpub.com)
Kleiner, S. M. (2001). Power Eating (2nd Edition). Human Kinetics Publishers (www.humankinetics.com/)

- I. Nutrient timing: Delivering the right nutrient mixture at the right time to enhance recovery from exercise and improve muscle growth, strength and power (three phases); Max the 24-hour growth cycle
 - A. Energy phase: release sufficient energy to drive muscle contraction
 - B. Anabolic phase: 45-minute window following a workout; with right combination of nutrients initiates repair of damaged muscle protein and replenishment of muscle glycogen
 - C. Growth phase: from end of anabolic phase to the beginning of the next workout
- II. Important terms and concepts in nutrient timing
 - A. The effectiveness of any protein product is largely dependent on when you take it
 - B. 'Metabolic sensitivity': muscles capacity to modify their metabolic activity in response to changing needs and stimuli
 - C. 'Nutrient activation'; the proportions & type of nutrients (fat, CHO, protein) effects the goals you wish to attain; for instance, high-glycemic CHO following exercise stimulates insulin which stimulates protein synthesis
 - D. 'Nutrient optimization'; consumption of certain nutrients at specific times to help recovering and to shift metabolic machinery from a catabolic state to an anabolic one
- III. Relationship between nutrition and energy production; and nutrition and recovery
 - A. ATP; muscle contraction is driven by ATP (adenosine triphosphate); only stores for 8-12 seconds of maximal exertion; so it must be constantly resynthesized
 - B. Phosphagen energy system: the immediate supply of energy via ATP and CP
 - C. Glycolytic energy system: anaerobic lasting up to a few minutes; glycogen & glucose
 - D. Mitochondrial respiration (cellular respiration or aerobic respiration)
 1. Oxygen drives this metabolic pathway occurring in the mitochondria of muscle
 - E. Why is carbohydrate the body's favorite fuel source during exercise? Because of the speed at which it can be broken down and delivered to muscle
 - F. Fat is the body's most concentrated fuel; not readily available during intense exercise
 - G. Protein is sparingly used for fuel; only when carbohydrate stores are very low
 1. Important note; for the body to build and repair muscle, all essential amino acids (those which the body cannot synthesize) must be present
 2. If glycogen stores are low during exercise, muscle proteins are broken down in the liver forming 'new' glucose (called gluconeogenesis); glucose released into blood to be used
- IV. Influence of hormones on muscle growth and development
 - A. Hormones are chemical messengers; anabolic hormones stimulate rebuilding and repair; catabolic hormones stimulate the breakdown of CHO, fat and protein
 - B. Hormones respond to 3 stimuli; other hormones, nerve fibers, levels of certain nutrients
 - C. Catabolic hormones of exercise; glucagon (stimulates fat and liver glycogen breakdown and gluconeogenesis), epinephrine (stimulates fat, liver, and muscle glycogen breakdown), norepinephrine (stimulates fat and liver glycogen breakdown), cortisol (stimulates fat, liver, glycogen and muscle protein breakdown)
 - D. Anabolic hormones of exercise; testosterone (blocks cortisol and stimulates protein synthesis), growth hormone (stimulates bone and cartilage growth and protein synthesis), IGF-1 (stimulates growth of bone, cartilage, and muscle), insulin (multiple effects on muscle protein synthesis, protein degradation, and glycogen replenishment)
 - E. Glucagon is an 'insulin antagonist'; released from pancreas in the presence of low-blood glucose to raise blood glucose; glucagon stimulates fat breakdown during exercise

- F. Epinephrine (adrenaline) and norepinephrine (noradrenaline); released from the adrenal glands in response to low blood glucose as well as from resistance training (the higher the intensity the greater the increase); promote breakdown of liver glycogen and an increase of blood flow to muscle (as well as increasing respiration and heart rate)
- G. Cortisol is released from the adrenal glands when blood glucose is low and during very intense exercise; its major function is to generate fuel for exercise; when released it causes a breakdown of CHO, fat and an increase in plasma amino acids (specifically glutamine and the BCAA)
- H. Testosterone is released from the testes (males) and ovaries and adrenal glands (females); its release is controlled by luteinizing hormone (secreted from pituitary gland); accelerates growth of muscle, bone and red blood cells; testosterone also blocks cortisol's 'anti-catabolic' effect
- I. Growth hormone is released from the pituitary, stimulating muscle growth, increasing fat breakdown, and inhibiting carbohydrate metabolism
- J. IGF-1 is insulin-like growth factor; from pituitary gland, liver and muscle; stimulates protein synthesis in bone, cartilage and muscle; higher intensity exercise elicits greater release of IGF-1
- K. Insulin (the anabolic regulator of muscle); high levels of insulin combined with high CHO intake increases fat synthesis and decreases fat breakdown (this is reflective of the level of insulin sensitivity in fat cells of a person—so it varies from person to person)
 1. Muscle cells are also very sensitive to insulin after exercise; if glucose and amino acids are available, insulin will help increase the synthesis of muscle proteins and muscle glycogen at a very rapid rate (slowing the synthesis and storage of fat); also slowing the degradation of muscle after exercise
 2. Insulin increased protein synthesis
 3. Insulin increases glucose transport into muscle cells and amino acid uptake by muscle
 4. Conversion of glucose into glycogen requires the enzyme glycogen synthase; following exercise, insulin aids to increase the activity of glycogen synthase by 70%
 5. The primary trigger for cortisol release during prolonged aerobic exercise is low blood glucose; carbohydrate supplementation during exercise helps to blunt the rise via insulin
 6. Insulin increases muscle blood flow to exercising muscle (enhances waste removal)

V. Physiological and metabolic changes during intense exercise

Description	Change	Description	Change
ATP	Depleted	Protein degradation	Increased
Muscle glycogen	Partially depleted	Muscle damage	Increased
Cortisol levels	Increased	Immune system	Suppressed
Insulin levels	Decreased	Acute inflammation	Stimulated
Blood flow to muscle	Increased	Fluid loss	Increased

VI. Three goals for the energy phase

- A. Increase nutrient delivery to muscles and spare muscle glycogen and protein
 1. Depleted muscle glycogen is a concern for aerobic and anaerobic exercise, although the phosphagen system provides the bulk of the energy; by consuming a carbohydrate/protein sports drink you can preserve muscle glycogen (may deplete about 40%)
 2. The combination of protein to a carbohydrate supplement during resistance exercise preserves muscle protein and increases protein synthesis after exercise
- B. Limit immune system suppression; during moderate-intensity exercise, immune function is elevated, increasing resistance to infection; during strenuous exercise it is suppressed
 1. Immune system activation causes the release of cortisol; blood cortisol can be regulated during exercise by controlling glucose availability

C. Minimize muscle damage; muscle damage is what stimulates the remodeling process, however, damage must be repaired before muscles can be remodeled

D. Theory to Application: Recommendations for the energy phase

1. Consume a 12-ounce carbohydrate/protein drink 10 minutes prior to your workout to raise blood glucose and insulin levels (greater sparing of muscle glycogen during exercise and elevated protein synthesis post-exercise); elevated blood glucose may reduce rise in cortisol
2. Carbohydrate (high glycemic) supplementation during exercise helps to extend endurance, suppress immune system and reduce muscle damage; every 15 minutes consume more

Nutrient	Amount in 12 ounces of water
High glycemic carbohydrates such as glucose, Sucrose, and maltodextrin	20-26 grams
Whey protein	5-6 grams
Leucine	1 gram
Vitamin C	30-120 mg
Vitamin E	20-60 IU
Sodium	100-250 mg
Potassium	60-100 mg
Magnesium	60-120 mg

VI. Anabolic phase: The most critical phase of nutrient timing; 45-minute window

- A. End of workout; catabolic conditions (ATP/CP depletion, glucose & glycogen reduction, cortisol elevation, epinephrine and norepinephrine elevated (for 30 to 60 minutes), acute inflammation, muscle damage, some essential amino acids, glutamine and BCAA depleted (don't forget water)
- C. 45-minute metabolic window; the most important nutrition opportunity for muscle
 1. Carbohydrate/protein supplement immediately post-exercise: stores 2x more glycogen
 2. Activation of protein synthesis by amino acids is most responsive immediately following exercise; amino acid uptake is 2x greater; muscle protein synthesis will be 3x greater when a carbohydrate/protein supplement is taken immediately versus two hours later
- E. Five goals of anabolic phase of nutrient timing
 1. Shift metabolic machinery from a catabolic state to an anabolic state; stimulate insulin with a carbohydrate/protein supplement
 2. Speed elimination of metabolic wastes by increasing blood flow; stimulating insulin will increase blood flow 2x
 3. Replenish muscle glycogen stores; a carbohydrate/protein supplement within the first 45 minutes results in 2x greater glycogen storage versus a 'carbohydrate only' supplement
 4. Initiate tissue repair and set the stage for muscle growth; supplementation with a carbohydrate/protein supplement both immediately and one hour after resistance exercise increases protein synthesis compared to a 'carbohydrate only' supplement
 5. Reduce muscle damage and bolster the immune system; excessive muscle damage will restrict glycogen recovery and protein synthesis; use of a carbohydrate/protein drink that contains vitamins E and C and glutamine reduces free-radical formation and lower CPK
- F. **Theory to Application: Recommendations for the anabolic phase**
 1. Whey protein; contains all 9 essential amino acids, very digestible, higher concentration of BCAA than any other protein, fast acting because it empties from the stomach and absorbed into the bloodstream faster than other proteins; precursor to body's natural antioxidants (disadvantage is it contains lactose, however there are lactose-free whey protein products)

2. High glycemic carbohydrates (sucrose, maltodextrin and dextrose); avoid products that contain high percentage of fructose and galactose as these are weak stimulators of insulin
3. **A carbohydrate/protein of 3:1 or 4:1 is recommended (3 or 4 grams of carbohydrate to every gram of protein)**
4. Ideal nutrient composition of supplement for the anabolic phase

Nutrient	Amount in 12 ounces of water
Whey protein (all 9 essential AA; very digestible; high concentration of BCAA)	13-15 grams
High glycemic carbohydrates such as glucose, Sucrose, and maltodextrin	40-50 grams (3:1 or 4:1 CHO/Protein Mix)
Leucine: very positive effect of protein synthesis	1-2 grams
Glutamine: most abundant amino acid in muscle	1-2 grams
Vitamin C: antioxidant vitamin	60-120 mg
Vitamine E: antioxidant vitamin	80-400 IU

VII. Growth Phase: The 18 to 24-hour period during which majority of gains in muscle mass and strength

- A. Rapid segment; high anabolic activity which lasts up to four hours (try to maintain insulin sensitivity and anabolic state of muscle)
 1. Maintain increased insulin sensitivity; consumption of a carbohydrate/protein sports drink during exercise and a carbohydrate/protein recovery drink prevents the development of insulin resistance (allowing muscle cells to maintain a high level of anabolic activity); consume carbohydrate/protein supplement 2 hours after exercise
- B. Sustained segment; muscle grown continues at a slower rate
 1. Maintain the anabolic state: extends from the rapid segment to the next workout;
 2. High CHO diet and high protein/low CHO snacks or supplements. How much protein can the strength enthusiast consume? Controversial topic/discussion

VIII. Feeding muscle and frequently asked questions

- A. Any nutrient timing products?
- B. Any pre and post snack ideas: energy bar and sports drink, 2 slices whole-grain toast with 2 tbs peanut butter, 1 cup cooked oatmeal with ¼ cup raisins, ½ cup sunflower seeds and 1 glass orange juice, ½ cup of nuts and an apple
- C. Any dietary guidelines? Establish protein intake at 1.6-1.7 g/kg/day, establish CHO intake at 5-9 g/kg/day, and let healthy fats fill in the rest
- D. RMR calculation: Women—body weight (lb) x 10 kcals/lb: Men—body weight (lb) x 10 kcals/lb
- E. Protein Quiz!