

Lecture 5: Body Composition, Weight Gain, Ergogenic Review and Meals for Competition

Course: Introduction to Sports Nutrition and Performance

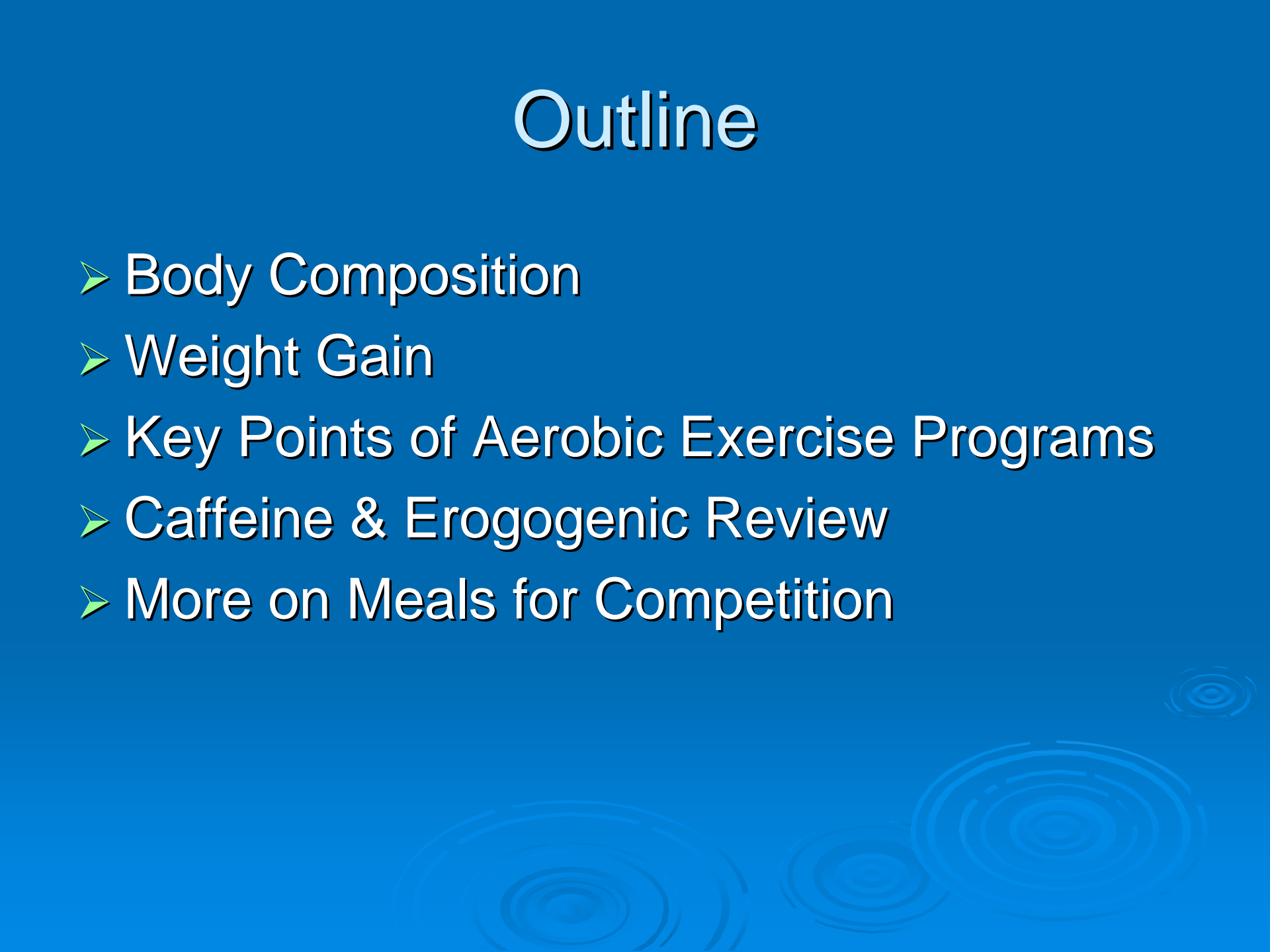


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Objectives

1. Be able to state the research techniques used in measuring body fat.
2. To be able to list ways that athletes can gain weight when needed.
3. To be able to explain how caffeine can be safely used as an ergogenic aid.
4. To be able to state the effects of other ergogenic aids on the body.
5. To explain the principles of healthy and effective meals for competition.

Outline

- Body Composition
 - Weight Gain
 - Key Points of Aerobic Exercise Programs
 - Caffeine & Ergogenic Review
 - More on Meals for Competition
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Body Composition



What techniques are available to measure body composition and how accurate are they?

They are all indirect measures & all current techniques are only estimates and are prone to error

Methods of Measuring the Energy Expenditure in Humans

- Direct calorimetry
- Indirect calorimetric technique
- Doubly labeled water technique

Research Techniques

- Underwater weighing (hydrodensitometry)
 - Most commonly used method for research purposes
 - The assumption that the density of the fat-free protein tissue is 1.10 g/cc^3 may not be valid for all individuals
 - The standard error is about 2 to 2.5 percent
 - It is time consuming and difficult for some individuals

Research Techniques

- Body plethysmography
 - Air displacement is measured
 - This method may be more valid and reliable for certain individuals
- Skinfolds: Subcutaneous fat is measured
 - Calipers
 - Ultrasound
 - Standard error is about 3 to 4 percent
 - This method is one of the best practical methods to measure body composition

Bioelectrical Impedance Analysis (BIA)

- New techniques are comparable to skinfold techniques
- Problems appear to exist in application to the very obese, the lean athlete, and the elderly
- Recent advancements may make BIA a more valid tool

Dual Energy X-ray Absorptiometry (DXA;DEXA)

- Assesses bone mineral content, fat-free mass, and body fat
- May be used to assess deep visceral fat
- Method of choice for measuring bone mass, but associated with errors in measuring fat content
- Does not appear to be more effective than underwater weighing

Body Fat Measurements

- Infrared interactance devices have error values greater than 3.5 percent
- Anthropometry:
 - Measurement of body parts is inexpensive and practical
 - Waist:hip ratio
- Body-fat percentages are approximations only as each technique is prone to errors
- Mirror test gives all the evidence needed if studied objectively

Body Fat Percentages

- Minimal levels of total fat for health
 - 5-10 percent for males
 - 15-18 percent for females
- Average levels
 - 15-18 percent for males
 - 22-25 percent for females
- Obesity levels
 - 25 percent for males
 - 30 percent for females

Weight issues such as disordered eating or eating issues are not addressed for the scope of this introductory course.

Weight Reduction

- What role does exercise play in weight reduction and weight maintenance
- Inactivity may be the most frequently responsible factor for obesity and can also help to maintain it
- Exercise can help reduce and control body weight so that it should be included in a weight-loss or maintenance program
 - Aerobic training
 - Resistance training

Aerobic Exercise is Theorized to Facilitate Weight Loss

- It may increase the REE during the period immediately following the exercise bout
- It may increase the thermic effect of feeding (TEF) if you exercise after eating a meal
- It may help minimize the decrease in the REE normally seen with weight loss
- Body-fat stores are reduced
- It may increase lean body mass
- It may decrease the REE in individuals who are already lean

What Types Of Exercise Programs Are Most Effective for Losing Body Fat

- The best type of exercise program for losing body fat involves aerobic exercises
- Key points of aerobic exercise programs
 - The mode of exercise must involve large muscle groups



Key Points of Aerobic Exercise Programs

➤ Intensity level

- The higher the intensity, the more Calories you expend
- The intensity must be adapted for the amount of time you plan to exercise
- Points to remember when using a table to figure the Calorie cost of exercise
 - The figures are approximate and include the resting metabolic rate
 - The figures are only for the time you are performing the activity
 - The figures give you some guidelines to total energy expenditure, but actual caloric costs vary according to certain factor
 - Skill level
 - Environmental factors

Exercise Energy Expenditure

- The most important factor in total energy expenditure is the duration of the exercise
 - Distance traveled is more important than time
 - Frequent short bouts of exercise per day are just as effective as a single longer bout in producing weight loss and cardiovascular fitness
 - Intensity and duration are interrelated, and if balanced, will result in equal weight losses

Exercise

- Exercise frequency complements duration and intensity
 - Three to four times per week would be satisfactory
 - Six to seven times would just about double your caloric output
- Enjoyment of the exercise is important
- The exercise should be practical
 - Brisk walking may be the best single exercise for a large portion of the population
 - Indoor exercise equipment may be a practical option
- Versatility is important

Weight Gain



Is Protein Supplementation Necessary During A Weight-Gaining Program?

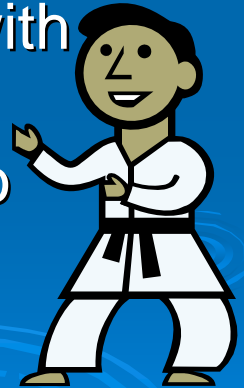
- One pound of muscle is equal to about 100 grams of protein
- You would need 14 grams/day above normal protein requirements
- *The average American diet already contains extra protein beyond the RDA*
- Sports nutrition authorities recommend 1.5 to 1.8 grams per kilogram body weight for the athlete who is training to increase muscle mass
- Supplementation by expensive protein powders or amino acids is not necessary
- Consume the additional protein and carbohydrate about two hours and immediately after the resistance training workout

Are Dietary Supplements Necessary During A Weight-Gaining Program?

- Dietary supplements appear to be popular among athletes attempting to gain strength and muscle mass
- There is no data to support the use of most supplements
- Creatine monohydrate does appear to increase body weight and strength
- There is no data supporting beneficial effects of DHEA supplementation and high serum DHEA levels have been associated with several health risks
- Most studies show no ergogenic effects of androstenedione supplementation and its use could exert feminizing effects in males and reduce HDL

Extra Protein to Build Muscles

- Lifting weights and eating protein is often perceived as the best way by the public as the best way to bulk up.
 - However, in addition to resistance training, extra calories primarily from extra carbohydrates rather than extra protein are needed.
- Carbohydrates fuel your muscles so they can perform intense muscle-building exercise.
- Overloading the muscle with weightlifting and not with protein increases the muscle fibers size.
- Research indicates that protein powders and amino acids do not work for gaining muscle weight.
- Eating the calories needed is better than taking additional supplements. You are most likely to gain weight if you consistently eat larger-than-normal meals.

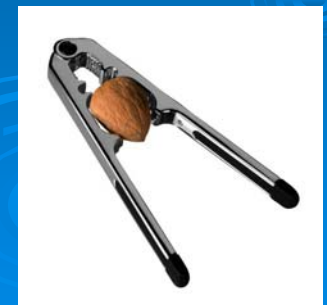


Suggestions for Those Trying to Gain Weight

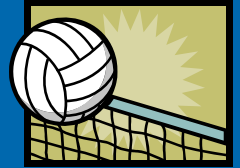
- Drink 1% or 2% milk
- Increase your intake of lean meats, poultry, and fish and use nuts, seeds, and limited amounts of peanut butter for snacks
- Increase your consumption of whole-grain products
- Add fruit to other food exchanges and drink more fruit juices
- Use fresh vegetables as snacks with melted low-fat cheese or a nutritious dip
- Try to minimize the intake of saturated fats, using monounsaturated and polyunsaturated fats instead

Suggestions for Those Trying to Gain Weight

- Add avocado to your daily diet
- Milk and juices are nutritious and high in Calories
- Obtain limited Calories through alcohol as it can impair sports performance
- Liquid supplements may contain 300-400 Calories with substantial protein if you are not able to consume all the calories needed through meals
- Eat three balanced meals per day supplemented with two or three snacks



Boosting Your Calories



➤ To gain weight:

- Take in the extra calories determined to gain weight & eat frequently throughout the day.
- Eat extra snacks & larger-than-normal portions for meals, and eat higher calorie foods.
- Eating foods which are more compact and dense can fit more calories into your stomach with less volume like dried apricots verses fresh.
- Fats are the most concentrated form of calories. One teaspoon of fat has 36 calories while the same amount of carbohydrate or protein only has 16 calories.

Boosting Calories

- High Calorie Breakfasts: Granola, muesli, Grape-Nuts, and Wheat Chex topped with nuts, sunflower seeds, or raisins, bananas, or other fruits.
- Hot cereal: Cooking with milk instead of water boosts the calories and nutritional value and can be made with mix-ins such as powdered milk, margarine, peanut butter, walnuts, sunflower seeds, wheat germ, ground flax meal, and dried fruit.
- Healthy Proteins: Lean Meats, Oily Fish
- Healthy Fats: Peanut butter, walnuts, almonds, avocado, olives, olive oil

Boosting Calories

- For competitive athletes who have difficulty consuming enough calories to maintain weight try:
Juices: apple, cranberry, cranapple, grape, pineapple, and most of the juice blends have more calories than grapefruit, orange, or tomato juice. To increase the calorie value of frozen orange juice, add less water than directed.
- Fruits: bananas, pineapple, mangoes, raisins, dates, and dried fruits contain more calories than watery fruits such as grapefruit, plums, and peaches.

Caffeine & Ergogenic Review



Nutrition and Sports Performance

- Athletes during training should be consuming more nutrients than the averagely inactive person.
- The nutrient supplements taken by most athletes are probably unnecessary and may even be detrimental.
- Excesses of some essential nutrients are toxic and some may reduce performance.
- Any deficiencies in athletes are likely to be the result of restricted food intake rather than increased requirements due to the effects of training.

Caffeine

- Caffeine is a central nervous system stimulant
 - Stimulates heart function
 - Stimulates blood circulation
 - Stimulates the release of epinephrine (adrenaline) from the adrenal gland
- One of the most observed effects at rest is an increase in blood levels of FFA
- Caffeine may help delay the onset of fatigue during exercise

Caffeine

- The International Olympic Committee (IOC) banned the use of caffeine as a drug prior to the 1972 Olympics.
- However, because caffeine is a natural ingredient in some beverages that athletes consume, the IOC removed it from the doping list from 1972 to 1982.
- The use of large amounts of caffeine was again banned for the 1984 Olympic games, probably because research had suggested that caffeine could artificially improve performance.
- Olympic athletes were permitted to consume small amounts of caffeine, but the use of large doses was grounds for disqualification. Until 2004, the maximal dose that could be used without exceeding the legal limit for doping approximated 8-10 mg/kg body weight.
- For a 70 kg athlete this would be 560-700 milligrams of caffeine, or about 4-6 cups of coffee or 3 Vivarin tablets.

General Summary of Available Research on the Ergogenic Effects of Caffeine

- Caffeine can increase alertness, which may improve simple reaction time. Large doses may adversely affect performance in events characterized by fine motor skills and control of hand steadiness.
- Earlier studies revealed that caffeine would not improve performance in events characterized by strength, speed, power, or local muscular endurance, nor in endurance events that last less than 30 minutes. Recent studies have shown caffeine-induced improvement in several high-intensity tasks.
- Caffeine may raise serum FFA levels at rest just before exercise. Significantly higher levels of FFA during exercise have been reported in subjects who are not regular caffeine users or who have abstained from caffeine use for 4-7 days, using large doses of caffeine (15mg/kg).
- The current belief is that caffeine will enhance the metabolism of FFA, either the FFA delivered in the plasma or the FFA derived from the intramuscular stores of triglycerides.

Caffeine

- Current data suggest that caffeine ingestion prior to exercise will induce a glycogen-sparing effect.
- As the duration of the endurance event increases to an hour or more, caffeine may enhance performance. Caffeine may exert a stimulating effect on psychological processes, such as alertness and mood, which may diminish the perception of effort during exercise and thereby improve performance.

Caffeine

- Whereas previous research has shown that carbohydrate loading and having a high-carbohydrate breakfast prior to competition may negate the metabolic effects of caffeine, recent research suggests it does not appear to affect the ergogenic effect of caffeine adversely
 - One of the more important factors determining whether caffeine is an effective ergogenic aid is the caffeine status of the subjects
 - Consuming caffeine as a capsule in water significantly improved exercise performance on a treadmill while drinking the same dose in coffee did not
 - Caffeine combined with ephedrine may enhance exercise performance in maximal tasks, however the use of ephedrine in any dose is prohibited

Caffeine

- Caffeine does not impair performance in a half-marathon run outdoors under hot humid conditions
- The maximal dose recommended without exceeding the legal limit approximates 8-10 mg/kg body weight (4-6 cups of coffee or 3 Vivarin tablets)
- Individuals vary in their responses to any drug
- In general, studies have not reported a decrease in performance following caffeine ingestion, with the possible exception of exercising in a warm or hot environment
- Experiment with caffeine in training prior to use in competition
- Caffeine appears to be an effective ergogenic in doses that are safe and legal

Ephedrine

- Ephedrine is considered the most active alkaloid, and its synthetic version is ephedrine hydrochloride.
- Pure ephedrine is regulated as a drug, and the FDA allows only very small amounts in over-the-counter drugs such as cold medications.
- In general, although a powerful stimulant, ephedrine by itself has not been shown to consistently enhance exercise performance.
- Use of ephedrine, ephedra, and ma huang in competition is prohibited by WADA and the IOC.
- Of all dietary supplements, the Consumers Union noted that the herbal supplement ephedra may be the most hazardous. Bent and others noted that ephedra use is associated with a greatly increased risk for adverse reactions compared with other herbs.
- Freudenberger indicated ephedra was associated with heart arrhythmias, myocardial infarction, cardiac arrest, and even sudden death.

Sodium Bicarbonate Review

- Sodium bicarbonate is an alkaline salt found naturally in the human body. It is the major component of the alkaline reserve in the blood, whose major function is to help control excess acidity by buffering acids.
- During high-intensity anaerobic exercise, sodium bicarbonate helps buffer the lactic acid that is produced when the lactic acid energy system is utilized.
- Recent research by McNaughton has indicated 0.30 grams per kilogram body weight appears to be the optimum dose, with higher dosages providing no additional benefits.
- Based on the available scientific data, alkaline salt supplementation does not appear to be an effective ergogenic aid for exercise tasks dependent primarily upon the ATP-PCr energy system, since most studies have reported no beneficial effects on performance in exercise bouts lasting less than 30 seconds or in resistive exercise tasks stressing strength, power, or short-term local muscle endurance.

Sodium Bicarbonate

- Sodium bicarbonate supplementation appears to be an effective ergogenic aid in exercise tasks that depend primarily upon the lactic acid energy system (anaerobic glycolysis), such as a 400-meter dash in track.
- Sodium bicarbonate supplementation may also enhance performance in other types of exercise tasks involved in various sports, such as multiple sprints and high-intensity endurance runs, if such activities depend somewhat on the lactic acid energy system.
- Ingestion of sodium bicarbonate is generally regarded as safe, but may cause acute gastrointestinal distress and diarrhea. Supplementation over a longer time frame may be effective and less likely to cause intestinal problems.

Ergogenic Aids

- The use of anabolic drugs or hormones to increase body weight may be effective but may also lead to a variety of health problems.
- Research has shown that prohormone dietary supplements marketed as anabolic agents, such as androstenedione, do not effectively increase muscle mass or strength.
- Such prohormones have been classified as controlled anabolic steroids and their use is illegal.
- There is limited well-controlled research regarding the effect of herbals on exercise or sport performance, and that which is available suggests herbal sports supplements are not effective ergogenic aids.

Ergogenic Aids Review

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Table 11-8 An Evaluation of Ergogenic Aids Currently in the Limelight

Substance/Practice	Rationale	Reality
Useful in Some Circumstances		
Creatine	Increase phosphocreatine (PCr) in muscles to keep ATP concentration high	Use of 20 grams per day for 5 to 6 days and then a maintenance dose of 2 grams per day may improve performance in those who undertake repeated bursts of activity, such as in sprinting and weightlifting. Some of the muscle weight gain noted with use results from water contained in muscles. Endurance athletes do not benefit from use. Little is known about the safety of long-term creatine use. Continual use of high doses has led to kidney damage in a few cases. Cost: \$25 to \$65 per month.
Sodium Bicarbonate (baking soda)	Counter lactic acid buildup	Partially effective in some circumstances, such as wrestling, but induces nausea and diarrhea. The dose used is 300 milligrams/kilogram, given 1 to 3 hours before exercise. Cost: nil.
Caffeine	Increase use of fatty acids to fuel muscles, promote psychological effects	Drinking two to three 5-ounce cups of coffee (equivalent to 3 to 9 milligrams of caffeine per kilogram of body weight) about 1 hour before events lasting about 5 minutes or longer is useful for some athletes; benefits are less apparent in those who have ample stores of glycogen, are highly trained, or habitually consume caffeine; intake of more than about 600 milligrams (six to eight cups of coffee) elicits a urine concentration illegal under NCAA rules (greater than 15 micrograms per milliliter). A possible side effect is reduced body hydration and shakiness. Cost: \$0.08 per 300 milligrams.

Table 11-8 An Evaluation of Ergogenic Aids Currently in the Limelight

Substance/Practice	Rationale	Reality
Possibly Useful, Still Under Study		
Beta-hydroxy-beta methylbutyric acid (HMB)	Decrease protein catabolism, causing a net growth-promoting effect	Research in livestock and humans suggests that supplementation with this substance may increase muscle mass. Still, safety and effectiveness of long-term HMB use in humans is unknown. Cost: \$100 per month.
Glutamine (an amino acid)	Enhance immune function, preserve lean body mass	Some preliminary studies show decreased occurrence of upper respiratory tract infections in athletes with use. It also may promote muscle growth, but long-term studies are lacking. Protein foods are a rich source of glutamine. Cost: \$10 to \$20 per month for 1 to 2 grams per day.
Branched-chain amino acids (BCAA) (leucine, isoleucine, valine)	Important energy source, especially when carbohydrate stores are depleted	Supplementation of BCAA (7 to 20 grams per day) during exercise can increase BCAA in the blood when it has been lowered due to exercise, but there is no consistent evidence of improved performance. Carbohydrate feeding, by delaying use of BCAA as fuel, may negate the need for BCAA supplementation. Preliminary studies show that BCAA use increases muscle mass more than does carbohydrate supplementation alone in swimmers, but there are no studies regarding resistance training. Protein-rich foods are also rich in BCAA. Cost: \$20 per month.
Chondroitin and glucosamine	Aid in repair of joint damage	Most of the positive evidence is for repair of knee damage in older people. May be of use to athletes experiencing knee damage, but reliable evidence is lacking. Cost: \$30 per month.
Dangerous or Illegal Substances/Practices		
Anabolic steroids (and related substances, such as androstenedione)	Increase muscle mass and strength	Although effective for increasing protein synthesis, anabolic steroids are illegal in the United States unless prescribed by a physician. They have numerous potential side effects, such as premature closure of growth plates in bones (thus possibly limiting the adult height of a teenage athlete), bloody cysts in the liver, increased risk of cardiovascular disease, increased blood pressure, and reproductive dysfunction. Possible psychological consequences include increased aggressiveness, drug dependence (addiction), withdrawal symptoms (such as depression), sleep disturbances, and mood swings (known as "roid rage"). Use of needles for injectable forms adds further health risk. Banned by the International Olympic Committee.

(continued)

Table 11-8 (continued)

Substance/Practice	Rationale	Reality
Growth hormone	Increase muscle mass	At critical ages may increase height; may also cause uncontrolled growth of the heart and other internal organs and even death; potentially dangerous; requires careful monitoring by a physician. Use of needles for injections adds further health risk. Banned by the International Olympic Committee.
Blood doping	To enhance aerobic capacity by injecting red blood cells harvested previously from the athlete, or alternately the athlete may use the hormone erythropoietin (Epogen) to increase red blood cell number	May offer aerobic benefit; very serious health consequences are possible, including thickening of the blood, which puts extra strain on the heart; is an illegal practice under Olympic guidelines.
Gamma hydroxybutyric acid (GHB)	Promoted as a steroid alternative for bodybuilding	FDA has never approved it for sale as a medical product; is illegal to produce or sell GHB in the United States. GHB-related symptoms include vomiting, dizziness, tremors, and seizures. Many victims have required hospitalization, and some have died. Clandestine laboratories produced virtually all of the chemical accounting for GHB abuse. FDA is working with the U.S. Attorney's office to arrest, indict, and convict individuals responsible for the illegal operations.

Substances that are promoted to athletes but have yet to show any clear ergogenic effects include pyruvic acid (pyruvate), glycerol, ribose, medium chain triglycerides, L-carnitine, conjugated linoleic acid (CLA), bovine colostrum, insulin, and amino acids not already mentioned in this section. Any use of these products is not recommended at this time. Note that these substances are defined in the glossary.

Meals for Competition



Pre-Endurance Event Meal

- Light meal 2-4 hours prior to event
- Consisting primarily of carbohydrate (top off glycogen stores)
- Low fat (<25% of energy intake)
- Little fiber (prevent bloating, gas)
- Moderate protein
- Avoid fatty, fried foods
- Blended or liquid meal recommended for meals eaten 1-2 hours prior

Pre-competition Meals

- To help optimize training, consume a daily diet rich in nutrient-dense carbohydrates and high-quality protein in order to provide adequate energy for muscular activity and maintenance of an optimal body weight and composition.
- This diet will also provide adequate amounts of vitamins, minerals, and other nutrients to help maintain optimal immune system functions.
- Athletes should also maintain optimal fluid intake, particularly in high heat-stress environments.
- It is a well established fact that the ingestion of food just prior to competition will not benefit physical performance in most athletic events.

Major Goals of the Pre-competition Meal

- Pre-competition meal should do the following:
 - Allow for the stomach to be relatively empty at the start of competition
 - Help to prevent or minimize gastrointestinal distress
 - Help avoid sensations of hunger, lightheadedness, or fatigue
 - Provide adequate fuel supplies, primarily carbohydrate, in the blood and muscles
 - Provide an adequate amount of body water.

Pre-competition Meal

➤ Five key factors

1. Stomach should be relatively empty at the start of the competition - not to “full” and not “hungry”
2. No GI distress
3. Avoid hunger, lightheadedness, or fatigue
4. Adequate CHO for fuel source
5. Adequate water

Pre-competition Meal

- Eat 3-4 hours before competition – to allow for digestion to occur so that the stomach is relatively empty and hunger is minimized
- Pre-game jitters may slow digestion
- Avoid spicy foods, beans, or other foods that may cause GI distress
- Avoid high sugar foods - could cause cramps or nausea
- Meal - high in complex CHO's (oatmeal, bagel, whole grain toast) and low/moderate protein (skim milk, turkey breast, non/lowfat yogurt)

A significant inverse correlation between the amount of carbohydrate consumed and the finishing time of male triathletes in an Ironman triathlon, suggesting that increasing carbohydrate consumption during such a prolonged event may enhance performance

Recovery Meal

- Carbohydrate-rich meal within 2 hours after endurance event
 - Glycogen synthesis is the greatest
 - 1-2 gm CHO/kg body weight
- Repeat meal over the next 2 hours
- Choose high glycemic index foods
- Aim for 3:1 carbohydrate-to-protein
- Fluid and electrolyte replacement



Table 11-7 Sample Postexercise Meals for Rapid Muscle Glycogen Replacement

Option 1

1 regular bagel
2 tbsp peanut butter, smooth
8 fl oz fat-free milk
1 medium banana
562 kcal, 77 grams carbohydrate, 23 grams protein, 18 grams fat

Option 2

1 packet Carnation Instant Breakfast
8 oz fat-free milk
1 medium banana
1 tbsp peanut butter
Blend until smooth
438 kcal, 70 grams carbohydrate, 17 grams protein, 10 grams fat

Option 3

1.5 cans GatorPro (11 fl oz per can)
559 kcal, 89 grams carbohydrate, 26 grams protein, 11 grams fat

Replenishing Muscle Glycogen

- Availability of adequate carbohydrate
- Ingestion of carbohydrate soon after exercise
- Selection of high-glycemic-load carbohydrate
- Combination of carbohydrate and protein foods



Sports Nutrition

There is a large and rapidly expanding literature on the effects of dietary manipulation and supplementation on athletic performance.

The field of Nutrition is forever evolving and becoming more specialized as new research demonstrates the effects food chemicals have on one's DNA.

Although success in sports may be largely determined by genetic potential along with physical and mental training to prepare both mind and body for intense competition, applying current nutrition applications can give an athlete a competitive edge.

Thank You

