Timing the Bite: Nutrient Timing Strategies for Athlete Success

Honors Thesis

Presented in Partial Fulfillment of the Requirements for the

University Honors Program

Colorado State University

By

John Zembeck

Food Science and Human Nutrition

Chris Gentile, Food Science and Human Nutrition

Colleen Burke, Food Science and Human Nutrition

Charlotte Carlson, Food Science and Human Nutrition

Fall 2025

Timing the Bite: Nutrient Timing Strategies for Athlete Success

Written by John Zembeck

Table of Contents

Abstract

This thesis integrates evidence-based sports nutrition with culinary application to empower athletes through strategic nutrient timing and accessible meal preparation. Drawing on current research and personal experience in athletics and culinary science, it addresses common barriers to optimal fueling such as time constraints, cost, knowledge gaps, and psychological stress. This will also offer practical solutions tailored to collegiate athletes. The framework centers on four critical fueling windows: breakfast, pre-workout, post-workout, and before bed, each supported by physiological rationale and targeted recipes. Emphasis is placed on calculating energy and macronutrient needs using methods such as the Mifflin-St Jeor equation and activity multipliers, while highlighting the importance of consistent eating patterns, micronutrient adequacy, and individualized experimentation. Recipes are designed to be nutrient-dense, budget-conscious, and performance-enhancing, with adaptations for varied schedules and training loads. By merging scientific insight with culinary creativity, this resource aims to foster sustainable fueling habits that enhance performance, recovery, and long-term athlete health.

Introduction

I wrote this cookbook because of my passion for sports and cooking tasty food. I grew up playing sports my whole life, and as a former athlete, I learned firsthand how important proper nutrition was to performing my best. Not only can nutrition help an athlete to perform better, but it can also help to prevent injuries and speed up recovery times. This, paired with my time working in kitchens, has made me want to develop recipes for athletes to be at their best, crafting meals that are both functional and flavorful, fueling not just the body, but the mindset of performance.

Background

There are many reasons people may not eat a balanced nutritious diet: lack of knowledge, misconceptions about restrictiveness or cost, psychological factors, time constraints, or misinformation around nutrition.[1] While these factors apply to anybody, they are even more applicable to athletes. Athletes spend much of their day occupied with their sport through training, recovery, practice, travel, and games. College athletes also must manage being students. According to a former college soccer player, Sean Tinney, college athletes typically spend over twenty hours a week dedicated to their sport.[2] The last thing athletes seemingly have time for is to go shopping and cook. They are often exhausted and stressed out about their sports and might not know how to cook a proper meal. College students especially may also struggle to afford to eat a balanced diet.

Although these barriers exist, there are ways they can be overcome. To fight the lack of time, athletes can take a brief period to prepare a meal prep on a day off. Simple meals such as salads or one tray oven meals are easy to quickly make in bulk.[1] A great resource to help with saving time is a Walmart+ membership. For under 100 dollars yearly, individuals can get same day grocery delivery without leaving their house.[3] Another aspect to help with is the cost. For produce, buy fresh when in-season, and buy frozen and canned produce outside of harvest season.[1] Another way to save is by looking at protein sources the athlete consumes. Meat and seafood are expensive, but beans, lentils, and nuts are often much cheaper. These can also be bought in bulk due to the extended shelf life. Knowledge is also a big struggle, with a 2018 study of 128 division 1 athletes, 70 women and 58 men concluded that, on a 100-point scale, the average knowledge score was a 57.6%. Women performed better than men, averaging 66.5% compared to the men at 46.2%.[4] More studies need to be done because of the small sample size, but these data show the importance of needing to teach athletes proper nutritional education. According to the Dietary Guidelines for Americans 2020–2025, the Healthy Eating Index (HEI) is used to assess how closely Americans' diets align with recommended dietary patterns. The HEI scores range from 0 to 100, based on intake of key food groups. On average, adults aged 19–30 score 56, while those aged 31–59 score slightly higher at 59.[5] A well-rounded diet including fruits, vegetables, lean proteins, and healthy fats lays a solid foundation for overall health and performance. Even having a solid base can still be perfected by seeing a dietitian. Dietitians can help with identifying nutrient gaps and deficiencies and individualize diets based on lab data, food logs, and performance metrics to perfect their diet[1]. The last barrier of psychological factors includes stress. All people, including athletes, may be stressed out and crave foods high in sugar and saturated fat. Athletes can help with this by having snacks like fruit or yogurt to satisfy cravings in these times.[1]

This cookbook was born from a simple goal of empowering athletes with the knowledge and recipes they need to fuel effectively throughout the day. It will focus on the key meals that matter the most for optimal performance and recovery with breakfasts, pre- and post-workout meals, on-the-go snacks and before bed snacks. Each recipe is designed to face the common barriers that athletes deal with such as limited time and money, along with uncertainty about how to eat. By combining practical guidelines and performance-focused meals, it will support energy and health without sacrificing flavor.

Determine Energy Balance

The first step in determining a proper diet for athletes is to calculate their total daily energy expenditure (TDEE). This is determined by a combination of basal metabolic rate (BMR) or resting metabolic rate (RMR), the thermic effect of food (TEF) which is regarding

the calories used by the body to break down food, and the activity factor. Some factors that may increase energy needs include training, environmental exposure (heat, cold, or altitude), fat-free mass (FFM), stress, illness, or some medications. Factors that also negatively affect energy requirements include decreased training and FFM.[6] Our energy requirements also decline as we age.

Resting metabolic rate (RMR) is the largest component of energy expenditure and refers to the amount of calories needed to maintain a normal cellular and metabolic function in a resting state.[37] RMR is representative of up to 80 percent of the TDEE.[6,7] Individuals can calculate RMR via indirect calorimetry or via estimated calculations. Indirect calorimetry measures the intake of oxygen and the output of carbon dioxide to determine calories. estimation of RMR via calculations. includes the Mifflin-St Jeor Equation. The Mifflin-St Jeor equation utilizes age, weight, and height to predict RMR within ten percent.[8]

The TEF is about three to ten percent of TDEE.[9] It can vary depending on types of food, being higher in protein heavy diets, but is often not included in the TDEE.[6] To calculate an individual's TDEE, athletes can multiply the RMR by their physical activity factor. PAL is a multiplier that scales to the activity level of the individual to account for energy burned through movement, exercise, and daily tasks. This is the category that separates athletes from the general population. This is because the physical activity factor for sedentary adults is 1.4-1.69, where people who are moderately active recreationally had a factor of 1.7-1.99. Elite athletes have a factor at minimum of 2.0-2.4.[6]

While indirect calorimetry and predictive equations are the most accurate methods for determining TDEE, athletes can also estimate their needs using simpler approaches. One method is the energy availability concept, which suggests that consuming approximately 45 kilocalories per kilogram of fat-free mass supports optimal health and energy balance.[10] However, this approach requires access to body composition data, which may not always be available. Another option is a basic multiplication method: multiplying body weight by 14 to estimate daily energy needs.[10] While convenient, this method doesn't account for differences in activity level or body composition, so it may be less precise for athletes with unique training demands or learn mass profiles.[6]

Calculating Nutrient Needs

Once an athlete knows their TDEE, they can determine the ratio of nutrients they need. Protein, carbohydrates, and fats are the three macronutrients, with 4 kilocalories per gram for protein and carbohydrates, and 9 kilocalories per gram for fat.

Proteins are important for many body processes. Not only are they the building blocks of muscle, tendons, and other soft tissues, but they also are essential for building enzymes, hormones, and neurotransmitters for many bodily functions.[6] Three of the major organizations responsible for recommendations of protein needs are International Society for Sports Nutrition (ISSN), American College of Sports Medicine (ACSM), and the International Olympic Committee (IOC). Proteins are made up of essential and nonessential amino acids. While the body can synthesize nonessential amino acids, essential amino acids must be obtained through the diet because the body cannot produce them.[6] There is a not much of a consensus for total daily protein requirements, but the general dietary allowance for all people is 0.8g/kg body weight, and ranges between 1.2 to 2.0 grams per kilogram of body weight for athletes.[6,11] For specific athletes, endurance athletes are recommended 1.2 to 1.4 grams per kilogram, strength athletes are recommended 1.6 to 2.0 grams per kilogram with higher amounts towards gaining muscle and lower towards maintenance. For restricted weight athletes, 1.8 to 2.0 grams per kilogram.[12] This should amount to approximately fifteen to thirty percent of total calories consumed daily[6]. Recommended protein sources for athletes are lean meats, seafood and eggs and dairy, but also through plant-based protein sources of lentils, beans, and nuts.[6] Unlike carbohydrates and fats, protein is not stored in large deposits within the body, instead using a system of building blocks called an amino acid pool.[39] This is located within the blood and inside of cells. The amino acid pool refers to the circulating supply of free amino acids in the body that is constantly available for protein synthesis, energy production, and other metabolic functions. It's a dynamic system that balances dietary intake, protein breakdown, and cellular demand. Spreading protein consumption thus helps maintain a steady supply of amino acids to the pool for use.[39]

Carbohydrates are the main energy source during high-intensity activity for athletes.[6] Carbohydrate needs have a lot more variance among athletes and the information online can cause confusion for athletes. The ACSM lists a daily recommendation of 6-10g/kg/bw for all athletes, whereas the ISSN and the IOC have varied recommendations. The ISSN recommends 3-5g/kg/bw for general physical activity of 30-60 minutes daily, three to four times a week, 5-8g/kg/bw for moderate to high intensity exercise 2-3 hours, 5-6 times a week. For the most active, they recommend 8-10g/kg/bw for high volume intense exercise of 3-6 hours, 5-6 times per week. For the IOC recommendations, it is primarily split by intensity of exercise or by endurance vs strength athletes. They recommend 3-5g/kg/bw for low intensity exercise, 5-7g/kg/bw for moderate, and 8-12g/kg/bw for extreme commitment. For endurance athletes, they recommend 6-10g/kg/bw, and 4-7g/kg/bw for strength-based athletes.[6] Although these variances in numbers can make it seem difficult to decide what works, total carbohydrate consumption

should be about 45 to 65 percent of total daily calories based off the acceptable macronutrient distribution ranges in the DGAs.[5]

Fat requirements for athletes are 20-35% of total daily calories.[13] This should come from at most 10% saturated fat, with the rest being unsaturated fats.[14] This recommendation is like that of the average person. Per the IOC, they do not recommend people to consume under 15-20% of their total calories as fat is vital for many bodily functions. Fats are responsible for cell membrane structure, fat-soluble vitamin absorption, hormone balance, brain health, and muscle metabolism energy.[13] Healthy sources of fat include salmon, nuts and nut butter, and avocado, as well as coconut and olive oil, but people can take omega-3 supplements if needed. Omega-3s can also help to counteract inflammation and free radicals from exercise.[6]

Outside of the macronutrients discussed above, there are also micronutrient needs that must be met. Micronutrients include vitamins and minerals and, despite having no energy, they are just as vital for athletes maintaining health and performance. Due to the stress of exercise, athletes may have increased micronutrient requirements, but they should be able to achieve this through a well-balanced diet.[6] There are no general micronutrient guidelines for athletes. Common deficiencies include iron, vitamin D, calcium, and some antioxidants such as vitamins E and C.[10] Vegetarians may require vitamin B_{12}, iron, calcium, vitamin D, riboflavin, and zinc supplementation based on their food preferences.[13]

Nutrition Timing Basics

Nutrient timing can vary wildly based off many distinct factors. One factor is the type of training, whether the athlete is practicing, strength training, conditioning, or recovery.[6] Dietary preferences and schedules are also major factors in timing. There are more variables from the length and intensity of training, seen specifically in the carbohydrate recommendations seen above. Timing also varies leading to competition. A pre-game meal will vary in calories and nutrients based on how far before the athletes' game is. Some athletes exercise twice in the same day with a combination of lifting, practicing, or multiple games. These athletes also have varied timing, where there needs to be quick refueling in between workouts or games. The United States Anti-Doping Agency (USADA) has three main points around timing. These are minimizing the time without eating, focusing on digestibility, and experimenting around what the athlete can tolerate before and after exercise.[15]

Consider how often athletes eat. How do athletes feel when too long passes without eating, or when athletes do not have a consistent eating schedule?[15] Athletes often go for

extended periods without eating, then suffer from cravings that they cannot stop. Under fueling during the day for athletes can lead to overeating. Athletes may then even overly restrict the next day to counteract for the overeating patterns in the prior day. Consistent eating patterns can help to keep food stores full, keep appetite-related hormones regular, and enhance recovery. Being consistent means eating every three hours and making sure each meal or snack includes both protein and complex carbohydrates. Keep a list of foods that athletes enjoy to help performance to reduce difficulty of making food choices when hungry.

Nutrition isn't just about what athletes eat, it's equally about when athletes eat it.[15,16] Timing plays a critical role in how well athletes' bodies perform, especially in the hours leading up to training. While foods rich in protein, fiber, and fat are essential for overall health and recovery, consuming them too close to a workout can lead to gastrointestinal discomfort, including cramping, bloating, and sluggishness. These nutrients digest more slowly and may divert blood flow away from working muscles, compromising performance. That's why the pre-workout window demands a strategic approach: the focus should be on carbohydrate-rich foods that are low in fiber and provide quick, accessible energy without taxing the digestive system. This cookbook will explore the science behind pre-workout fueling and offer practical, athlete-tested meals tailored to different training intensities and schedules. Whatever an athlete is preparing for, the pre-workout section will help athletes fuel with confidence and precision.

The third point centers on experimentation, a cornerstone of personalized nutrition. While general fueling principles provide a solid foundation, the reality is that nutrition is highly individualized, especially for athletes whose training loads, digestive tolerance, and metabolic responses vary widely.[17] Non-competition days offer a valuable opportunity to assess and refine athletes' fueling strategy without the pressure of peak performance. Use these days to experiment with meal timing, portion sizes, macronutrient ratios, and food types to discover what leaves athletes feeling energized, focused, and adequately fueled. Pay attention to how an athlete's body responds: Are athletes crashing in mid-afternoon? Feeling bloated during training? Struggling to sleep after late meals? These signals are data. Keep a simple log or journal to track observations; what worked, what didn't, and how athletes felt before, during, and after training. Over time, this self-awareness becomes a powerful tool for building a fueling routine that's not just effective, but sustainable. Remember, the goal isn't perfect, it's adaptability. What works during off-season training may need to shift during competition weeks, travel, or recovery phases. By embracing experimentation, athletes empower themselves to make informed, confident choices that support both performance and long-term health.

There are four crucial times for meal timing that will be emphasized throughout this cookbook: breakfast, pre-workout, post-workout, and before bed. Each of these windows represents a unique physiological opportunity to optimize performance, recovery, and long-term adaptation. Breakfast jumpstarts metabolism and replenishes glycogen stores after an overnight fast. Pre-workout meals prime the body for exertion, enhancing energy availability and mental focus.[18] Post-workout nutrition accelerates recovery by restoring glycogen and stimulating muscle protein synthesis.[19] Before bed, targeted fueling with casein protein supports overnight repair and prevents catabolism during sleep.[20] Recognizing the demanding schedules athletes face, from early practices to late classes, this cookbook also includes a dedicated section for on-the-go nutrition, offering practical, portable snack solutions that maintain energy balance and prevent under-fueling throughout the day. Together, these sections form a strategic framework for fueling with intention, not just eating with convenience.

Breakfast:

Eating breakfast is important for everyone but has higher importance for athletes. Breakfast serves as the foundation for an athlete's day. It replenishes glycogen stores, supports mental focus and mood, and sets the stage for effective fueling throughout the day.[18] These meals are designed for athletes with workouts around noon or later. However, if training in the early morning, athletes can swap the breakfast and pre workout times. For optimal breakfast fueling, aim for 1-1.5g/kg/bw of carbohydrates and 0.4g/kg/bw of protein. This will help replenish glycogen stores, enhance muscle repair, and support sustained energy throughout the day.[18,21] If athletes take the proposed 75kg athlete from above, that will mean a breakfast with 75-112g of carbohydrates, with 30g of protein. This could be achieved through use of oat dishes, eggs, or protein pancakes with fruit.

Eating breakfast was associated with a lower fat and higher carbohydrate intake over 24 hours compared to those who skipped breakfast.[22] This study used adults 19-64 using seven days of weighed food records totaling out to just over 12,000 occasions to access breakfast quality with the dietary quality the rest of the day. Compared with people who were skipping breakfast, micronutrient intakes were marginally higher on days when non-cereal breakfast was consumed but 30–90% higher on days where cereal was consumed.[18] A cereal breakfast also helps meet nutritional guidelines for fat, SFA, NMES and dietary fiber, but just as importantly, in enhancing micronutrient intakes. Other studies have generally demonstrated a favorable impact of a breakfast habit on metabolism, body weight, and some aspects of cognitive function. There was also a study showing that a breakfast consisting of twenty percent of daily energy requirements and 1.5 grams of carbohydrates per kilogram of body weight leads to 17 percent higher back squat repetitions and six percent higher repetitions of bench press completed when compared to people who skip breakfast.[18]

Avocado Toast – 1 Serving

Ingredients

- **2 slices of sourdough**
- **1/2 of avocado**
- **1/2 cup of butter beans**
- **2 large eggs**
- **1 tablespoon everything bagel seasoning**

Directions

1. **Toast sourdough bread**
2. **Mash avocado and beans**
3. **Spread avocado and bean mixture over toast**
4. **Cook eggs to desired liking (scrambled, poached, fried)**
5. **Top toast with egg**
6. **Sprinkle everything bagel seasoning as garnish**

Nutrition

- **Calories: 787 kcal**
- **Carbohydrates: 83g**
- **Protein: 33g**
- **Fats: 34g**

PB Honey Banana Toast – 1 Serving

Ingredients

- **2 slices of sourdough**
- **1/2 cup of Greek yogurt**
- **3 tablespoons of peanut butter**
- **1 large banana**
- **1 tablespoon of honey**

Directions

1. **Toast sourdough**
2. **Mix yogurt and peanut butter**
3. **Spread mixture onto toast**
4. **Slice banana, layering onto toast**
5. **Drizzle with honey**

Nutrition

- **Calories: 781 kcal**
- **Carbohydrates: 108g**
- **Protein: 34g**
- **Fat: 28g**

Egg Bake: - 4 Servings

Ingredients

- **1 cup cottage cheese**
- **10 large eggs**
- **1/4 cup of milk**
- **2 large, diced russet potatoes**
- **1 cup diced ham**
- **1/2 cup of spinach**
- **1 cup diced bell peppers**
- **4 cups of black beans**
- **3/4 cup shredded cheddar**

Directions

1. **Preheat oven to 375*F, grease 9x13” pan**
2. **Blend cottage cheese**
3. **In large bowl, whisk eggs, cottage cheese, and milk**
4. **Fold in potatoes, beans, ham, veggies, and half of cheese**
5. **Pour into 9x13” pan, sprinkle rest of cheese**
6. **Bake 35-40 minutes until top is browned (broil extra 3-5 minutes for extra brown top)**
7. **Cool slightly, cut into 4 servings**

Nutrition

- **Calories: 723 kcal**
- **Carbohydrates: 86g**
- **Protein: 52g**
- **Fat: 20g**

Overnight Oats – 1 Serving

Ingredients

- **1/2 cup of oats**
- **3/4 cup of milk**
- **1/2 cup Greek yogurt**
- **1/4 scoop vanilla protein**
- **1 teaspoon chia seeds**
- **1 sliced banana**
- **1 tablespoon honey**
- **1/2 cup of blueberries**
- **1/2 cup of strawberries**
- **2 tablespoons coconut shavings**

Directions

1. **Mix oats, milk, yogurt, protein, and chia seeds in jar**
2. **Fold in bananas and honey**
3. **Refrigerate for 4 hours, but better overnight**
4. **Add blueberries and strawberries**
5. **Top with coconut shavings**

Nutrients

- **Calories: 772 kcal**
- **Carbohydrates: 112g**
- **Protein: 39g**
- **Fat: 25g**

Pre-Workout:

Before working out it is vital to eat for many reasons. Athletes need to maximize and top off muscle glycogen, delay fatigue, enhance output while minimizing gastrointestinal distress. Although a similar meal to breakfast, there is a distinct difference. Breakfast is a balanced meal to prepare for the start of their day, where the pre workout or competition meal is targeted towards precision, timing, and digestibility. The pre-exercise nutritional window has often been thought to be within an hour of a training session, but studies have shown the impact of feeding up to four hours before exercise.[23] Eating before competition or training can increase performance when compared to exercising in a fasted state.[23, 24]

Carbohydrates and fatty acids are the main sources of energy during a workout, with fats being the prime substrate for low intensity exercise and carbohydrates being the primary energy source for high intensity.[23] To find an ideal fuel substrate for their sport, athletes can test their respiratory exchange rate (RER) on a scale of 0.7-1.15. A lower RER shows use of fats, where a higher RER means the athlete is using more carbs.[25] Consuming a meal three to four hours before exercise is optimal due to providing proper energy supply while also giving proper digestion time.[24] It is recommended for these meals to range from 500-1,000 calories, with it being smaller and closer to competition. The meal should be higher in complex carbohydrates, which will digest slowly over time to provide a steady energy source when compared to simple carbohydrates that would cause a spike in blood glucose or proteins and fats.[23,24]

Studies have shown performance benefit to consuming 1.1-2.2 g/kg carbohydrates one-hour pre-exercise.[23] A study by xxx et al., demonstrated that a large bolus of carbohydrate four hours before exercise produced an ergogenic effect to distance cyclers when compared to a placebo.[23] Consuming protein, specifically whey, before working out has been shown to bolster the post-exercise response for muscle protein synthesis.[26] Additionally, pre-training consumption of both CHO (0.5–2.2 g/kg) and PRO (0.3–0.35 g/kg) can aid not only in maximizing acute performance, but also in facilitating recovery and adaptation from that training. This likely depends on the quantity and timing of post-exercise protein intake as well.[23] Concentrated sweets should also be avoided too close to exercise, as it can draw fluid into the gastrointestinal tract and contribute to dehydration, cramping, nausea, and diarrhea.[24] Make sure to consume adequate fluids during this time and avoid excessive caffeine consumption to avoid dehydration. It is important to eat familiar foods before an event, so it is known that they can be tolerated before exercising.[24]

Smaller meals should be consumed if less time remains before an event. If a competition is less than two hours away, athletes may benefit from consuming a liquid pre-game meal to avoid gastrointestinal distress. Remember to include water with this meal.

There is also a slight difference between fueling for competition compared to fueling for training. For a 75 kg athlete pre-training, it is recommended to have 20g protein, 75-90g carbohydrates, and under 10g fat. The main differences before competition are the increased carb and protein intake from training. Pre competition meal recommendations include 20-30g protein and 110-150g carbohydrates for that same athlete.[23]

Pancakes – 4 Servings

Ingredients

- **2 cups A.P. flour**
- **4 tablespoons sugar**
- **4 teaspoons baking powder**
- **1/2 teaspoon salt**
- **1 1/2 cup of milk**
- **1 large egg**
- **5 tablespoons of margarine**
- **2 teaspoons vanilla extract**
- **4 tablespoons of maple syrup**

Directions

1. **In a large bowl, combine flour, sugar, baking powder, salt**
2. **Form well in middle, add milk, 4T margarine, egg, and vanilla**
3. **Mix batter until no visible lumps, not completely smooth**
4. **Heat griddle medium heat, grease surface with margarine**
5. **Pour 3T sized pancakes, spaced evenly onto griddle**
6. **Cook until bubbles appear on the surface and edges are set**
7. **Flip, and cook until golden brown.**
8. **Top with maple syrup**

Nutrition (4 pancakes, 4in diameter)

- **Calories: 503 kcal**
- **Carbohydrates: 82g**
- **Protein: 13g**
- **Fats: 14g**

Bagels and Lox – 1 Serving

Ingredients

- **1 bagel**
- **2 tablespoons cream cheese**
- **1 oz lox**
- **1 tablespoon capers**
- **1 tablespoon red onions**
- **1 tablespoon fresh dill**
- **1 medium apple**

Directions

1. **Slice bagel, toasting if you want the crunch**
2. **Spread cream cheese**
3. **Arrange smoked salmon or salmon lox of choice**
4. **Garnish with capers, onion, and dill**

Nutrition

- **Calories: 443 kcal**
- **Carbohydrates: 81g**
- **Protein: 18g**
- **Fat: 6g**

Pesto Pasta – 1 Serving

Ingredients

- **1 cup dry pasta**
- **1/4 cup sun-dried tomatoes, drained**
- **1/2 cup of kale, stemmed, rough chopped**
- **1/2 cup of spinach**
- **2 tablespoons of pesto**
- **1 tablespoon grated parmesan**
- **1/ teaspoon salt**

Directions

1. **Bring pot of water to a boil, add salt**
2. **Cook the pasta until al dente**
3. **Drain and set aside, saving 1/4 cup of salted pasta water**
4. **Preheat pan to medium heat**
5. **Add sun-dried tomatoes, kale, and spinach to the skillet**
6. **Cook for 2–3 minutes until greens are wilted and tender**
7. **Add all of pasta, pesto, and half of the reserved pasta water, adding more if needed**
8. **Toss everything together until evenly coated**
9. **Sprinkle with grated parmesan and serve warm.**

Nutrition

- **Calories: 514 kcal**
- **Carbohydrates: 76g**
- **Protein: 19g**
- **Fat: 16g**

Post-Workout:

After working out, athletes can experience fatigue, muscle soreness, and a decrease in performance.[27] Exercise causes a catabolic state, to allow for glucose and fatty acids to be released into the bloodstream for energy. It also leads to elevated cortisol and catecholamines, low insulin levels, reduced glycogen availability and increased muscle protein breakdown rate.[27] Eating after a workout will help to transition the body from a catabolic state to an anabolic state. Carbohydrates and protein ingestion will increase blood glucose, decrease cortisol, and increase substrate availability.[27]

Within the first thirty to sixty minutes following exercise GLUT4 transporters are hyperactive. GLUT4 transporters are transport proteins beneath the membranes of cells that surface due to insulin reaching cells. During exercise though, AMP-activated protein kinase, Calcium, and Nitric oxide signaling can cause these GLUT4 to come to the surface of cells.[38] This leads to higher uptake of glucose into muscle cells to restore glycogen levels immediately post-exercise.[28] Consuming a high dose of carbohydrates immediately after exercise, typically between 1.0-1.85g/kg/bw, has been shown to maximize muscle glycogen synthesis rates. Adding specific amino acids or protein can further enhance this effect, supporting faster recovery and improved performance in subsequent sessions.[28] Because of this, timed nutrient intake promotes restoration of muscle glycogen and protein synthesis, while helping to reduce muscle protein breakdown.[29] In doing so, post-exercise nutrient timing may be an essential aspect of an optimal training program as it has the potential to improve the rate of recovery and maximize training adaptations.[27] This becomes even more vital when needing to refuel for days with multiple bouts of exercise from practices or games.

It has been suggested that an optimal restoration of muscle glycogen post-exercise can occur through carbohydrate intakes of 1.0–1.5 g/kg/h initiated within the first 2 h after the cessation of exercise and should continue for 4 to 6 hours with more frequent feedings being favorable for maximal glycogen resynthesis.[27] Protein is also vital for recovery. The addition of protein at 0.4 g/kg per hour to carbohydrates may stimulate glycogen synthesis to a greater extent than carbohydrates alone.[27] Protein is also the key nutrient involved in stimulating muscle protein synthesis.[30] Carbohydrates play a vital role in maintaining healthy glucose levels during and after exercise, helping to prevent the body from breaking down protein into amino acids for energy. When it comes to protein, the key priority is consuming rapidly digestible, high-quality sources that contain sufficient levels of essential amino acids to support muscle repair and recovery.[27]

The exact amount of protein that is optimal for MPS is unclear, but studies suggest that rates from 20-40g of a high-quality protein may maximize MPS. Some studies show 20g

can maximize muscle protein synthesis.[31] This study characterized the dose-response relationship of muscle protein synthesis in resistance-trained athletes who ingested increasing doses of whey protein (0, 10, 20, or 40 g) after a standardized breakfast and unilateral leg resistance exercise. The primary finding was that a 20-g dose of whey protein was sufficient for the maximal stimulation of MPS in both rested and exercised muscle, as the larger 40-g dose failed to augment MPS further.[31] Another study found that 40g stimulated muscle protein synthesis best.[32] This research assessed the muscle protein synthesis response to 20 g versus 40 g of whey protein following a bout of whole-body resistance exercise in resistance-trained athletes, specifically examining the influence of high versus low lean body mass (LBM). Contrary to findings from studies involving only leg exercise, the overall results showed that ingesting 40 g of whey protein stimulated a significantly greater MPS response than 20 g, suggesting that the protein dose needed for maximal MPS increases when a greater total amount of muscle mass is activated during exercise.[32] Regardless of the dose of protein post workout, the consumption may be inconsequential however if not meeting their protein goals spread throughout the day.[27] The bottom line is that quality of training and total protein intake in a day are more important than acute post-workout protein ingestion for strength and hypertrophy. Once training quality and total protein intake are both accounted for, PRO timing may provide the added support to optimize performance.[27] For resistance athletes, they aim for at least 40g of protein, with 0.5g/kg of carbs being beneficial. For those endurance athletes who often deplete their glycogen stores through long durations of exercise, 1-1.5g/kg carbohydrates and 0.4g/kg of protein is ideal.[21,27] Chocolate milk is one of the best immediate carb and protein items, as the liquid also helps with low hunger levels in some athletes.[24]

Chicken Parm w/Spaghetti – 6 Servings

Ingredients

- **3 large chicken breasts**
- **1 large egg**
- **1/2 cup of water**
- **1 1/2 cup of breadcrumbs**
- **3 tablespoons grated parmesan**
    - **(1T Breading, 2T bake topping)**
- **1 tablespoon dried oregano**
- **1 teaspoon basil**
- **1/2 teaspoon garlic powder**
- **1/2 teaspoon dried thyme**
- **3 cups of diced butternut squash**
- **3 cups of diced carrots**
- **3 tablespoons of maple syrup**
- **1/4 teaspoon salt**
- **3 cups of jarred tomato sauce**
- **1 cup shredded mozzarella**
- **3 cups of cooked spaghetti**

Directions

1. **Preheat oven to 350*F, lightly grease 9x13” dish**
2. **Prepare breading:**
    a. **In one bowl, whisk one large egg with water**
    b. **In another bowl, mix breadcrumbs, 1T parmesan, oregano, basil, garlic powder, thyme**
3. **Bread the chicken:**
    a. **Dip each chicken breast into the egg mixture, then into the breadcrumb mixture**
    b. **Repeat previous step for a thicker fry**
    c. **Place breaded chicken into the baking dish**

4. **Vegetable Prep**
    a. **In a separate dish, mix squash, carrots, syrup, salt**
5. **Bake both chicken and veggies for 40 minutes**
6. **Spread tomato sauce and cheese on chicken**
7. **Bake another 15 minutes to melt the cheese.**
8. **Serving:**
    a. **Place spaghetti mixed with remaining sauce**
    b. **Rest chicken on top of pasta**
9. **Put roasted vegetables on the side**

Nutrition

- **Calories: 520 kcal**
- **Carbohydrates: 78g**
- **Protein: 38g**
- **Fats: 7g**

Meat and Bean Chili – 8 Servings

Ingredients

- 1 tbsp vegetable oil
- 2 large, diced onions
- 2 medium bell peppers
- 2-3 diced jalapenos
- 8 cloves garlic
- 1 lbs ground turkey
- 1/4 cup of chili powder
- 2 tbsp cumin, 1 tsp paprika
- 28 oz can diced tomatoes
- 2 15oz cans drained kidney beans
- 14 oz can beef broth
- 15 oz can pinto beans, drained and rinsed
- 15 oz can navy beans, drained and rinsed
- 4 cups of corn
- 2 oz tortilla strips

Directions

1. Heat oil in large pot on medium-high heat
2. Cook onions and peppers until brown, for about 6 minutes
3. Add jalapeños and garlic, cook for 1 minute
4. Add turkey, cooking until browned, for about 5 minutes
5. Add other ingredients except tortilla strips
6. Bring chili to a boil, simmer on low for 45-60 minutes

Nutrition

- Calories: 533 kcal
- Carbohydrates: 79g
- Protein: 3g
- Fat: 13g

Chicken Fajitas – 6 Servings

Ingredients

- **3 chicken breasts**
- **1 onion, sliced thin**
- **3 bell peppers, sliced thin**
- **2 tablespoons fajita seasoning**
- **2 tablespoons of olive oil**
- **1 lime**
- **2 cups of black beans**
- **12 flour tortillas, fajita size**
- **Optional: shredded cheese, sour cream, salsa, guacamole**

Directions

1. **Sprinkle fajita seasoning on chicken, pressing it in**
2. **Heat oil in pan on medium heat**
3. **Sear chicken 7-8 minutes per side**
4. **Remove from pan, resting 2-3 minutes before slicing**
5. **Cook peppers and onions for 4-5 minutes, stir frequently**
6. **Add beans and put chicken back in, then squeeze in lime**
7. **Serve with warmed tortillas, topped with optional toppings of choosing.**

Nutrition

- **Calories: 600 kcal**
- **Carbohydrates: 83g**
- **Protein: 34g**
- **Fat: 15g**

Before Bed:

While protein intake throughout the day is vital, the extended fasting period during overnight sleep represents a significant challenge to maintaining an anabolic state. During this time, without nutrient intake, muscle protein synthesis rates are typically low, and the body can enter a catabolic state where protein breakdown exceeds synthesis.[34,35] Recent research has identified pre-sleep protein ingestion as an effective nutritional strategy to counteract this overnight catabolism, stimulate muscle protein synthesis, and enhance the overall adaptive response to exercise.[33,35,36]

Milk protein, a common source for post-exercise recovery, is composed of two main types: whey and casein.[33] Casein constitutes 75-80% of the protein in milk and is classified as a high-quality protein, providing all essential amino acids and demonstrating high digestibility.[33] The key characteristic that makes casein particularly suitable for pre-sleep consumption is its rate of digestion. Casein is known as a "slow" protein due to its unique behavior in the stomach.[33] When exposed to the acidic environment of the stomach, casein proteins form a gel or precipitate, which significantly slows the rate of gastric emptying. This delayed emptying results in a slow, steady, and prolonged release of amino acids into the bloodstream.[33,35] This contrasts sharply with whey, a "fast" protein, which is digested and absorbed rapidly, causing a quick but transient spike in plasma amino acid levels and MPS.[33,35] Studies have shown that while whey protein might peak MPS rates around 60 minutes after ingestion, casein can sustain an increase in MPS for up to six hours.[33] This prolonged elevation in circulating amino acids is ideal for the 7–8-hour overnight period, providing the necessary building blocks to support muscle repair and synthesis throughout the night.[35]

The fundamental mechanism by which pre-sleep protein enhances recovery is by increasing the availability of amino acids during sleep.[33] A foundational study demonstrated that ingesting 40 grams of casein 30 minutes before sleep following an evening resistance exercise session leads to effective digestion and absorption throughout the night.[36] This resulted in a sustained rise in circulating amino acid levels, a condition known as hyperaminoacidemia.[33,34] This increased availability of amino acids directly fuels muscle protein synthesis, inhibits protein breakdown, and shifts the body from a net catabolic state to an anabolic one.[33]

In the same study, this pre-sleep protein intake led to a significant increase in whole-body protein synthesis rates and dramatically improved the net protein balance overnight.[34] While the placebo group had a negative balance, the protein group achieved a positive balance.[34] Furthermore, mixed muscle protein synthesis rates were found to be approximately 22% higher in the protein group, a finding that reached borderline statistical

significance.[34] This provides direct evidence that the protein consumed before sleep is not only absorbed but is actively used to build new muscle tissue during the overnight recovery period.

The effectiveness of pre-sleep protein supplementation appears to be highly dependent on the amount of protein consumed. Studies that have reported significant positive effects on acute muscle recovery and MPS have consistently used larger doses.[33] A consensus from the available research suggests that at least 40 grams of protein are required to elicit a robust and detectable increase in muscle protein synthesis rates throughout the night.[35] Studies using 40-48 grams of pre-sleep casein observed positive outcomes. Conversely, studies that provided a more moderate amount, such as 30 grams of casein, did not find a statistically significant increase in overnight myofibrillar protein synthesis rates.[36] This suggests that a distinct dose-response relationship exists for the prolonged overnight period, which differs from the immediate post-exercise window where 20 grams of protein may be sufficient to maximize MPS.[36]

The anabolic effect of pre-sleep protein is significantly amplified when it is combined with resistance exercise performed earlier in the evening. Exercise sensitizes the muscle to amino acids, enhancing the muscle protein synthetic response to protein ingestion.[35] Research has shown that when pre-sleep protein ingestion follows an evening workout, a greater proportion of the protein-derived amino acids are directed toward the synthesis of new myofibrillar proteins. One study found that myofibrillar MPS rates were 37% higher when 30 grams of pre-sleep casein was combined with resistance exercise compared to consuming the protein alone.[36] This demonstrates that the combination of evening exercise and pre-sleep protein is a highly effective strategy to enhance the efficiency of protein utilization for muscle accretion.

The acute increases in overnight MPS are not just temporary benefits; they are believed to be predictive of long-term muscle adaptations. Supporting this, a 12-week study on healthy athletes undergoing a resistance training program found that those who consumed protein (27.5 g) before sleep showed significantly greater increases in both muscle mass and strength compared to a non-caloric placebo group.[33] This indicates that the cumulative effect of improved overnight recovery can translate into superior long-term training outcomes. From a practical standpoint, it is concerned that a pre-sleep protein meal might negatively affect sleep, or next-day appetite appear unfounded in healthy individuals. The sources indicate that pre-sleep protein ingestion does not seem to affect sleep quality or reduce appetite at breakfast the following morning. Additionally, some evidence suggests it may help reduce markers of muscle soreness, further aiding recovery.[33,36]

Berry Yogurt Parfait – 1 Serving

Ingredients

- **1 1/2 cup yogurt**
- **1 tablespoon honey**
- **1/4 cup blueberries**
- **1/4 cup of strawberries**
- **1/4 cup granola**

Directions

1. **Put half of yogurt in a jar**
2. **Layer with half of fruit**
3. **Add rest of yogurt**
4. **Add rest of fruit**
5. **Drizzle with honey**
6. **Add granola to the top**

Nutrition

- **Calories: 451 kcal**
- **Carbohydrates: 56g**
- **Protein: 41g**
- **Fat: 8g**

Cottage Cheese Bowls – 1 Serving

Ingredients

- **1 1/2 cup cottage cheese**
- **1 tablespoon honey**
- **1/4 cup mango**
- **1/4 cup of pineapple**
- **1 oz shaved coconut**
- **1/4 cup granola**

Directions

1. **Put cottage cheese into a bowl**
2. **Drizzle honey onto the cottage cheese**
3. **Add pineapple, mango, and shaved coconut evenly on top**
4. **Top with granola**

Nutrition

- **Calories: 666 kcal**
- **Carbohydrates: 76g**
- **Protein: 42g**
- **Fat: 26g**

Protein Banana Pudding - 1 Serving

Ingredients

- **2 ripe bananas**
- **1 cup Greek yogurt**
- **1 cup milk**
- **1/2 scoop vanilla protein**
- **1 tsp vanilla extract**
- **1/4 tsp cinnamon**
- **Optional: Extra sliced bananas, Nilla wafers, whipped cream**

Directions

1. **In bowl, mash bananas with a fork until smooth**
2. **Add yogurt, milk, protein, vanilla, and cinnamon to bananas**
3. **Whisk ingredients until combined and smooth**
4. **If desired, add any optional toppings to liking**

Nutrition

- **Calories: 515 kcal**
- **Carbohydrates: 78g**
- **Protein: 47g**
- **Fat: 3g**

Chocolate PB Banana Shake – 1 Serving

Ingredients

- 1 cup of whole milk
- 1 scoop chocolate protein powder
- 1 tablespoon honey
- 1 tablespoon peanut butter
- 1 banana

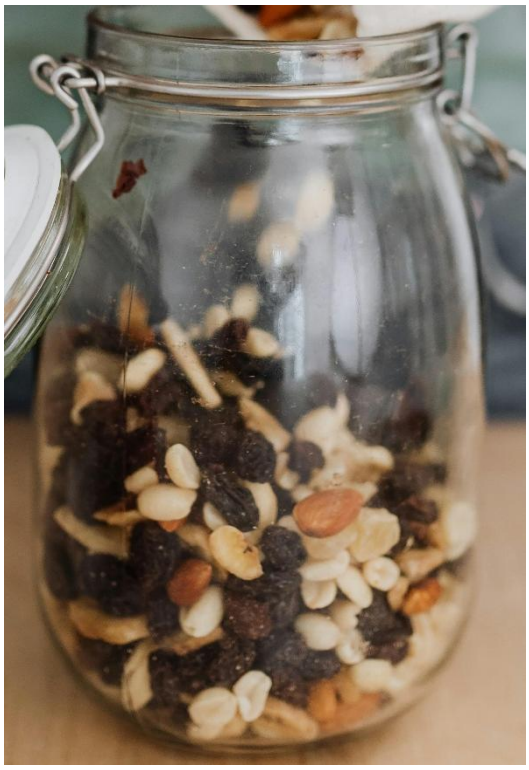
Directions

1. Pour all ingredients
2. Blend until smooth, scraping the sides if needed.
3. Pour into desired glass

Nutrition

- Calories: 546 kcal
- Carbohydrates: 66g
- Protein: 37g
- Fat: 18g

Homemade Trail Mix – 16 Servings



Ingredients

- **1 cup roasted, salted peanuts**
- **1/2 cup raw, unsalted almonds**
- **1 cup of shelled sunflower seeds**
- **1 cup of raisins**
- **1/2 cup dark chocolate chips**
- **1/4 teaspoon salt**

Directions

1. **Pour ingredients into a large bowl**
2. **Mix well**
3. **Pour into desired storage container**

Nutrition

- **Calories: 202 kcal**
- **Carbohydrates: 15g**
- **Protein: 6g**
- **Fat: 15g**

Homemade Energy Balls – 5 Servings

PHOTO CREDIT: Energy Balls {No Bake with 7 Recipes} -WellPlated.com

Ingredients

- 1 1/4 cups of rolled oats
- 2 tablespoons chia seeds
- 1/2 cup creamy peanut butter
- 1/3 cup of honey
- 1 teaspoon vanilla extract
- 1/4 teaspoon kosher salt
- 1/2 cup of chocolate chips

Directions

1. Add all ingredients into a large mixing bowl, mix well
2. It should resemble a somewhat sticky dough holding together when lightly squeezed.
3. If it is too wet, add oats. If it is too dry, add peanut butter.
4. Put into fridge for 30 minutes to make rolling easier later
5. Portion into 1-inch balls (20 total)

Nutrition (4 balls per serving)

- Calories: 419 kcal
- Carbohydrates: 51g
- Protein: 11g
- Fat: 21g

Conclusion

This cookbook bridges the gap between scientific theory and everyday practice, empowering athletes with evidence-based strategies for fueling. By blending culinary creativity with performance nutrition research, this cookbook transforms complex concepts into practical, visually engaging tools that athletes can apply in real time. Each section is designed to meet athletes where they are; addressing barriers, enhancing timing, and supporting sustainable habits that align with their goals. Ultimately, this resource serves not just as a guide, but as a catalyst for performance, resilience, and long-term well-being.

Works Cited:

1. Barriers to healthy eating(And how to overcome them!). November 18, 2024. Accessed September 28, 2025. https://www.nutritiousfoundations.com/barriers-to-healthy-eating-and-how-to-overcome-them
2. How Much Time Do Student-Athletes Spend on Their Sport? (Real Examples)
3. Walmart+ Membership - Walmart.com
4. Werner EN, Guadagni AJ, Pivarnik JM. Assessment of nutrition knowledge in division I college athletes. *Journal of American College Health*. 2022;70(1):248-255. doi:10.1080/07448481.2020.1740234
5. dietaryguidelines.gov/sites/default/files/2021-03/Dietary_Guidelines_for_Americans-2020-2025.pdf
6. Bytomski JR. Fueling for performance. *Sports Health: A Multidisciplinary Approach*. 2018;10(1):47-53. doi:10.1177/1941738117743913
7. Manore M, Thompson J. Energy requirements of the athlete: assessment and evidence of energy efficiency. In: Burke L, Deakin V, eds. *Clinical Sports Nutrition*. McGraw Hill Australia; 2006:113-134.
8. Frankenfield D, Roth-Athletessey L, Compher C. Comparison of predictive equations for resting metabolic rate in healthy nonobese and obese adults: a systematic review. *J Am Diet Assoc*. 2005;105(5):775-789. doi:10.1016/j.jada.2005.02.005
9. Reed GW, Hill JO. Measuring the thermic effect of food. *Am J Clin Nutr*. 1996;63(2):164-169. doi:10.1093/ajcn/63.2.164
10. Thomas DT, Erdman KA, Burke LM. Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. *J Acad Nutr Diet*. 2016;116(3):501-528. doi:10.1016/j.jand.2015.12.006
11. Phillips SM, Van Loon LJ. Dietary protein for athletes: from requirements to optimum adaptation. *J Sports Sci*. 2011;29 Suppl 1:S29-S38. doi:10.1080/02640414.2011.619204
12. Alger AH. 7. 5 estimating protein needs. Published online 2022. Accessed November 29, 2025. https://pressbooks.calstate.edu/nutritionandfitness/chapter/7-5-estimating-protein-needs/
13. Potgieter S. Sport nutrition: a review of the latest guidelines for exercise and sport nutrition from the american college of sport nutrition, the international olympic committee and the international society for sports nutrition. *South African Journal of Clinical Nutrition*. 2013;26(1):6-16. doi:10.1080/16070658.2013.11734434

14. Athletes, A. (2015). Dietary guidelines for Americans. *US department of health and human services and US department of agriculture*, *7*, 95.
15. Perishable. Nutrient timing: how do i space out meals around training? September 12, 2023. Accessed September 28, 2025. https://www.usada.org/spirit-of-sport/nutrient-timing-around-training/
16. Jeukendrup AE. Training the Gut for Athletes. *Sports Med*. 2017;47(Suppl 1):101-110. doi:10.1007/s40279-017-0690-6
17. Guest NS, Horne J, Vanderhout SM, El-Sohemy A. Sport Nutrigenomics: Personalized Nutrition for Athletic Performance. *Front Nutr*. 2019;6:8. Published 2019 Feb 19. doi:10.3389/fnut.2019.00008
18. Bin Naharudin MN, Yusof A, Shaw H, Stockton M, Clayton DJ, James LJ. Breakfast omission reduces subsequent resistance exercise performance. *Journal of Strength and Conditioning Research*. 2019;33(7):1766-1772. doi:10.1519/JSC.0000000000003054
19. Naderi A, Rothschild JA, Santos HO, et al. Nutritional strategies to improve post-exercise recovery and subsequent exercise performance: a narrative review. *Sports Med*. 2025;55(7):1559-1577. doi:10.1007/s40279-025-02213-6
20. Bedtime protein for bigger gains? Here's the scoop. ScienceDaily. Accessed September 28, 2025. https://www.sciencedaily.com/releases/2019/03/190306081832.htm
21. Fernandes H. A dietary, hydration, and supplementation intake proposal for high-performance elite soccer players during a match day. *J Clin Biomed Invest*. 2022;2(2):43-44. doi:10.52916/jcbi224020
22. Gibson SA, Gunn P. What's for breakfast? Nutritional implications of breakfast habits: insights from the NDNS dietary records: Nutritional implications of breakfast habits. *Nutrition Bulletin*. 2011;36(1):78-86. doi:10.1111/j.1467-3010.2010.01873.x
23. Ormsbee MJ, Bach CW, Baur DA. Pre-exercise nutrition: the role of macronutrients, modified starches and supplements on metabolism and endurance performance. *Nutrients*. 2014;6(5):1782-1808. Published 2014 Apr 29. doi:10.3390/nu6051782
24. Nutrition for the athlete | Colorado State University extension website. July 15, 2025. Accessed September 28, 2025. https://extension.colostate.edu/resource/nutrition-for-the-athlete/
25. Topend sports | sports science, fitness testing & event analysis. Topend Sports. Accessed November 29, 2025. https://www.topendsports.com/testing/respiratory-exchange-ratio.htm

26. Burke LM, Hawley JA, Ross ML, et al. Preexercise aminoacidemia and muscle protein synthesis after resistance exercise. *Med Sci Sports Exerc*. 2012;44(10):1968-1977. doi:10.1249/MSS.0b013e31825d28fa
27. Arent SM, Cintineo HP, McFadden BA, Chandler AJ, Arent MA. Nutrient timing: a garage door of opportunity? *Nutrients*. 2020;12(7):1948. doi:10.3390/nu12071948
28. Jentjens R, Jeukendrup AE. Determinants of post-exercise glycogen synthesis during short-term recovery. *Sports Med*. 2003;33(2):117-144. doi:10.2165/00007256-200333020-00004
29. Beelen M, Burke LM, Gibala MJ, Van Loon LJC. Nutritional strategies to promote postexercise recovery. *International Journal of Sport Nutrition and Exercise Metabolism*. 2010;20(6):515-532. doi:10.1123/ijsnem.20.6.515
30. Hawley JA, Tipton KD, Millard-Stafford ML. Promoting training adaptations through nutritional interventions. *Journal of Sports Sciences*. 2006;24(7):709-721. doi:10.1080/02640410500482727
31. Witard OC, Jackman SR, Breen L, Smith K, Selby A, Tipton KD. Myofibrillar muscle protein synthesis rates subsequent to a meal in response to increasing doses of whey protein at rest and after resistance exercise. *The American Journal of Clinical Nutrition*. 2014;99(1):86-95. doi:10.3945/ajcn.112.055517
32. Macnaughton, L. S., Wardle, S. L., Witard, O. C., McGlory, C., Hamilton, D. L., Jeromson, S., ... & Tipton, K. D. (2016). The response of muscle protein synthesis following whole-body resistance exercise is greater following 40 g than 20 g of ingested whey protein. *Physiological reports*, *4*(15), e12893. (APA, NOT YET AMA)
33. Kim J. Pre-sleep casein protein ingestion: new paradigm in post-exercise recovery nutrition. *Phys Act Nutr*. 2020;24(2):6-10. doi:10.20463/pan.2020.0009
34. Res, P. T., Groen, B., Pennings, B., Beelen, M., Wallis, G. A., Gijsen, A. P., ... & van Loon, L. J. (2012). Protein ingestion before sleep improves postexercise overnight recovery. Medicine & Science in Sports & Exercise, 44(8), 1560-1569.
35. Trommelen, J., & Van Loon, L. J. (2016). Pre-sleep protein ingestion to improve the skeletal muscle adaptive response to exercise training. Nutrients, 8(12), 763.
36. Snijders, T., Trommelen, J., Kouw, I. W., Holwerda, A. M., Verdijk, L. B., & Van Loon, L. J. (2019). The impact of pre-sleep protein ingestion on the skeletal muscle adaptive response to exercise in humans: an update. Frontiers in nutrition, 6, 436442.
37. Resting metabolic rate - an overview | sciencedirect topics. Accessed October 19, 2025. https://www.sciencedirect.com/topics/medicine-and-dentistry/resting-metabolic-rate
38. Flores-Opazo M, McGee SL, Hargreaves M. Exercise and glut4. *Exercise and Sport Sciences Reviews*. 2020;48(3):110-118. doi:10.1249/JES.0000000000000224

39. Amino acid metabolism : introduction. Accessed October 19, 2025. https://education.med.nyu.edu/mbm/aminoAcids/introduction.shtml