David S. Anlian

Mastering Resistance Training

The Complete Resource for Strength and Muscle Growth

Contents

A Message From AnlianFitness…

The goal of this manual is to provide accurate and reliable information to help you achieve and maintain fitness and health. To effectively manage weight, train with resistance, and avoid injury, it's crucial to grasp the complete picture. By implementing all the guidelines outlined in this manual collectively and correctly, you can significantly enhance your fitness level. Understanding and following the steps laid out here will inevitably lead to success through consistent effort and patience. Remember, this journey is a marathon, not a sprint. Once you establish a foundational understanding of incorporating resistance training into an active lifestyle, you'll enjoy numerous benefits that not only enhance your physique but also your overall well-being. Take the time to learn and do it right from the start—your future self will thank you. Here's to your health and fitness!

Brief Introduction

What follows is your ultimate guide to kickstarting your fitness journey. Use the included Quick Start Cheat Sheet to dive in immediately. This handbook is designed to equip you with everything you need to master resistance training and achieve your fitness goals.

You'll learn how to calculate your nutritional needs using simple, step-by-step formulas provided in the book. Whether your aim is strength training or hypertrophy (muscle growth), this guide offers detailed instructions on how to train specific muscles and muscle groups effectively.

This handbook takes a holistic approach, covering not just workouts but also essential topics like gym equipment—how to use it and recommended accessories—along with the critical role of sleep and recovery in your progress. It even explores various recovery methods to help you optimize your performance and results.

Everything has been meticulously synthesized to serve as the only resource you'll ever need in your fitness toolkit. I hope this handbook becomes a valuable companion on your path to a healthier, stronger you.

Your Quick Start Cheat Sheet

NUTRITION

Step 1. Calculate your EER. Section 1.1

- ☐ Use the appropriate equation to calculate your EER.

Step 2. Set your calorie goal. Section 1.2

- ☐ Use your calculated EER to set your calorie goal.
  Suggestion: start training with your calculated EER before adding/subtracting calories.

Step 3. Determine your macros. Section 1.3

- ☐ Determine your daily macros using the AMDRs.
  Suggestion: start with the middle value for each range (i.e., approximately 22-23% protein, 27-28% fat, and 55% carbohydrate).

Step 4. Calculate your fluid intake. Section 1.6

- ☐ Calculate how much water to drink daily.
  Suggestion: start with baseline hydration (i.e., your weight in pounds divided by 2 to obtain fluid ounces).

Step 5. Construct your diet. Section 1.7

- ☐ Create your meal plan.
  Suggestion: Sections 1.4, 1.5. Also see Appendices A.1, A.2.

TRAINING

Choose your training goal. Chapter 3

- ☐ **Strength**
  - ✓ Beginner. Section 3.1
  - ✓ Advanced Beginner. Section 3.1
  - ✓ Intermediate. Section 3.1
- ☐ **Hypertrophy**
  - ✓ Beginner. Section 3.2
  - ✓ Intermediate. Section 3.2
  - ✓ Advanced. Section 3.3
  - ✓ Example Programs. Appendix B

SLEEP & RECOVERY

Step 1. Establish your sleep routine. Chapter 5

- ☐ Prioritize your sleep.

Step 2. Implement recovery methods when necessary. Chapter 6

- ☐ Learn some modalities that can help you recover faster.

Chapter 1 - Nutrition

1.1 Calculate your estimated energy requirement (EER).

Start by calculating your Estimated Energy Requirement (EER), which represents the daily calories (or energy) your body needs. This value is determined using five key factors: sex, physical activity level, age, height, and weight. Follow Step 1 to begin.

Step 1. Identify the correct physical activity level (PAL) category.

The following PAL categories are per the 2023 Dietary Reference Intakes for Energy published by the National Academy of Sciences [43].

Inactive. Individuals are not completely sedentary but are minimally active beyond activities of daily living (ADL), which include 30 minutes of walking plus approximately 90 minutes of light to moderate activity (i.e., household tasks, vacuuming, raking the lawn, etc.). Individuals do little or no occupational physical activity.

Low Active. Individuals perform ADL plus an additional 60-80 minutes of moderate intensity activity, such as walking at a 3-4 mile per hour pace.

Active. Individuals perform ADL plus 30-50 minutes of walking (3-4 mph) and 85 minutes of vigorous activity (e.g., 45 minutes of moderate cycling and 40 minutes of doubles tennis).

Very Active. Individuals perform ADL plus more than 2 hours of vigorous activity (e.g., 45 minutes of moderate cycling plus 25 minutes of jogging at a 10 min. per mile pace, plus 60 minutes of doubles tennis).

Step 2. Select the appropriate EER equation and calculate your EER.

The EER is calculated by inserting your age (years), height (centimeters), and weight (kilograms) into the appropriate EER equation in the table below.

Table 1-1. Summary of EER Equations by Age, Sex, and Physical Activity Level for Adults. Data taken from DRIs for Energy 2023 (see source [43]).

Age	Sex	PAL	EER Equation (kcal/day)
19+ yrs.	Male	Inactive	EER = 753.07 - (10.83 × age) + (6.50 × height) + (14.10 × weight)
		Low Active	EER = 581.47 - (10.83 × age) + (8.30 × height) + (14.94 × weight)
		Active	EER = 1,004.82 - (10.83 × age) + (6.52 × height) + (15.91 × weight)
		Very Active	EER = -517.88 - (10.83 × age) + (15.61 × height) + (19.11 × weight)
19+ yrs.	Female	Inactive	EER = 584.90 - (7.01 × age) + (5.72 × height) + (11.71 × weight)
		Low Active	EER = 575.77 - (7.01 × age) + (6.60 × height) + (12.14 × weight)
		Active	EER = 710.25 - (7.01 × age) + (6.54 × height) + (12.34 × weight)
		Very Active	EER = 511.83 - (7.01 × age) + (9.07 × height) + (12.56 × weight)

Note: kcal/day = kilocalories per day; PAL = physical activity level; EER = estimated energy requirement; age is in years, height is in centimeters, and weight is in kilograms.

Example

The EER for a 32-year-old man who is 183 cm in height (6 feet), weighs 90 kilograms (199 pounds) and is determined to have an active PAL based on the guidance provided above is calculated as follows:

EER = 1,004.82 - (10.83 × age in years) + (6.52 × height in cm) + (15.91 × weight in kg)
= 1,004.82 - (10.83 × 32) + (6.52 × 183) + (15.91 × 90)
= 1,004.82 - 346.56 + 1,193.16 + 1,431.90
= 3,283 kcal/day

This calculated EER value represents the average requirement of men with these values for age, height, weight, and PAL category. Like other nutrients, however, requirements for energy vary (even among individuals with the same age, height, weight, and PAL category). The extent of variability is indicated by the standard error of the predicted value (SEPV). The SEPV reflects how much an individual's energy requirement may vary from the value predicted by the EER equation. Assuming that this variation is based on normal distribution characteristics, it means that approximately 68 percent of individuals will have an energy requirement within 1 standard error of the EER value, and 95 percent will have an energy requirement within 1.96 SEPV of the predicted EER [43].

For men and women 19 years and above, the SEPV is 342 and 241 kcal/day. For the man with an EER of 3,283 kcal/day in this example, this means that 68 percent of men with his characteristics would have an actual energy requirement between 2,941 and 3,625 kcal/day (3,283 ± 342), and that 95 percent of men with those characteristics would have actual energy requirements between 2,613 and 3,953 kcal/day (3,283 ± [1.96 × 342]). Therefore, it is possible that the man in the example would have an actual energy requirement reasonably close to the EER. It is also possible that his energy requirement could be considerably less than or more than the EER. For those whose actual energy requirements differ from the EER, providing energy intakes equal to the EER would lead to either weight gain or loss over time [43].

Step 3. Monitor body weight over time and adjust intake as needed.

Because an individual's actual energy requirement may vary considerably from the EER, it is important to monitor body weight over time. If undesired weight gain or loss occurs, energy intake should be adjusted incrementally to maintain the desired weight [43].

1.2 Set your calorie goal.

Objective A: To create a calorie deficit (to lose weight).

To create a calorie deficit, you will need to subtract calories from your calculated EER value. For example, you can subtract 500 calories from your calculated EER. This number is not absolute and may not apply to you. You'll need to adjust actual calories as you go based on your results. Using the EER from the example above, you would subtract 500 calories from the man's EER of 3,283 kcal/day. The man's calorie goal would then become 2,783 kcal/day.

Objective B: To create a calorie surplus (to gain weight).

To create a calorie surplus, you will need to add calories to your calculated EER value. For example, you can add 500 calories to your calculated EER. Remember that this number is not absolute and may not apply to you. You'll need to adjust actual calories as you go based on your results. Using the EER from the example above, you would add 500 calories to the man's EER of 3,283 kcal/day. The man's calorie goal would then become 3,783 kcal/day.

Objective C: To maintain current weight.

To maintain your current weight, you will not add or subtract any calories. Instead, you will use your calculated EER value to determine your macronutrients (covered in the next section). In the example above, the man's calorie goal would be 3,283 kcal/day.

1.3 Determine macronutrients.

After you have calculated your EER and set your calorie goal, you are ready to determine daily macronutrient amounts. The table below shows the Acceptable Macronutrient Distribution Range (AMDR), which was developed by the Institute of Medicine, for each macronutrient [6, 38, 39].

Table 1-2. Summary of AMDRs.

Macro	AMDR (%)
Protein	10 - 35
Fat	20 - 35
Carbohydrates	45 - 65

When calculating your macros, it is advised to stay within the ranges shown in Table 1-2 above. Otherwise, you may experience adverse effects over time. Each macronutrient plays an important role in maintaining the body's life processes.

Protein is a key macronutrient that serves many functions in the body. Protein not only forms the major structural components of muscle, but it also forms the structural components of the bones, organs, connective tissues, the brain, nervous system, blood, skin, and hair [6, 38, 39, 63]. Furthermore, protein aids in food digestion; serves as the transport mechanism for vitamins, minerals, fats, and oxygen within the body; and protects against illness as an antibody [6, 14, 38, 39, 63]. Excess protein intake beyond the upper limit is unlikely to result in further muscle gains because of the body's limited capacity to utilize amino acids to build muscle and will likely be converted to fat or carbohydrates [6, 38, 39].

Fats provide a readily available source of stored energy during times of caloric deprivation, help thermally insulate the body, protect vital organs and bones, help the body absorb vitamins, regulate nerve transmission, support cell function, and produce important hormones [6, 14, 38, 39, 63]. Fat is the most energy-dense of the three macronutrients (providing 9 calories per gram), which means that it can contribute to obesity, cardiovascular disease, and overall poor health if consumed in excess [38, 39].

Carbohydrates are the body's preferred energy source [6, 14, 38, 39]. Carbs are ideally suited to provide fuel for the body's many metabolic functions [39]. Carbs are broken down into simple sugar (glucose), which is easily assimilated and used in the body [14]. This glucose is absorbed into the bloodstream and powers cell energy to fuel activity (sitting, walking, eating, digesting, thinking, and the like) [14]. In fact, the brain runs exclusively on glucose, and if carb consumption is inadequate, the individual will likely experience brain fog or have difficulty concentrating [6, 14, 38, 39]. Carbs play other important roles, including satiety, providing flavor and sweet taste to foods, and serving as signaling molecules for essential biological reactions in the body [39]. In addition, fiber, which is an important type of carb, improves digestive health and blood cholesterol levels [39]. In fact, healthy carbohydrates chosen in appropriate amounts and at appropriate times can benefit athletic performance, weight management, and optimal health [39]. If carbs are consumed in excess, the body will convert the excess glucose into fat for long-term storage [6, 38, 39].

Continuing with the example from above, we can determine the man's macronutrient amounts based on his calorie goal. His macros are calculated for each objective on the following pages.

Objective A: To create a calorie deficit (to lose weight).

Example

The 32-year-old man's calorie goal is 2,783 kcal/day. Per the AMDRs, the macronutrient ranges are as follows.

Table 1-3. Example AMDRs Calculation for Objective A: To create a calorie deficit (to lose weight).

Macro	Range	Equation	AMDR (g)	AMDR (kcal)
Protein	Lower Limit	2,783 kcal/day × (10% ÷ 100) ÷ 4 ≈ 70 g	70 - 244	280 - 976
	Upper Limit	2,783 kcal/day × (35% ÷ 100) ÷ 4 ≈ 244 g		
Fat	Lower Limit	2,783 kcal/day × (20% ÷ 100) ÷ 9 ≈ 62 g	62 - 108	558 - 972
	Upper Limit	2,783 kcal/day × (35% ÷ 100) ÷ 9 ≈ 108 g		
Carbs	Lower Limit	2,783 kcal/day × (45% ÷ 100) ÷ 4 ≈ 313 g	313 - 452	1,252 - 1,808
	Upper Limit	2,783 kcal/day × (65% ÷ 100) ÷ 4 ≈ 452 g		

Note: 1 g of protein = 4 kcal; 1 g of fat = 9 kcal; 1 g of carbohydrates = 4 kcal

Protein. Since protein provides a satiating effect, the recommendation is to consume an intake closer to the upper limit for weight loss. Eating more protein will also help preserve muscle. For the calculated protein range in this example, the 32-year-old man would aim to consume 198-244 grams/day. We will choose 210 grams (840 kcal).

Fat. The calculated fat range gives the man flexibility when constructing his diet (as you will see in section 1.7). We will choose 70 grams (630 kcal).

Carbohydrates. After determining the protein and fat values, the rest of the calories will come from carbohydrates. In this example, the man's daily carbohydrate intake will be about 328 grams, i.e., 2,783 – (840 + 630) = 1,313 kcal. The following table summarizes the final macro numbers.

Table 1-4. Example Final Weight Loss Macro Values.

Macro	Value (g)	Calories (kcal)	% of Total Calories
Protein	210	840	30.2
Fat	70	630	22.6
Carbohydrates	328	1,313	47.2

Objective B: To create a calorie surplus (to gain weight).

Example

The 32-year-old man's calorie goal is 3,783 kcal/day. Per the AMDRs, the macronutrient ranges are as follows.

Table 1-5. Example AMDRs Calculation for Objective B: To create a calorie surplus (to gain weight).

Macro	Range	Equation	AMDR (g)	AMDR (kcal)
Protein	Lower Limit	3,783 kcal/day × (10% ÷ 100) ÷ 4 ≈ 95 g	95 - 331	380 - 1,324
	Upper Limit	3,783 kcal/day × (35% ÷ 100) ÷ 4 ≈ 331 g		
Fat	Lower Limit	3,783 kcal/day × (20% ÷ 100) ÷ 9 ≈ 84 g	84 - 147	756 - 1,323
	Upper Limit	3,783 kcal/day × (35% ÷ 100) ÷ 9 ≈ 147 g		
Carbs	Lower Limit	3,783 kcal/day × (45% ÷ 100) ÷ 4 ≈ 426 g	426 - 615	1,704 - 2,460
	Upper Limit	3,783 kcal/day × (65% ÷ 100) ÷ 4 ≈ 615 g		

Note: 1 g of protein = 4 kcal; 1 g of fat = 9 kcal; 1 g of carbohydrates = 4 kcal

Protein. Since protein can be too satiating, the recommendation for weight gain is to consume an intake closer to the lower limit, which would allow the individual to eat the calories they need to gain weight. For the calculated protein range in this example, the 32-year-old man would aim to consume 95-174 grams/day. We will choose 135 grams (540 kcal).

Fat. For fat, we will choose 100 grams (900 kcal).

Carbohydrates. The rest of the calories will come from carbohydrates. In this example, the man's daily carbohydrate intake will be about 586 grams, i.e., 3,783 – (540 + 900) = 2,343 kcal. The following table summarizes the final macro numbers.

Table 1-6. Example Final Weight Gain Macro Values.

Macro	Value (g)	Calories (kcal)	% of Total Calories
Protein	135	540	14.3
Fat	100	900	23.8
Carbohydrates	586	2,343	61.9

Objective C: To maintain current weight.

Example

The 32-year-old man's calorie goal is 3,283 kcal/day. Per the AMDRs, the macronutrient ranges are as follows.

Table 1-7. Example AMDRs Calculation for Objective C: To maintain current weight.

Macro	Range	Equation	AMDR (g)	AMDR (kcal)
Protein	Lower Limit	3,283 kcal/day × (10% ÷ 100) ÷ 4 ≈ 82 g	82 - 287	328 - 1,148
	Upper Limit	3,283 kcal/day × (35% ÷ 100) ÷ 4 ≈ 287 g		
Fat	Lower Limit	3,283 kcal/day × (20% ÷ 100) ÷ 9 ≈ 73 g	73 - 128	657 - 1,152
	Upper Limit	3,283 kcal/day × (35% ÷ 100) ÷ 9 ≈ 128 g		
Carbs	Lower Limit	3,283 kcal/day × (45% ÷ 100) ÷ 4 ≈ 369 g	369 - 534	1,476 - 2,136
	Upper Limit	3,283 kcal/day × (65% ÷ 100) ÷ 4 ≈ 534 g		

Note: 1 g of protein = 4 kcal; 1 g of fat = 9 kcal; 1 g of carbohydrates = 4 kcal

Protein. For those individuals who want to maintain their current weight or to optimize their body composition by maintaining lean mass and/or losing body fat, they can choose a value in the middle of the range or closer to the upper limit. For this example, we will choose 185 grams (740 kcal).

Fat. For fat, we will choose 101 grams (909 kcal).

Carbohydrates. The rest of the calories will come from carbohydrates. In this example, the man's daily carbohydrate intake will be about 409 grams, i.e., 3,283 – (740 + 909) = 1,634 kcal. The following table summarizes the final macro numbers.

Table 1-8. Example Final Maintain Macro Values.

Macro	Value (g)	Calories (kcal)	% of Total Calories
Protein	185	740	22.5
Fat	101	909	27.7
Carbohydrates	409	1,634	49.8

1.4 Learn about the three macronutrients.

Protein

Protein is an essential macronutrient that plays a vital role in building, repairing, and maintaining tissues in the body. It is composed of amino acids, often referred to as the "building blocks of life," which are crucial for various bodily functions, including muscle growth, enzyme production, and immune system support. For athletes and fitness enthusiasts, protein is especially important as it supports recovery, enhances performance, and helps maintain lean muscle mass. In the following sections, we will explore the differences between complete and incomplete proteins, examine the various types of protein sources, discuss how protein impacts athletic performance, and provide recommendations for protein intake to optimize health and fitness goals.

Complete vs. incomplete proteins

Complete proteins (i.e., animal products) contain all nine essential amino acids (histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine), which must be consumed in the diet. Complete protein foods include beef, poultry, fish, eggs, and dairy. Most plant foods, however, are incomplete protein sources because they are low in one or more of the nine essential amino acids. Plant foods can become complete protein sources by combining complementary incomplete plant proteins that together can provide all the essential amino acids. Some excellent combinations include grains-legumes (e.g., rice and beans), grains-dairy (e.g., pasta and cheese), and legumes-seeds (e.g., falafel) [6]. There are certain plant foods that are complete proteins, such as soy, hemp seeds, peas, quinoa, and buckwheat.

Types of protein

Whey. Whey is rapidly digested and absorbed and has a remarkable ability to stimulate muscle protein synthesis, even more so than other high-quality proteins [5, 39]. It takes the body 20 minutes to digest, absorb, and metabolize whey protein, and within one hour, the body will have used up the whey for either protein synthesis or oxidation. Whey contains high levels of the amino acid leucine, which plays a particularly important role in muscle hypertrophy [5, 39]. There are three varieties of whey: whey protein powder, whey protein concentrate, and whey protein isolate. All provide high levels of the essential and branched chain amino acids, vitamins, and minerals [38]. Whey powder is 11-15 percent protein and is used as an additive in many food products [39]. Whey concentrate is 25-89 percent protein, whey isolate is 90+ percent protein, and both are commonly used in dietary supplements [39]. It should be noted that while whey isolate is nearly pure whey, some of the proteins can be lost during the manufacturing process [39]. It is recommended to take whey protein around workouts.

Casein. Casein is slowly digested, resulting in a more prolonged and sustained release of amino acids into the bloodstream that can last for several hours [5, 39]. Protein synthesis peaks 3-4 hours after consuming casein. Like whey, casein also provides all the essential amino acids, but it does not raise amino acid levels as high or as quickly as whey. Even though casein does not elevate amino acid production as high as whey protein does, it significantly slows the rate of protein breakdown, protecting existing muscles. It is recommended to take casein around fasting periods or before bed. During a resistance training workout that produces microtears in the muscle tissues, a ready supply of amino acids is useful. Some studies suggest that combined casein and whey may produce the greatest muscular strength improvements after an intensive resistance training program [39].

Alternatives. Common alternatives to whey and casein include soy, egg, hemp, and pea proteins. Soy is the most widely used vegetable protein because it is one of the only vegetable proteins that contain all the essential amino acids. Like whey, soy proteins can be consumed in three types: flour (50 percent protein), which is often used in baked goods; concentrates (70 percent protein), which are commonly added to nutrition bars, cereals, and yogurts; and isolates (90 percent protein), which are highly digestible and often added to sports drinks, health beverages, and infant formulas [39]. Soy foods (e.g., tofu, soy burgers, and soy nuts) are considered heart healthy due to their low levels of saturated fats and high content of polyunsaturated fats, fiber, vitamins, and minerals [39]. In addition to soy, eggs (like all animal products) are a complete and an excellent source of high-quality protein [54, 56]. Large eggs contain about 6 grams of protein each, and egg protein is highly bioavailable, which means that the body uses more of it when it is digested [54, 56]. Hemp is another popular plant-based complete protein. Hemp protein contains a high content of omega-6 and omega-3 fatty acids, which usually come from foods like fish [54, 56]. Lastly, pea protein is very popular among vegetarians, vegans, and people with allergies or sensitivities to dairy or eggs. Pea protein contains all the essential amino acids and is considered a complete protein [54, 56]. It is comparable to whey protein in terms of its ability to increase fullness and improve body composition, strength, and performance when combined with exercise [54]. Soy, egg, hemp, and pea proteins are great alternatives for vegetarians, vegans, and people with allergies or sensitivities to dairy or eggs. Due in part to their high fiber content, plant proteins tend to digest slower than animal proteins. Although this may not pose a problem for most people, it can limit the amino acids the body can use immediately post exercise [54]. It should also be noted that most plant protein sources are incomplete proteins, so it is recommended to mix different plant proteins to provide the body with all the essential amino acids.

Protein and athletic performance

Protein metabolism becomes more efficient with exercise training, which supports the Institute of Medicine's assertion that athletes do not have increased protein needs compared to the more sedentary population [39]. Muscle protein synthesis is further enhanced if protein is consumed around the time of exercise training [39]. Research indicates meals and snacks consumed throughout the day, particularly foods consumed before, during, and after exercise, should be a combination of carbohydrates and protein at approximately a 3:1 ratio to encourage a positive nitrogen balance, which ensures muscle synthesis, hydration, and adequate energy to sustain exercise [39]. Consumption of protein immediately after exercise (within 15 to 30 minutes) helps in the repair and synthesis of muscle proteins [39]. Furthermore, it is recommended that 6 to 20 grams of protein be consumed with 30 to 40 grams of carbohydrates within 3 hours' post-exercise as well as immediately before exercise to encourage muscle resynthesis. Research indicates that as little as 5 to 10 grams of protein consumed immediately after exercise can promote optimal muscle repair [5, 39]. Protein consumption with the intake of water post-exercise also helps to restore hydration. Carbohydrates are important to pair with protein. If only protein is consumed without sufficient carbs to provide the body's energy needs, then muscle synthesis may be compromised [39].

Protein recommendation

- ✓ Per the Acceptable Macronutrient Distribution Range (AMDR), which was developed by the Institute of Medicine, protein should account for 10-35 percent of total daily calories [6, 38, 39].
- ✓ Recommended protein intakes are best met through diet, though many athletes do turn to whey- or casein-based protein powders and other supplements to boost protein intake [38].

Fat

Fat is a crucial macronutrient that provides energy, supports cell growth, protects organs, and aids in the absorption of fat-soluble vitamins (A, D, E, and K). Despite its often-negative reputation, fat is essential for overall health and athletic performance when consumed in appropriate quantities and forms. It serves as a long-lasting fuel source, particularly during low- to moderate-intensity exercise, and plays a key role in hormone production and recovery. In the following sections, we will discuss the different types of fats—trans fats, saturated fats, monounsaturated fats, and polyunsaturated fats—their effects on health, their impact on athletic performance, and recommendations for fat intake to support fitness and wellness goals.

Trans fats

Trans fats are the product of the hydrogenation process, which is a man-made effort to make an unsaturated fat solid at room temperature with the intention to prolong shelf life [6, 39]. Both partial and full hydrogenation cause changes to cell membrane fluidity and negatively affect cell function in the body [6, 39]. These synthetic trans fats significantly elevate low-density lipoprotein (LDL) cholesterol, which is the bad cholesterol [39, 63]. Trans fats are also linked to an increased risk of heart disease, diabetes, and cancer [6, 39, 63].

Saturated fats

Saturated fats are normally very stable and solid at room temperature. Saturated fats are naturally occurring fats in animal sources (e.g., red meat) and full-fat dairy products [39, 63]. Because saturated fats increase LDL cholesterol and are linked with cardiovascular disease, the American Heart Association (AHA) and 2015-2020 Dietary Guidelines advise consumers to either avoid or significantly reduce the consumption of saturated fats [39]. Saturated fats should not be viewed as good for you, but a balanced diet can include saturated fats [38]. The recommendation is to consume fewer than 10 percent of total calories from saturated fats [5, 39]. Replacing saturated fats with polyunsaturated fats (like omega-3 and omega-6 fatty acids) is beneficial for overall health and cardiovascular disease risk mitigation [38].

Monounsaturated fats

Monounsaturated fats are one of two types of unsaturated fats. Unsaturated fats are normally unstable and liquid at room temperature [38]. Unsaturated fats are found in plant sources and have a shorter shelf life than trans fats and saturated fats [38]. Monounsaturated fats are heart-healthy; they lower blood cholesterol levels and therefore reduce the risk of cardiovascular disease [38, 39, 63]. Most plant oils (e.g., olive, sesame seed, and avocado) are excellent sources of monounsaturated fat. According to the National Institutes of Health, in the context of a diet moderately high in carbohydrates, consuming monounsaturated fats as compared to saturated fats leads to greater fat burning, reduced body fat (particularly abdominal fat), and improved insulin sensitivity, and increased satiety. The Academy of Nutrition and Dietetics recommends that 15-20 percent of total caloric intake comes from monounsaturated fats [63].

Polyunsaturated fats

Polyunsaturated fats are the healthiest of fats and are especially important for optimal health. In fact, substituting polyunsaturated fats for saturated fats and refined carbohydrates contributes to a significant risk reduction of cardiovascular disease [5, 6, 38, 39, 63]. The two main types of polyunsaturated fats are omega-3

and omega-6 fatty acids, which are essential fatty acids that must be obtained from diet (or supplementation), because the body cannot produce them [5, 6, 38, 39]. Both omega-3 and omega-6 fatty acids are important for brain function and cell growth [6, 38, 39].

Omega-3 (alpha-linolenic acid). A diet high in omega-3 fatty acids has been shown to help protect the heart from cardiovascular disease [63]. Overall, omega-3 fatty acids reduce blood clotting, dilate blood vessels, and reduce inflammation [5, 6, 38, 39]. They play a crucial role in growing a fetus in the late stages of pregnancy [6, 38, 39]. They reduce cholesterol and triglyceride levels [6, 38, 39, 63]. They are important for eye and brain development [6, 38, 39]. They also contribute to preserve brain function and reduce the risk of mental illness and attention deficit hyperactivity disorder (ADHD) [6, 38, 39]. Most Americans tend not to consume enough omega-3 fatty acids, although this recommendation can be met through the consumption of approximately 8 ounces of a fatty fish per week [39]. Examples of fatty fish include salmon, mackerel, herring, lake trout, sardines, and albacore tuna. Though natural food sources are best, people who do not meet this recommendation or do not like fish may benefit from omega-3 supplementation or from fortified food (e.g., eggs, margarine, or milk) [39].

Omega-3 fatty acids provide benefits for athletes as well as a variety of performance-enhancing effects, such as increasing muscle growth, improving strength and physical performance, reducing exercise-induced muscle damage and delayed-onset muscle soreness (DOMS), combating negative immune effects of intensive training, strengthening bones, improving heart and lung function, and enhancing cognitive function [5]. Approximately 1-2 grams per day of omega-3 fatty acids, with an eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) ratio of 2:1, can improve cardiovascular function and exercise performance [5].

Omega-6 (linoleic acid). Along with omega-3 fatty acids, omega-6 fatty acids play a crucial role in brain development and function [45]. Omega-6 fatty acids help stimulate skin and hair growth, maintain bone health, regulate metabolism, and maintain the reproductive system [45]. They help regulate blood sugar levels by improving the body's sensitivity to insulin [44]. They also lower harmful low-density lipoprotein (LDL) cholesterol and raise protective high-density lipoprotein (HDL) cholesterol [44]. Examples of omega-6 fats include green leafy vegetables, safflower oil, sunflower oil, corn oil, soybean oil, sunflower seeds, walnuts, and pumpkin seeds [39, 44]. The AHA and Institute of Medicine recommend obtaining 5-10% of total daily calories from omega-6 fatty acids [44].

Fats and athletic performance

There is no evidence for performance benefit from a very low-fat diet (<15% of total calories) or from a high-fat diet [6, 38]. Omega-3 fatty acids provide a variety of performance-enhancing effects for athletes, such as increasing muscle growth, improving strength and physical performance, reducing exercise-induced muscle damage and delayed-onset muscle soreness (DOMS), combating negative immune effects of intensive training, strengthening bones, improving heart and lung function, and enhancing cognitive function [5].

Fat recommendation

- ✓ Per the Acceptable Macronutrient Distribution Range (AMDR), which was developed by the Institute of Medicine, fats should account for 20-35 percent of total daily calories [6, 38, 39].
- ✓ Consume fewer than 10 percent of total calories from saturated fat [39].
- ✓ The Academy of Nutrition and Dietetics recommends that 15-20 percent of caloric intake comes from monounsaturated fatty acids [39].

- ✓ The Academy of Nutrition and Dietetics recommends that intake from polyunsaturated fatty acids comprise 3-10 percent of total caloric intake [39].
- ✓ Approximately 1-2 grams per day of Omega-3 fatty acids, with an eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) ratio of 2:1, can improve cardiovascular function and exercise performance [5].
- ✓ The AHA and Institute of Medicine recommend obtaining 5-10 percent of total daily calories from omega-6 fatty acids [44].

Carbohydrates

Carbohydrates are a primary source of energy for the body, especially during high-intensity exercise and athletic performance. They are broken down into glucose, which fuels muscles and supports brain function. Carbohydrates are classified into simple and complex carbs, each affecting energy levels and digestion differently. Additionally, factors such as the glycemic index and glycemic load influence how quickly carbs are digested and absorbed, impacting blood sugar levels. Fiber, a type of carbohydrate that aids in digestion and promotes gut health, also plays an important role in overall well-being, and understanding fiber types and recommendations can help optimize dietary balance. In the following sections, we will explore these carbohydrate categories, examine their impact on athletic performance, and provide carbohydrate recommendations to support energy needs and recovery.

Simple and complex carbohydrates

Carbohydrates are built from chains of monosaccharides (i.e., sugars) that bind together to form larger carbohydrate compounds called disaccharides, oligosaccharides, and polysaccharides [38, 39]. Simple carbohydrates include monosaccharides and disaccharides, and complex carbohydrates include oligosaccharides and polysaccharides [39]. After being consumed, all carbs are eventually digested into monosaccharides (i.e., glucose) and absorbed into the bloodstream [39]. The cells in the body use the monosaccharide form of glucose for energy. Simple carbs are more quickly digested and absorbed than complex ones, so simple carbs can raise blood glucose levels faster and higher.

Glycemic index and load

Generally, carbohydrates are ranked based on their blood glucose response using the glycemic index (GI). Foods are divided into those that have a high GI of 70+ (glucose, bread, potatoes, breakfast cereal, sports drinks), a moderate GI of 56-69 (sucrose, soft drinks, oats, tropical fruits such as bananas and mangos), or a low GI of 0-55 (fructose, milk, yogurt, lentils, pasta, nuts, cold climate fruits such as apples and oranges) [5, 32]. High-GI foods break down quickly (causing a large glucose spike), and low-GI foods break down slowly (causing a smaller glucose spike) [6, 38, 63]. Although valuable, the GI does not account for the caloric content of a food.

The glycemic load (GL) considers both the GI and caloric content in one serving of a food [39, 63]. GI is based on a reference carb amount of 50 grams, whereas GL accounts for portion size (GL = GI x grams of carbs / 100). Notably, food can have a high GI but low GL [39]. For example, while carrots have a high GI, to actually eat 50 grams of carrot, a person would need to eat 4 cups of the vegetable [39]. Because the typical serving size is approximately one-half cup, the GL is small [39]. Also, minimally processed carb-containing foods that are also moderate to high in fat or protein, fiber, and other nutrients may have a high GI but a low GL [39].

A growing body of research supports eating a diet that is mostly of lower GL [39]. A lower GL diet may offer health benefits including weight control, decreased risk of diabetes and heart disease, as well as reduced morbidity in individuals with chronic diseases including diabetes and heart disease [39]. Furthermore, foods with a low GL are commonly nutrient dense, meaning they provide more nutrients per calorie [39]. For example, 16 ounces of soda have about the same amount of carbs as two medium-sized apples, though the GL of the soda is much higher [39]. The two apples provide more vitamins, minerals, and fiber compared to the soda, making the apples more nutrient dense [39]. However, an appropriate GL may be better than an excessive restriction. The optimal GL range was determined to be 85-100 per 1,000 kcal [24].

Fiber

Fiber is a diverse group of carbohydrates that serve many important and beneficial roles in the human body. Fiber lowers the risk of developing various conditions, including heart disease, diabetes, diverticulitis, and constipation [18]. Fiber also plays a key role in weight management by regulating the body's use of sugars, helping to keep hunger and blood sugar in check [18, 39]. Fiber is nondigestible, because humans lack the digestive enzymes required to break these types of carbs down, so they pass through the digestive system undigested [17, 18, 33, 49]. Though humans cannot digest fiber, there are different types and varieties of fiber that are crucial for optimal health. Fiber is formally classified into two main types of fiber called functional fiber and dietary fiber, which together comprise total fiber [33, 39]. Fiber is further classified based on its solubility (soluble vs. insoluble), viscosity (viscous vs. non-viscous), and fermentability (fermentable vs. non-fermentable) [33]. Soluble fibers dissolve in water, while insoluble fibers do not [17, 18, 33, 39]. Viscous fibers thicken in the presence of water, forming sticky, glue-like solutions [17]. Fermentable fiber is metabolized to form short-chain fatty acids, which are absorbed and metabolized to produce energy [17]. Fiber fermentation contributes up to 10 percent of daily energy intake [17].

Fiber recommendation

- ✓ The Adequate Intake (AI) recommendations for total fiber intake, set by the Food and Nutrition Board of the Institute of Medicine, are approximately 14 grams for every 1,000 calories (kcal) consumed [17, 18, 33, 39].
- ✓ For most adults (19-50 years), the recommended intake is 38 grams for men and 25 grams for women. This fiber goal is easily achievable by eating a wide variety of fruits, vegetables, whole grains, legumes, nuts, and seeds [17, 18, 33, 39].

Carbohydrates and athletic performance

Healthy carbohydrates chosen in appropriate amounts and at appropriate times can benefit athletic performance [39]. Some practitioners suggest that manipulating the GI of foods and meals may enhance carbohydrate availability and improve athletic performance [5]. For example, low GI carbohydrate-rich foods may be recommended before exercise to promote sustained carbohydrate availability [5]. Moderate to high GI carbohydrate-rich foods may be recommended during exercise to promote carbohydrate oxidation and after exercise to promote glycogen repletion [5]. Research suggests that a diet based on consumption of high-GI carbs promotes greater glycogen storage following strenuous exercise [6]. Overall, high-GI glucose-rich foods are good for refueling and athletic performance [6]. However, the total amount of carbs consumed is the most important consideration for replenishing glycogen stores following daily training sessions and competitive events [5]. While the GI may be useful in sports by helping to fine tune food choices, it should not be used exclusively to provide guidelines for carb and food intake before, during, and after exercise [5]. Other features of foods such as nutritional content, palatability, portability, cost, gastrointestinal comfort, and ease of preparation are also important [5]. Athletes should choose foods according to their nutritional goals and exercise situation [5].

A small snack before strenuous or prolonged exercise will help to optimize the training session. The food should be relatively high in carbohydrate to maximize blood glucose availability, relatively low in fat and fiber to minimize gastrointestinal distress and facilitate gastric emptying, moderate in protein, and well-tolerated by the

individual [6]. During extended training sessions, exercisers should consume 30 to 60 grams of carbohydrate per hour of training to maintain blood glucose levels [6]. This is especially important for training sessions lasting longer than one hour; exercise in extreme heat, cold, or high altitude; and when the individual did not consume adequate amounts of food or drink prior to the training session. After exercise, individuals should focus on carbs and protein. Studies show that the best meals for post-workout refueling include an abundance of carbs accompanied by some protein (3:1 carb to protein ratio) [6, 39]. The carbs replenish the used-up energy that is normally stored as glycogen in the muscle and liver, and the protein helps to rebuild the muscles that were fatigued with exercise. The amount of refueling depends on the intensity and duration of the training session, but the exerciser should eat as soon after exercising as possible, preferably within 30 minutes. This is the time when the muscles are best able to replenish energy stores, enabling the body to prepare for the next workout [6].

Carbohydrate recommendation

- ✓ Per the Acceptable Macronutrient Distribution Range (AMDR), which was developed by the Institute of Medicine, carbohydrates should account for 45-65 percent of total daily calories [39].
- ✓ Consume fewer than 10 percent of total calories from added sugars [6, 38, 39].
- ✓ The daily minimum for most healthy individuals is 130 grams per day [39]. This is a minimum requirement based on the amount of carbs needed by the brain daily [39]. Therefore, for energy maintenance the body needs more than 130 grams per day [39].
- ✓ Athletes need anywhere from 6 to 10 g/kg (3 to 5 g/lb.) of body weight per day depending on their total energy expenditure, type of exercise performed, gender, and environmental conditions, to maintain blood glucose levels during exercise and to replace muscle glycogen [5, 6, 38, 39].
- ✓ The American Dietetic Association (ADA) recommends a carb intake of 1.0 to 1.5 g/kg (0.5 to 0.7 g/lb.) of body weight in the first 30 minutes after exercise and then every 2 hours for 4-6 hours [6].
- ✓ The optimal GL range was determined to be 85-100 per 1,000 kcal [24].

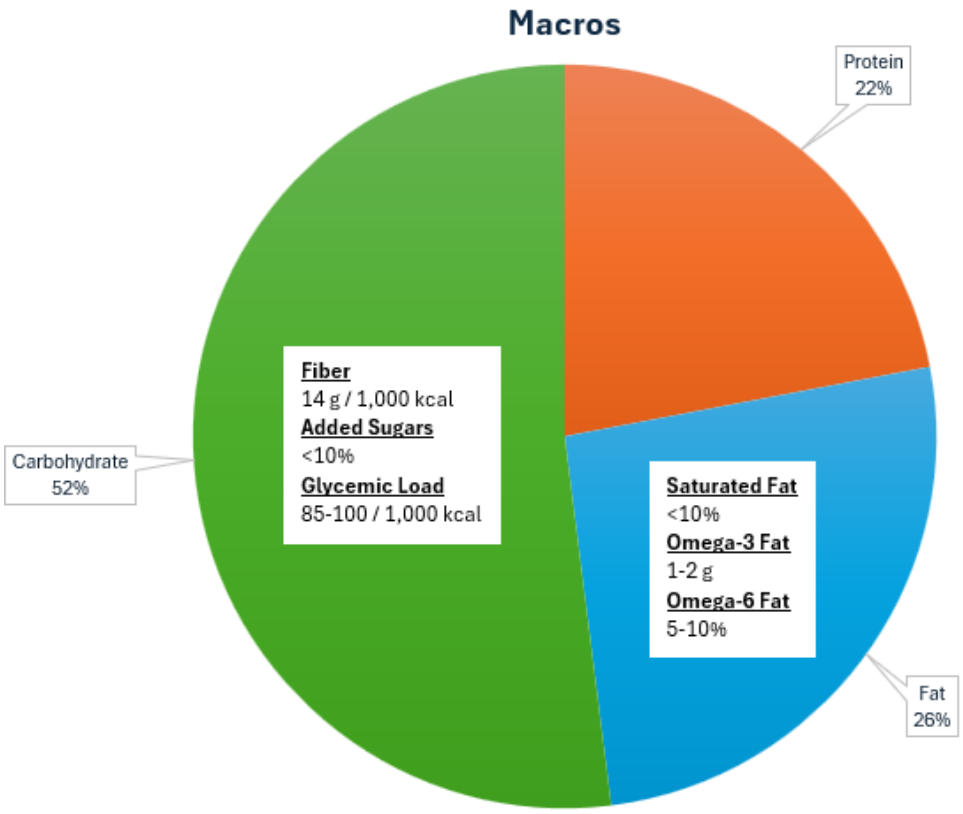


Figure 1-1. A pie chart summarizing macronutrient recommendations encompassing fiber, added sugars, glycemic load, saturated fat, omega-3 fat, and omega-6 fat.

1.5 Learn about micronutrients.

Micronutrients enable the body to produce enzymes, hormones, and other substances essential for proper growth and development. When the body is deprived of or excessively overloaded with micronutrients, the consequences are severe. But when consumed in just the right amounts through a varied, balanced, and nutrient-rich diet, vitamins and minerals contribute to optimal health, function, and well-being [6, 38, 39].

Vitamins

Vitamins are organic, non-caloric substances that are essential for normal physiological function and must be consumed through food [6, 38, 39]. However, there are three exceptions:

- ✓ Vitamin K and biotin (vitamin B7) can be produced by normal intestinal flora.
- ✓ Vitamin D can be self-produced with sun exposure.
- ✓ Vitamin A and Niacin (vitamin B3) can be synthesized from tryptophan and beta-carotene.

*No perfect food contains all the vitamins in just the right amount. Instead, a variety of nutrient-dense foods must be consumed to ensure adequate vitamin intake [6, 38, 39].

Humans need 13 different vitamins, which are generally classified as either fat soluble or water soluble [6, 38, 39]. Fat-soluble vitamins (A, D, E, and K) dissolve in fat and tend to accumulate in the body. Water-soluble vitamins (B1, B2, B3, B5, B6, B7, B9, B12, and C) must dissolve in water before they can be absorbed by the body and therefore cannot be stored. Any water-soluble vitamins unused by the body are primarily lost through urine. Choline is an organic, water-soluble essential nutrient that must be included in your diet [6, 38, 39]. It is needed by the brain and nervous system to regulate memory, mood, muscle control, and other functions [6, 38, 39]. It is neither a vitamin nor a mineral, however, it is often grouped with the vitamin B complex (see Appendix A, Tables A-1 and A-2 for vitamin facts).

Minerals

Minerals are inorganic elements (also non-caloric) that must be ingested and absorbed in adequate amounts to satisfy a wide variety of essential metabolic and structural functions in the body (e.g., regulating enzyme activity, maintaining acid balance, assisting with muscle contraction, and helping with growth) [6, 38, 39]. Minerals are categorized as macrominerals (major elements) and microminerals (trace elements) according to the amount required in the human diet to maintain good nutrition. Macrominerals are elements the body requires in amounts of 100 milligrams or more per day [6, 38, 39]. These include calcium, chloride, magnesium, phosphorus, potassium, sodium, and sulfur. Microminerals are elements the body requires in amounts less than 20 milligrams per day [6, 38, 39]. These include chromium, copper, fluoride, iodine, iron, manganese, molybdenum, selenium, and zinc. The recommended dietary allowance (RDA), adequate intake (AI), and tolerable upper intake level (UL) for each mineral are listed in Table A-3 of Appendix A.

The Impact of Micronutrients on Athletic Performance

Micronutrients play important roles in energy production, red blood cell formation, bone strength, immune system function, muscle growth and repair, and protection from oxidative damage [21, 39]. These are all critical foundational functions for optimal athletic performance. Vitamins and minerals are crucial for an athlete's health and physical performance, and no single micronutrient is more important than the other. Because exercise increases demand on the body's metabolic processes, athletes tend to have increased vitamin and mineral needs compared to the sedentary or less active population [39]. It is important to note here that the published DRIs are the same for active individuals as for the sedentary population. That being said, athletes are prone to consuming insufficient amounts of micronutrients due to inappropriate dietary habits, especially if they are not matching their physical activity requirements [21, 39]. Furthermore, athletes who severely restrict intake of specific food groups or do not consume a generally balanced and wholesome diet may suffer from a nutritional deficiency [21, 39]. By making sure they are receiving adequate levels of micronutrients, athletes can give themselves a competitive edge and maximize the potential of their training. **The specific micronutrients that offer the most significant enhancements in terms of athletic performance are discussed next.**

Fat-Soluble Vitamins

Vitamin A

Vitamin A plays a significant role in promoting the overall well-being of athletes, as it aids in the formation of healthy tissues and improves oxygen access throughout the body, thereby supporting the maintenance of an adequate level of physical activity [21]. It also has a crucial influence on vision, skin health, and immune system functioning [21, 39]. Moreover, vitamin A is a powerful antioxidant that helps neutralize free radicals generated by oxidative stress during advanced physical training [21]. The adequate consumption of vitamin A may help alleviate the reactive oxygen species and avoid the onset of illnesses such as heart failure and muscle damage [21]. Vitamin A has been proven to enhance and support various physiological functions, including reaction time, muscle recovery, and protein synthesis [21]. Furthermore, vitamin A can help protect athletes against injuries by increasing healing times and promoting the formation of healthy connective tissues [21]. Finally, vitamin A may help fight off colds, the flu, and other illnesses, which can be particularly helpful for traveling athletes [21]. Without adequate vitamin A intake, high levels of physical activity could deplete the body's reserves. Athletes on a calorically restricted, low-fat diet with minimal fruits, vegetables, and whole grains are at increased risk of deficiency, which in some cases could affect performance [39].

Food Sources:
High vitamin A foods include sweet potatoes, carrots, fish (tuna), winter squashes, dark leafy greens, cantaloupe, lettuce, bell peppers, pink grapefruit, and broccoli [21, 39, 40].

Vitamin D

Vitamin D plays an important role in maintaining and optimizing bone health [21, 39]. It also functions in improving the immune system, musculoskeletal system, power, and force output [21]. Additionally, vitamin D improves the body's utilization of carbohydrates during exercise, providing the body with increased energy, which can help to enhance performance [21]. Female athletes tend to be more susceptible to vitamin D deficiencies than male athletes, especially female athletes who engage in weight-sensitive sports like gymnastics, running, and cycling [39]. Women who show signs of the female athlete triad, which is characterized by disordered eating, negative energy balance, and irregular or absent menstrual cycles, must pay extra attention to

vitamin D intakes [39]. This condition, if not addressed, predisposes women to menstrual dysfunction (amenorrhea), diminished bone mineral density, and premature osteoporosis [21, 39].

The most appropriate way to maintain sufficient vitamin D levels is to spend time outdoors in direct sunlight, because the body can synthesize vitamin D with only 15-20 minutes of direct exposure a day [21]. This prescription for sun exposure should also be combined with foods that are rich in vitamin D.

Food Sources:
Dairy products, egg yolk, fatty fish, and fortified foods are rich dietary intake sources [21, 39, 40].

Vitamin E

Overtraining and intense exercise are associated with reactive oxygen species (ROS) production, which aids in enhanced muscular and endurance adaptation to exercise through the upregulation of endogenous antioxidant enzymes [21]. However, excess accumulation of ROS accompanied by the inability of the body to scavenge these compounds is harmful to the body's cell components which is associated with fatigue, delayed recovery, and reduced performance [21]. Vitamin E can have protective effects against chronic stress associated with exercise, because it possesses antioxidant properties that help protect cells and tissues [21]. Vitamin E can also assist with improving blood flow, which is important for athletes [21]. Improved blood flow means better performance in delivering nutrients and oxygen to the muscles, allowing them to perform at their best. Without adequate Vitamin E intake, high levels of physical activity could deplete the body's reserves. Athletes on a calorically restricted, low-fat diet with minimal fruits, vegetables, and whole grains are at increased risk of deficiency, which in some cases could affect performance [39].

Food Sources:
Foods high in vitamin E include sunflower seeds, almonds, spinach, avocados, squash, kiwifruit, trout, shrimp, olive oil, wheat germ oil, and broccoli [21, 40].

Vitamin K

Vitamin K helps various proteins that are needed for blood clotting (coagulation) and maintenance of strong bones [21, 39]. In elite female athletes, vitamin K has been shown to improve bone remodeling and cardiovascular function [21].

Food Sources:
Vitamin K is present in large amounts in green, leafy vegetables (broccoli, cabbage, kale, spinach, parsley) [21, 39, 40].

Water-Soluble Vitamins

B Vitamins

The B-complex vitamins offer a wide variety of benefits that contribute to an athlete's optimal health and performance. These vitamins aid in muscle recovery, energy levels, help with stress and anxiety management, regulate blood pressure, and improve brain function, focus, and sleep quality [21]. While necessary in recommended amounts for optimal athletic performance, taking extra B vitamins does not benefit athletic performance [39]. At the same time, a short-term dietary lapse leading to marginally deficient B vitamins

probably will not negatively affect exercise performance [39]. For example, vitamin B12 deficiency often takes months to years to develop [39]. Female athletes, especially vegetarians and those with disordered eating habits, are most likely to suffer B vitamin deficiency [39]. Each B vitamin that is significant to athletic performance is discussed separately below.

Thiamin (B1) must be consumed regularly from the diet because it is essential for carbohydrate metabolism and plays a role in nerve function [39]. Signs of a deficiency of this vitamin include decreased appetite, weight loss, and cardiac and neurological irregularities (such as mental confusion, muscular wasting, swelling, decreased sensation in the hands and feet, a fast heart rate, and an enlarged heart) [39]. The biochemical outcomes include a failure to create adenosine triphosphate (ATP), lactic acidosis resulting in a greater lactic acid generation, and a reduction in neurotransmitter synthesis (e.g., acetylcholine, glutamate, aspartate, and gamma-aminobutyric acid (GABA)) [21]. The major causes of thiamin deficiency are either insufficient intake, poor absorption or metabolism, or an increase in demand. Furthermore, diuretics and diarrhea lead to thiamin deficiency [21]. Regarding thiamin and exercise, research suggests that thiamin availability in the diet appears to influence exercise capacity when athletes consume the recommended amount [21]. However, thiamin deficiency is rare in the United States because of enrichment in rice and cereal products [39].

Food Sources:
Foods high in thiamin include pork, fish, seeds, nuts, beans, green peas, tofu, brown rice, squash, asparagus, and seafood [40].

Riboflavin (B2) is essential and must be obtained from food sources. This vitamin assists with reduction and oxidation (redox) processes and with amino acid, lipid, and carb metabolism. Riboflavin does not have an effect on athletic performance.

Food Sources:
Foods high in riboflavin include beef, tofu, milk, fish, mushrooms, pork, spinach, almonds, avocados, and eggs [40].

Niacin (B3) also assists with redox processes and with amino acid, lipid, and carb metabolism [39]. It is hypothesized that this vitamin lowers cholesterol, improves thermoregulation, and improves oxidative metabolism [21].

Food Sources:
High niacin foods include fish, chicken, turkey, pork, beef, mushrooms, brown rice, peanuts, avocados, and green peas [40].

Pantothenic Acid (B5) is widely available in the diet. Pantothenic acid functions as a coenzyme for acetyl coenzyme A (acetyl CoA) and acyl-carrier protein (ACP), which are essential for metabolism of fatty acids, amino acids, lipids, and carbs [21, 39]. It is implied that vitamin B5 plays an important role in aerobic or oxygen-based energy systems [21].

Food Sources:
Foods high in vitamin B5 include mushrooms, fish, avocados, eggs, lean chicken, beef, pork, sunflower seeds, milk, sweet potatoes, and lentils [40].

Pyridoxine (B6) plays an important role in protein metabolism, red blood cell production, glycogenolysis, conversion of the amino acid tryptophan to niacin, neurotransmitter formation, and immune system function [39]. It may also increase muscular growth, strength, and aerobic capacity [21]. Most studies have reported a positive impact on exercise performance, especially for athletes who had a vitamin B6 deficiency and ingested vitamin B6 either as part of a multivitamin supplement or as a sole intake [21].

Food Sources:
Foods high in vitamin B6 include fish, chicken, tofu, pork, beef, sweet potatoes, bananas, potatoes, avocados, and pistachios [39, 40].

Folate (B9) plays a crucial role in the production of DNA, formation of red and white blood cells, formation of neurotransmitters, and metabolism of amino acids [39]. An increased red blood cell count enhances oxygen supply to muscles during exercise [21].

Food Sources:
Foods high in vitamin B9 include beans, lentils, asparagus, spinach, broccoli, avocado, mangoes, lettuce, sweet corn, oranges, and whole wheat bread [40].

Cobalamin (B12) is crucial for proper brain functioning, as it aids in faster information processing and enhances concentration levels [21]. This is especially important for athletes, as improved brain functioning may help improve performance in many ways, from learning new techniques to continuous focus maintenance during long competitions [21].

Food Sources:
High vitamin B12 foods include clams, fish, crab, low-fat beef, fortified cereal, fortified soy milk, fortified tofu, low-fat dairy, cheese, and eggs [39, 40].

Vitamin C

Vitamin C plays an important role in immunity (i.e., improving the immune system and reducing the risk of illnesses like colds and other viruses) [21, 39]. Studies have shown that vitamin C can also eliminate fatigue, improve coordination, and increase endurance [6]. Moreover, vitamin C plays a crucial role in wound healing (i.e., it can shorten the time it takes to heal a wound) and collagen production [21, 39]. Furthermore, vitamin C contributes to the strength and integrity of joints and muscles, which is essential for the success of any athlete [21]. High levels of vitamin C can, in turn, act as a pro-oxidant rather than an antioxidant [21]. In fact, the overconsumption of vitamin C supplements decreases exercise-induced adaptation, delays post-exercise recovery, increases lipid peroxidation, and diminishes mitochondrial biogenesis [21]. These effects can hinder skeletal muscle adaptation to exercise. Since athletes push their bodies to the limits, they require more vitamin C than the average person. Researchers have reported that the intake of vitamin C supplements does not boost physical performance in well-nourished athletes [21]. Therefore, athletes should obtain an adequate amount of vitamin C from a balanced diet.

Food Sources:
High vitamin C foods include guavas, bell peppers, kiwi fruit, strawberries, oranges, papayas, broccoli, tomatoes, kale, and snow peas [21, 40].

Minerals

Calcium

Numerous studies have indicated that the adequate and consistent consumption of calcium can potentially enhance physical performance in athletes, because it plays a crucial role in maintaining bone and muscle strength [21]. Calcium may also help reduce injuries and improve recovery time by protecting the bones and joints from stress caused by continuous physical activity [21]. Furthermore, calcium reduces fatigue, delayed onset muscle soreness (DOMS), impacts muscle contraction and relaxation, and helps to convert carbohydrates and fat into energy [21]. Women who show signs of the female athlete triad (disordered eating, negative energy balance, and irregular or absent menstrual cycles) must also pay extra attention to calcium in addition to vitamin D intakes [39].

Food Sources:
High calcium foods include tofu, milk, yogurt, cheese, leafy greens, beans, clams, okra, trout, and acorn squash [21, 39, 40].

Iron

Iron is a crucial mineral for physical performance, and its importance cannot be overstated. It helps the body produce red blood cells, which are necessary for transporting oxygen to the muscles [21]. Without enough iron, athletes and other physically active individuals may suffer from fatigue and lethargy as the body struggles to meet the increased demands [21]. In addition to red blood cell production, iron is also important for energy metabolism [21]. The mineral converts food into energy, and it helps to ensure that the body can use energy efficiently for physical activities [21]. Iron also helps the body regulate its temperature, making it an essential nutrient for athletes competing in warm climates or hot weather [21]. Finally, iron is important for the immune system, growth, and hormone production [21]. When considering physical performance, it is important to ensure that iron intake is adequate and balanced. It is also important to make sure that athletes have enough time to rest and recover between workouts. Iron helps to replenish energy stores and reduce fatigue, so it is important to give the body time to absorb the nutrient [21].

Food Sources:
Foods high in iron include fortified cereals, beef, shellfish, dried fruit, beans, lentils, dark leafy greens, dark chocolate, quinoa, mushrooms, and squash seeds [21, 40].

Magnesium

Magnesium is an essential mineral that is recognized for its critical role in athletic performance and overall health. The mineral is present primarily in bone, muscle, soft tissue, and body fluids [39]. Magnesium helps to improve energy levels, reduce fatigue, and even increase muscle performance, making it a vital nutrient for athletes [21]. With its numerous benefits, magnesium is being increasingly taken by athletes to help them reach peak performance and maintain their physical health [21]. Magnesium helps to improve energy levels by raising the ATP availability, which is best defined as the gold energy stores of cells. Deficiency may cause ATP levels to be depleted, resulting in fatigue and overall reduced performance. The regular consumption of magnesium can improve ATP production, providing athletes with increased energy and improved endurance [21]. It also supports muscle contraction and relaxation, allowing for better muscle control and improved performance [21]. It also works to reduce lactic acid build-up in muscles, which may help reduce pain during exercise and improve

recovery time [21]. Moreover, magnesium has numerous other benefits that support physical well-being. It helps to improve sleep quality, regulate blood sugar, reduce stress, and even support the cardiovascular system [21]. By regularly consuming foods high in magnesium, athletes may benefit from improved energy production, reduced fatigue, and improved physical health, allowing them to reach their maximum performance potential.

Some athletes consume inadequate amounts of magnesium. Wrestlers, dancers, gymnasts, and tennis players, who may restrict their energy intake to maintain a specific weight, are highly susceptible to having low magnesium levels [39]. Magnesium deficiency worsens endurance performance through increased oxygen requirements at any given submaximal intensity [39]. In general, a diet high in vegetables and unrefined grains will contain more than adequate amounts of magnesium [39].

Food Sources:
High magnesium foods include dark leafy greens, seeds, beans, fish, whole grains, nuts, dark chocolate, yogurt, avocados, and bananas [21, 39, 40].

Manganese

Early studies have shown that manganese may help improve various aspects of athlete health and performance, but little is known about the exact benefits of the mineral for athletes [21]. Manganese plays an important role in energy production, as it is involved in the breaking-down of carbohydrates, proteins, and fats needed for energy [21]. It also helps the body to utilize energy more efficiently, which may result in improved endurance during long-term workouts and competitions [21]. Additionally, it aids in the production of important neurotransmitters, which may improve mental focus and coordination during physical activities [21]. Studies reported the relationship between manganese and bone health indicating that the mineral helps in the development of strong and healthy bones, which is crucial for athletes to prevent injury and speed up recovery time [21].

Food Sources:
Foods high in manganese include mussels, wheat germ, tofu, sweet potatoes, nuts, brown rice, lima beans, chickpeas, spinach, and pineapple [40].

Potassium

Potassium is a key electrolyte that together with sodium helps regulate the amount of fluid in the body [21, 39]. Potassium maintains normal fluid levels inside the cells, while sodium maintains normal fluid levels outside the cells [39]. Potassium also supports muscle contraction, normal blood pressure, and nerve function [21, 39]. Furthermore, proper potassium levels can help prevent injuries and help athletes maintain their energy levels, especially during long practices or games. The mineral helps to reduce how much lactic acid is stored in the muscles, thereby delaying premature fatigue [21]. It is also involved in the breakdown of carbohydrates, which helps keep energy levels high during intense physical activity [21]. Low potassium levels can cause muscle cramping and weakness, and severe cases can lead to heart rhythm irregularities and low blood pressure [39].

Food Sources:
High potassium foods include leafy green vegetables, fish, white beans, avocados, potatoes, acorn squash, milk, mushrooms, bananas, and cooked tomatoes [40].

Selenium

Selenium, when consumed in proper amounts, will help to boost an athlete's performance, improve mental focus, and reduce inflammation, thereby contributing to overall health and fitness [21]. This mineral is advantageous for athletes due to its powerful antioxidant characteristics that boost the body's defenses against cell damage, hence increasing endurance, strength, and overall performance [21]. Incorporating selenium into an athlete's diet may be as simple as consuming more foods that are naturally rich in selenium or taking it in supplemental form. However, studies have shown that the consumption of selenium supplements has no impact on aerobic or anaerobic performance [21]. Hence, it is important to integrate it into a balanced diet in appropriate doses rather than consuming mega doses. Without sufficient dietary intake of selenium, high levels of physical activity could deplete the body's reserves, especially athletes who are on a calorically restricted, low-fat diet [39].

Food Sources:
Foods high in selenium include Brazil nuts, tuna, oysters, pork, beef, chicken, tofu, whole wheat pasta, shrimp, and mushrooms [40].

Zinc

Zinc is an essential mineral that our bodies need for metabolic functions such as cell repair, immune system function, hormone production, and healthy skin [21]. By boosting the immune system, zinc may help athletes fight off colds and other illnesses that can impede progress [21]. Zinc helps reduce blood thickness, which enhances oxygen delivery, thereby improving aerobic endurance [21]. Zinc also helps to increase strength and endurance, so athletes may push their bodies to the limit while still receiving the nutrients they need [21]. Zinc may also help to reduce inflammation and soreness, which can accelerate recovery time and reduce the risk of injury [21]. Moreover, zinc may help improve attention and focus, which can assist athletes in staying focused on their tasks and performing at their best [21].

Unfortunately, not all athletes receive enough zinc from food intake, which may leave athletes at a disadvantage. Including it as a supplement may help athletes meet their nutritional goals without having to increase caloric intake [21]. Despite zinc supplements being popular among athletes, there is limited proof regarding athletic performance improvement in a period of 1–6 weeks [21]. Low zinc levels can negatively affect athletic performance by decreasing cardiorespiratory endurance and muscle strength [39]. Too much zinc supplementation can decrease high-density lipoprotein (HDL) cholesterol, interfere with copper absorption, and alter iron function [39]. Therefore, athletes should attempt to consume adequate levels of zinc from food the best they can.

Food Sources:
Foods high in zinc include oysters, beef, chicken, tofu, pork, nuts, seeds, lentils, yogurts, oatmeal, and mushrooms [21, 39, 40].

Conclusion

Vitamins and minerals are crucial for an athlete's health and physical performance, and **no single micronutrient is more important than others**. Because exercise increases demand on the body's metabolic processes, athletes tend to have increased vitamin and mineral needs compared to the sedentary or less active population. A balanced diet that includes a variety of fruits, vegetables, whole grains, and lean proteins can help athletes meet their micronutrient needs. Table A-4 (see Appendix A) summarizes the micronutrients having the most significant impact on athletic performance, and these vitamins and minerals have been extensively researched in sports medicine.

A note on weight management…

Vitamins and minerals are calorie-free and are not a source of energy, but they are essential for optimal health. For individuals who are attempting to lose weight, it is crucial for them to adopt a nutrient-dense, low-calorie eating plan. Not only should individuals limit empty calories from nutrient-poor foods, but they should also pay special attention to eating a balanced diet that includes all of the major food groups to ensure sufficient vitamin and mineral intake [39].

1.6 Calculate your fluid intake.

General guidelines

For healthy individuals (19 years and older), the average daily water intake is about 15.5 cups (3.7 liters) for men and about 11.5 cups (2.7 liters) for women [25, 26, 27, 36, 41]. About 20 percent of the water typically comes from food [25, 36, 41]. Taking this into account, the adequate intake of daily fluids is about 13 cups (104 fluid ounces or 3.1 liters) for men and about 9 cups (72 fluid ounces or 2.1 liters) for women [25, 59]. However, this adequate intake should not be interpreted as a specific requirement, because higher intakes of total water will be required for those who are physically active or who are exposed to hot environments [41].

For a more individualized recommendation, you can calculate your fluid needs using your weight. Healthy adults need around 35 mL (1 oz.) of water per kilogram (2 lbs.) of body weight [20, 27, 60]. For example, a person weighing 50 kg (110 lbs.) requires 1.7 liters (55 oz.) of water, and a person weighing 90 kg (198 lbs.) requires about 3.2 liters (100 oz.).

How much water you drink overall really depends on your diet, your weight, your physical activity level, the climate you live in, and your overall health [26]. So, a good starting point would be to calculate your fluid needs using your weight. Additionally, you should monitor your urine. If you are adequately hydrated, you should urinate about once every 2-4 hours, and your urine should be colorless or a very pale yellow. If it is darker than that, you have not had enough fluid [27]. Headaches and dizziness are a late sign of dehydration [27]. If you start experiencing those, you really need to up your water intake, and quickly [27].

Hydration and athletic performance

Because there is considerable variability in sweating rates and sweat electrolyte content among individuals, individual sweat rates can be estimated by measuring body weight before and after exercise. During exercise, consuming beverages containing electrolytes and carbohydrates can provide benefits over water alone under certain circumferences. After exercise, the goal is to replace any fluid electrolyte deficit.

Pre-exercise hydration

People who begin exercise with a fluid deficit display an impaired ability to dissipate body heat during subsequent exercise [7]. They demonstrate a faster rise in body core temperature and greater cardiovascular strain [7, 39]. As a result, exercise performance is impaired, and this effect is exaggerated in a hot environment [7, 39]. It is recommended that individuals consume a nutritionally balanced diet and drink adequate fluids during the 24-hour period before an event, especially during the period that includes the meal prior to exercise, to promote proper hydration before exercise or competition [7]. It is recommended that individuals drink about 400-600 mL (about 14-20 ounces) of fluid about 2 hours before exercise to promote adequate hydration and allow time for excretion of excess ingested water [7].

Intra-exercise hydration

The goal of proper fluid intake during exercise is to prevent excessive (>2% body weight loss from water deficit) dehydration and excessive changes in electrolyte balance to avert performance-diminishing or health-altering effects [39]. During exercise, athletes should start drinking early and at regular intervals attempting to consume

fluids at a rate sufficient to replace all the water lost through sweating (i.e., body weight loss), or consume the maximal amount that can be tolerated without gastrointestinal discomfort [7]. It is recommended that fluids be cooler than ambient temperature, i.e., 15-21 degrees Celsius (59-70 degrees Fahrenheit) and flavored to enhance palatability and promote fluid replacement [7].

If exercising longer than 1 hour, you should obtain some additional carbohydrates with fluids [6, 7, 38, 39]. With prolonged exercise, muscle glycogen stores become depleted and blood glucose becomes a primary fuel source [6, 38, 39]. To maintain blood glucose levels and prevent fatigue, consume drinks and snacks that provide about 30-60 grams of rapidly absorbed carbohydrates for every hour of training [6, 7, 38, 39]. These amounts of carbohydrates can be obtained while also replacing relatively large amounts of fluid if the concentration of carbohydrates is kept below 10 percent (see "*For your information*" below for a detailed explanation on carb concentration) [7]. Carbohydrates can be sugars (glucose or sucrose) or starch, e.g., maltodextrin [7]. Fructose should not be the predominant carbohydrate because it converts to blood glucose slowly, which does not improve performance and may cause gastrointestinal distress [7]. Additionally, the inclusion of about 500-700 mg of sodium per liter of water during exercise lasting longer than 1 hour is recommended since it can enhance palatability, promote fluid retention, and prevent hyponatremia in certain individuals who drink excessive quantities of fluid [7].

For exercise lasting less than 1 hour, there is little evidence of physiological or physical performance differences between consuming a carbohydrate-electrolyte drink and plain water [7].

Studies suggest that during prolonged exercise, frequent (every 15-20 minutes) consumption of 150-350 mL (5-12 ounces) of fluids is possible [7].

For your information

You can replenish blood glucose by drinking 600-1,200 mL/hour of solutions containing carbohydrate concentrations of 4-8 percent [7]. A percent concentration is the number of grams of a solution in 100 mL of total volume. For example, to calculate the carbohydrate concentration (in %) of a sports drink that contains 18 grams of carbohydrates per 240 mL (8 oz.) serving, you would divide 18 grams by 240 mL and then multiply by 100 (18 g ÷ 240 mL × 100) to obtain 7.5 percent. Contingent on the carbohydrate concentration being 4-8 percent, it will have little effect on gastric emptying, which is the speed with which the stomach empties its contents into the small intestine [39]. Solutions containing carbohydrate concentrations greater than 10 percent can exacerbate the effects of dehydration [7].

Post-exercise hydration

Following exercise, aim to correct any fluid imbalances that occurred during the workout. This includes consuming water to restore hydration, carbohydrates to replenish glycogen stores, and electrolytes to speed rehydration [6, 38, 39]. It is recommended to drink 450-675 mL for every 0.5 kg body weight lost (or 15-23 oz. for every pound) [6, 38, 39]. If you know you will have at least 12 hours to recover before your next workout, then rehydration with the usual meals and water should be adequate [6, 38, 39]. The sodium in the foods will help retain the fluid and stimulate thirst.

If rehydration needs to occur quickly, you should drink about 1.5 liters of fluid for each kilogram (or 0.75 liters of fluid for each pound) of body weight lost [6, 38, 39]. This will be enough to restore lost fluid and compensate for increased urine output that occurs with rapid consumption of large amounts of fluid [6, 38, 39]. For example, if

you lose 2 lb. of body weight during your exercise session, this will equate to 1.5 liters (0.75 × 2 lb.) or about 50 fluid ounces that you would need to replenish.

Summary of fluid intake recommendation for active adults.

- ✓ **Baseline hydration**. Baseline fluid recommendation is around 35 mL (1 oz.) of water per kilogram (2 lbs.) of body weight.
- ✓ **Pre-exercise hydration**. Drink 400-600 mL (about 14-20 ounces) of fluid about 2 hours before exercise.
- ✓ **Intra-exercise hydration**. Every 15-20 minutes during exercise, drink 150-350 mL (5-12 oz.) or, preferably, drink based on sweat loss. If exercising longer than 1 hour, consume drinks and snacks that provide about 30-60 grams of rapidly absorbed carbohydrates for every hour of training. Furthermore, drink 600-1,200 mL/hour of solutions containing carbohydrate concentrations of 4-8 percent and 500-700 mg of sodium per liter of water.
- ✓ **Post-exercise hydration**. Following exercise, drink 450-675 mL for every 0.5 kg body weight lost (or 15-23 oz. for every pound).

Example

An active 32-year-old healthy man weighing 200 pounds plans to exercise in a moderately warm environment for 2 hours starting at 4 p.m. His baseline daily hydration requirement is 100 fluid ounces (200 ÷ 2). We are assuming he is drinking fluids throughout the day. For his pre-exercise hydration, he drinks 16 ounces of water around 2 p.m. He begins his exercise session on time, and 20 minutes into his workout, he drinks 12 ounces of water. Another 20 minutes later, he drinks 12 more ounces. At the one-hour mark, he is at a total of 36 ounces of water. At this point, he is starting to feel fatigued, so he starts to sip on a 32-ounce carbohydrate-sodium solution containing about 45 grams of carbs and 600 mg of sodium. This provides him with the energy to continue his workout. He continues to exercise for another hour, drinking about 12 ounces of fluids every 20 minutes until 6 p.m. At the end of the workout, he weighs himself and finds out that he lost 2 pounds. He proceeds to consume about 40 ounces of water (20 × 2) to rehydrate.

- ✓ **Baseline hydration**. 200 lbs. ÷ 2 = 100 oz.
- ✓ **Pre-exercise hydration**. 16 oz.
- ✓ **Intra-exercise hydration**. 12 oz. × six 20-min intervals = 72 ounces (this includes the 32-oz. carb-sodium solution)
- ✓ **Post-exercise hydration**. 20 oz. × 2 lbs. = 40 oz.

His daily total water intake is 100 + 16 + 72 + 40 = 228 ounces.

In Section 1.3, we showed you how to determine your macronutrients for weight loss, weight gain, and weight maintenance using our 32-year-old man example. The following section continues with the same example to demonstrate how to construct a diet aligned with your specific calorie target, providing detailed breakdowns of the macro- and micronutrients. For comprehensive lists of foods rich in each nutrient type, refer to Appendix A: '*Food Information*.'

1.7 Construct your diet.

Reading the nutrition label

Nutrition Facts

8 servings per container

Serving size **2/3 cup (55g)**

Amount per serving

Calories **230**

	% Daily Value*
Total Fat 8g	**10%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 37g	**13%**
Dietary Fiber 4g	**14%**
Total Sugars 12g	
Includes 10g Added Sugars	**20%**
Protein 3g	
Vitamin D 2mcg	10%
Calcium 260mg	20%
Iron 8mg	45%
Potassium 240mg	6%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Serving Size. This tells the size of a single serving and the total number of servings per container. All the nutrition information on the label is based on one serving. If you eat twice the serving size shown here, multiply the calorie and nutrient values by two.

Calories. This tells how many calories (kcal) are in one serving. If you eat two servings, multiply this number by two.

Total Fat. This tells you the amount of fat per serving (some labels will also list mono- and polyunsaturated fat amounts). When the label lists "0 g" of trans fat but includes "partially hydrogenated oil" in the ingredient list, it means the food contains some trans fat, but less than 0.5 grams per serving.
Cholesterol. Many foods that are high in cholesterol are also high in saturated fat.
Sodium. For healthy adults, the American Heart Association recommends no more than 3,000 mg of sodium per day.
Total Carbohydrate. This tells you the amount of carbs per serving and is further broken down into dietary fiber and sugars. Consume foods high in fiber more often, i.e., 14 grams per 1,000 kcal. Also, it is best to consume no more than 10% of total calories from added sugars.
Protein. This tells you the amount of protein per serving.

Vitamins and Minerals. This tells you how many vitamins and minerals there are and the amount in each serving. You should be getting 100% of each daily.

Daily Value. The % Daily Value (DV) tells you the percentage of each nutrient in a single serving, in terms of the daily recommended amount. If you want to consume less of a nutrient, choose foods with a lower % DV (5% or less). If you want to consume more of a nutrient, choose foods with a higher % DV (20% or more). The information shown on the label is based on a diet of 2,000 calories a day. You may need less or more than 2,000 calories depending upon your age, gender, activity level, and whether you're trying to lose, gain, or maintain your weight.

Ingredients: This portion of the label lists all the foods and additives contained in a product, in descending order by weight.

Allergens: This portion of the label identifies which of the most common allergens may be present in the product.

Constructing your diet: Example, Objective A (to lose weight).

A 32-year-old man who is 183 cm in height (6 feet), weighs 90 kilograms (199 pounds) and is determined to have an active PAL has a calorie goal of 2,783 kcal/day. His weight loss macro values have been determined and are shown in Table 1-4, i.e., Protein = 210g, Fat = 70g, Carbs = 328g. To meet his macro- and micronutrient requirements, the man's diet might look like the meal plan shown in Table 1-9 below.

Table 1-9. Example Weight Loss Meal Plan.

Meal #	Food Description	Serving Size	Serving Measure	Energy (kcal)
1	Oatmeal (cooked)	1	cup	166
	Milk, almond, unsweetened	1	cup	39
	Bananas	1	cup	134
	Honey	1	tbsp.	64
	Blueberries	0.5	cup	42
	Walnuts	0.5	oz.	93
2	Egg, scrambled	2	large	182
	Egg, whites	6	oz.	90
	Cheese, feta	1	oz.	75
	Bread, sprouted grain	1	slice	80
	Jam, strawberry	1	tbsp.	50
3	Quinoa (cooked)	0.75	cup	167
	Beans, garbanzo (chickpeas)	0.38	cup	102
	Cucumbers	0.25	cup	4
	Onions	0.2	cup	13
	Sweet red bell peppers	0.25	cup	10
	Parsley	0.25	cup	6
	Lemon Juice	0.1	cup	5
	Garlic	0.25	oz.	11
	Fish, salmon, canned pink	6	oz.	232
4	Yogurt, non-fat	2	cup	274
	Squash and pumpkin seeds (roasted, unsalted)	0.5	oz.	82
	Apricots, dried (low-moisture)	0.25	cup	95
	Apples	1	cup	65
5	Beef, chuck steak	6	oz.	322
	Potatoes, sweet (baked)	1	cup	180
	Carrots (cooked)	0.25	cup	14
	Broccoli (cooked)	0.5	cup	28
	Fluids			
	Coffee	2	cup	4
	Water, average city tap	14	cup	0
	Black tea (brewed)	1	cup	2
	Grape juice	1	cup	152

Tables 1-10 and 1-11 show the total amount of macro- and micronutrients consumed. The total macronutrients (Table 1-10) are close to the values calculated in Table 1-4 and meet the minimum requirements for fats, fiber, added sugar, and glycemic load. The total micronutrients (Table 1-11) also meet the minimum requirements.

Note: Calories do not always align with macros due to rounding on food labels and the ability for food manufacturers to subtract the calories from dietary fiber and sugar alcohols.

Table 1-10. Example Weight Loss Macronutrient Analysis.

Macros	Total Amount	% Total Calories	Requirement
Calories, kcal	2,780		
Total Fat, g	69	22.3%	20 - 35%
Saturated Fat, g	18	5.8%	< 10%
Omega-3 Fat, g	4		1 - 2 g
Omega-6 Fat, g	17	5.4%	5 - 10 %
Carbs, g	355	51.1%	45 - 65%
Fiber, g	40		14 g per 1,000 kcal
Added Sugars, g	12	1.7%	< 10%
Glycemic Load	151		85-100 per 1,000 kcal or lower
Protein, g	204	29.4%	10 - 35%

Table 1-11. Example Weight Loss Micronutrient Analysis.

Vitamins	Total Amount	Requirements	Minerals	Total Amount	Requirement
Vitamin A	2,916	900 - 3,000 µg	**Calcium**	2,267	1,200 - 2,000 mg
Vitamin D	29	20 - 100 µg	**Chromium**	43	≥ 35 µg
Vitamin E	26	15 - 1,000 mg	**Copper**	3	0.9 - 10 mg
Vitamin K	405	≥ 120 µg	**Fluoride**	4,488	4,000 - 10,000 µg
Vitamin B1 (Thiamin)	2	≥ 1.2 mg	**Iodine**	430	150 - 1,100 µg
Vitamin B2 (Riboflavin)	4	≥ 1.3 mg	**Iron**	26	18 - 45 mg
Vitamin B3 (Niacin)	33	16 - 35 mg	**Magnesium**	781	≥ 420 mg
Vitamin B5 (Pantothenic Acid)	13	≥ 5 mg	**Manganese**	9	2.3 - 11 mg
Vitamin B6 (Pyridoxine)	4	1.7 - 100 mg	**Molybdenum**	143	45 - 2,000 µg
Vitamin B7 (Biotin)	64	≥ 30 µg	**Phosphorus**	3,108	700 - 4,000 mg
Vitamin B9 (Folate)	577	400 - 1,000 µg	**Potassium**	7,242	≥ 3,400 mg
Vitamin B12 (Cobalamin)	21	≥ 2.4 µg	**Selenium**	257	55 - 400 µg
Vitamin C	208	90 - 2,000 mg	**Sodium**	2,523	≥ 1,500 mg
Choline	924	550 - 3,500 mg	**Zinc**	38	11 - 40 mg

Constructing your diet: Example, Objective B (to gain weight).

A 32-year-old man who is 183 cm in height (6 feet), weighs 90 kilograms (199 pounds) and is determined to have an active PAL has a calorie goal of 3,783 kcal/day. His weight gain macro values have been determined and are shown in Table 1-6, i.e., Protein = 135g, Fat = 100g, Carbs = 586g. To meet his macro- and micronutrient requirements, the man's diet might look like the meal plan shown in Table 1-12 below.

Table 1-12. Example Weight Gain Meal Plan.

Meal #	Food Description	Serving Size	Serving Measure	Energy (kcal)
1	Oatmeal (cooked)	2	cup	332
	Milk, almond, unsweetened	2	cup	78
	Bananas	1.5	cup	201
	Honey	2	tbsp.	128
	Blueberries	1	cup	84
	Walnuts	1	oz.	186
2	Egg, scrambled	2	large	182
	Egg, whites	2	oz.	30
	Cheese, feta	1	oz.	75
	Cream cheese	2	tbsp.	102
	Bread, sprouted grain	2	slice	160
	Orange Juice (fortified)	2	cup	234
3	Quinoa (cooked)	1	cup	222
	Beans, garbanzo (chickpeas)	0.38	cup	102
	Cucumbers	0.25	cup	4
	Onions	0.2	cup	13
	Sweet red bell peppers	0.25	cup	10
	Parsley	0.25	cup	6
	Lemon Juice	0.1	cup	5
	Garlic	0.25	oz.	11
	Chicken breast (lean)	3	oz.	134
	Apples	1	cup	65
4	Bread, white	2	slice	154
	Peanut butter (smooth)	2	tbsp.	188
	Jam, strawberry	2	tbsp.	100
5	Fish, salmon, farmed Atlantic (cooked fillet)	4	oz.	233
	Potatoes, sweet (baked)	2	cup	360
	Carrots (cooked)	0.25	cup	14
	Broccoli (cooked)	0.5	cup	28
	Fluids			
	Coffee	2	cup	4
	Water, average city tap	14	cup	0
	Black tea (brewed)	1	cup	2
	Grape juice	2	cup	304

Tables 1-13 and 1-14 show the total amount of macro- and micronutrients consumed. The total macronutrients (Table 1-13) are close to the values calculated in Table 1-6 and meet the minimum requirements for fats, fiber, added sugar, and glycemic load. The total micronutrients (Table 1-14) also meet the minimum requirements.

Note: Calories do not always align with macros due to rounding on food labels and the ability for food manufacturers to subtract the calories from dietary fiber and sugar alcohols.

Table 1-13. Example Weight Gain Macronutrient Analysis.

Macros	Total Amount	% Total Calories	Requirement
Calories, kcal	3,749		
Total Fat, g	106	25.5%	20 - 35%
Saturated Fat, g	26	6.1%	< 10%
Omega-3 Fat, g	6		1 - 2 g
Omega-6 Fat, g	28	6.6%	5 - 10 %
Carbs, g	579	61.8%	45 - 65%
Fiber, g	64		14 g per 1,000 kcal
Added Sugars, g	24	2.6%	< 10%
Glycemic Load	279		85-100 per 1,000 kcal or lower
Protein, g	152	16.2%	10 - 35%

Table 1-14. Example Weight Gain Micronutrient Analysis.

Vitamins	Total Amount	Requirement	Minerals	Total Amount	Requirement
Vitamin A	4,793	900 - 3,000 µg	**Calcium**	2,628	1,200 - 2,000 mg
Vitamin D	27	20 - 100 µg	**Chromium**	71	≥ 35 µg
Vitamin E	48	15 - 1,000 mg	**Copper**	4	0.9 - 10 mg
Vitamin K	426	≥ 120 µg	**Fluoride**	5,118	4,000 - 10,000 µg
Vitamin B1 (Thiamin)	3	≥ 1.2 mg	**Iodine**	154	150 - 1,100 µg
Vitamin B2 (Riboflavin)	3	≥ 1.3 mg	**Iron**	29	18 - 45 mg
Vitamin B3 (Niacin)	44	16 - 35 mg	**Magnesium**	950	≥ 420 mg
Vitamin B5 (Pantothenic Acid)	16	≥ 5 mg	**Manganese**	14	2.3 - 11 mg
Vitamin B6 (Pyridoxine)	6	1.7 - 100 mg	**Molybdenum**	74	45 - 2,000 µg
Vitamin B7 (Biotin)	97	≥ 30 µg	**Phosphorus**	2,758	700 - 4,000 mg
Vitamin B9 (Folate)	795	400 - 1,000 µg	**Potassium**	8,096	≥ 3,400 mg
Vitamin B12 (Cobalamin)	5	≥ 2.4 µg	**Selenium**	214	55 - 400 µg
Vitamin C	426	90 - 2,000 mg	**Sodium**	2,209	≥ 1,500 mg
Choline	839	550 - 3,500 mg	**Zinc**	22	11 - 40 mg

Constructing your diet: Example, Objective C (to maintain current weight).

A 32-year-old man who is 183 cm in height (6 feet), weighs 90 kilograms (199 pounds) and is determined to have an active PAL has a calorie goal of 3,283 kcal/day. His weight maintenance macro values have been determined and are shown in Table 1-8, i.e., Protein = 185g, Fat = 101g, Carbs = 409g. To meet his macro- and micronutrient requirements, the man's diet might look like the meal plan shown in Table 1-15 below.

Table 1-15. Example Weight Maintenance Meal Plan.

Meal #	Food Description	Serving Size	Serving Measure	Energy (kcal)
1	Oatmeal (cooked)	1	cup	166
	Milk, low fat 2%	1	cup	122
	Bananas	0.5	cup	67
	Honey	1	tbsp.	64
	Blueberries	0.5	cup	42
	Walnuts	1	oz.	186
2	Egg, scrambled	2	large	182
	Egg, whites	4	oz.	60
	Cheese, feta	1	oz.	75
	Bread, sprouted grain	2	slice	160
	Cream cheese	2	tbsp.	102
	Orange Juice (fortified)	0.5	cup	59
3	Chicken breast (lean)	4	oz.	178
	Rice, white (cooked)	1	cup	205
	Butter, salted	0.5	oz.	102
	Beans, black	0.5	cup	114
	Flax seeds	0.5	oz.	76
4	Pasta, spaghetti, enriched (cooked)	2	cup	440
	Sauce, pasta	1	cup	132
	Cheese, grated parmesan (hard)	2	oz.	222
5	Fish, salmon, sockeye (cooked fillet)	4	oz.	177
	Potatoes, sweet (baked)	1	cup	180
	Carrots (cooked)	0.25	cup	14
	Broccoli (cooked)	0.5	cup	28
	Fluids			
	Coffee	2	cup	4
	Water, average city tap	14	cup	0
	Black tea (brewed)	1	cup	2
	Grape juice	1	cup	152

Tables 1-16 and 1-17 show the total amount of macro- and micronutrients consumed. The total macronutrients (Table 1-16) are close to the values calculated in Table 1-8 and meet the minimum requirements for fats, fiber, added sugar, and glycemic load. The total micronutrients (Table 1-17) also meet the minimum requirements.

Note: Calories do not always align with macros due to rounding on food labels and the ability for food manufacturers to subtract the calories from dietary fiber and sugar alcohols.

Table 1-16. Example Weight Maintenance Macronutrient Analysis.

Macros	Total Amount	% Total Calories	Requirement
Calories, kcal	3,308		
Total Fat, g	110	29.8%	20 - 35%
Saturated Fat, g	39	10.7%	< 10%
Omega-3 Fat, g	8		1 - 2 g
Omega-6 Fat, g	21	5.7%	5 - 10 %
Carbs, g	404	48.8%	45 - 65%
Fiber, g	49		14 g per 1,000 kcal
Added Sugars, g	0	0.0%	< 10%
Glycemic Load	195		85-100 per 1,000 kcal or lower
Protein, g	190	22.9%	10 - 35%

Table 1-17. Example Weight Maintenance Micronutrient Analysis.

Vitamins	Total Amount	Requirement	Minerals	Total Amount	Requirement
Vitamin A	3,150	900 - 3,000 µg	**Calcium**	1,916	1,200 - 2,000 mg
Vitamin D	26	20 - 100 µg	**Chromium**	43	≥ 35 µg
Vitamin E	15	15 - 1,000 mg	**Copper**	3	0.9 - 10 mg
Vitamin K	191	≥ 120 µg	**Fluoride**	4,341	4,000 - 10,000 µg
Vitamin B1 (Thiamin)	3	≥ 1.2 mg	**Iodine**	303	150 - 1,100 µg
Vitamin B2 (Riboflavin)	4	≥ 1.3 mg	**Iron**	24	18 - 45 mg
Vitamin B3 (Niacin)	52	16 - 35 mg	**Magnesium**	749	≥ 420 mg
Vitamin B5 (Pantothenic Acid)	13	≥ 5 mg	**Manganese**	9	2.3 - 11 mg
Vitamin B6 (Pyridoxine)	5	1.7 - 100 mg	**Molybdenum**	124	45 - 2,000 µg
Vitamin B7 (Biotin)	56	≥ 30 µg	**Phosphorus**	2,849	700 - 4,000 mg
Vitamin B9 (Folate)	800	400 - 1,000 µg	**Potassium**	5,992	≥ 3,400 mg
Vitamin B12 (Cobalamin)	9	≥ 2.4 µg	**Selenium**	290	55 - 400 µg
Vitamin C	153	90 - 2,000 mg	**Sodium**	4,084	≥ 1,500 mg
Choline	822	550 - 3,500 mg	**Zinc**	20	11 - 40 mg

Table 1-18. Side-by-side comparison of macronutrients for objectives A, B, and C.

Macros	Weight Loss		Weight Gain		Weight Maintain		Requirement
	Total	**%**	**Total**	**%**	**Total**	**%**	
Calories, kcal	2,780		3,749		3,308		
Total Fat, g	69	22.3%	106	25.5%	110	29.8%	20 - 35%
Saturated Fat, g	18	5.8%	26	6.1%	39	10.7%	< 10%
Omega-3 Fat, g	4		6		8		1 - 2 g
Omega-6 Fat, g	17	5.4%	28	6.6%	21	5.7%	5 - 10 %
Carbs, g	355	51.1%	579	61.8%	404	48.8%	45 - 65%
Fiber, g	40		64		49		14 g per 1,000 kcal
Added Sugars, g	12	1.7%	24	2.6%	0	0.0%	< 10%
Glycemic Load	151		279		195		85-100 per 1,000 kcal or lower
Protein, g	204	29.4%	152	16.2%	190	22.9%	10 - 35%

Chapter 2 – Training Specific Muscles and Muscle Groups

Biomechanical Similarity

Muscular performance is enhanced when exercises are paired in such a way that establishes biomechanical similarity. Biomechanical similarity is the degree to which two or more exercises use the same or similar muscles and primary joint actions in one exercise session [2]. The degree of biomechanical similarity of paired exercises provides exercise-specific timing cues based on the primary muscles trained and the primary joint actions performed [2]. For example, the triceps pushdown is similar to the overhead triceps extension because both exercises use the triceps brachii muscle and elbow extension as the primary joint action [2]. In a well-planned training program, biomechanically similar exercises that use similar joint actions and muscles are paired together during sessions and on a regular schedule. Furthermore, muscle performance can be enhanced with similar movement patterns, similar muscle activation patterns, and exercise intensity [2]. Basically, muscles have the ability to anticipate exercises when given the proper cues regularly using biomechanical similarity and will turn on the associated molecular actions to enhance performance.

This concept is simplified by categorizing resistance exercises into four groups: bilateral lower-body, unilateral lower-body, upper-body, and isolation exercises. Although there are many exercises that can fit into each one of these categories, the exercises featured in this chapter were selected based on the similarity of primary muscles and muscle groups used, and the similarity of primary joint actions.

Bilateral Lower-Body Exercises. Bilateral exercises can be single-joint or multi-joint exercises and include single-muscle exercises, such as knee extensions for the quadriceps femoris, and multiple-muscle exercises, such as squats for the gluteus maximus and quadriceps femoris. For analysis purposes, only the primary muscles and joint actions are included to keep the focus on biomechanical similarity.

Unilateral Lower-Body Exercises. Unilateral lower-body exercises use only one side of the body to complete the movement, although the opposite side of the body helps support and stabilize the body. Unilateral exercises can use small muscles, like those of the upper arm, but they can also use larger muscles, like those in the thigh. The focus here is on unilateral lower-body exercises that share biomechanical similarity with all-body power exercises.

Upper-Body Exercises. Upper-body exercises use the muscles and joints of the upper body only to complete the exercise, although the lower body and core are used to support and stabilize the body during the movement. Similar to lower-body exercises, only the primary muscles and joints are included in the analysis.

Isolation Exercises. Isolation exercises are single-joint movements. They typically require the use of only one joint at a time and normally focus on one muscle group at a time. Isolation exercises complement compound, multi-joint exercises and are used here to build paired workouts focused on biomechanical similarity. In this section, the exercises are categorized based on the primary joint movement, with a list of common exercises that use that movement.

Bilateral Lower-Body Exercises

Front Squat

Primary muscles:

- ✓ Quadriceps femoris (rectus femoris, vastus medialis, vastus intermedius, and vastus lateralis)
- ✓ Gluteus maximus
- ✓ Hamstrings (semimembranosus, semitendinosus, and biceps femoris)

Primary joint actions:

- ✓ Hip extension
- ✓ Knee extension

Instructions:

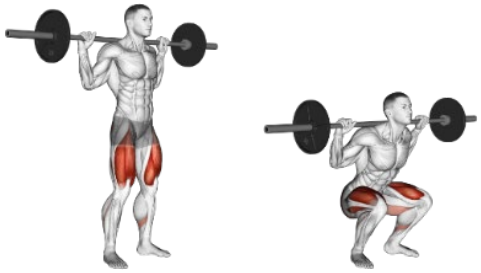
1. Stand in a shoulder-width stance with feet pointed out slightly. Cross your arms, placing each hand on top of the bar and place the barbell onto your shoulders.

2. Your upper arms should remain parallel to the floor to keep the weight on top of your shoulders. Make sure you keep your elbows high throughout the exercise.

3. Inhale as you begin to lower the weight until your thighs are parallel to the floor. Keep your back straight and do not allow it to round.

4. Pause at the bottom. Exhale and quickly accelerate the hips back to the starting position.

Back Squat



Primary muscles:

- ✓ Quadriceps femoris (rectus femoris, vastus medialis, vastus intermedius, and vastus lateralis)
- ✓ Gluteus maximus
- ✓ Hamstrings (semimembranosus, semitendinosus, and biceps femoris)

Primary joint actions:

- ✓ Hip extension
- ✓ Knee extension

Instructions:

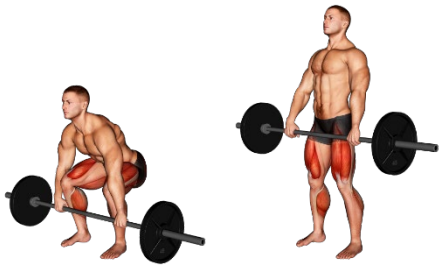
1. Hold a barbell across your upper back with an overhand grip (avoid resting it on your neck). Hug the bar into your traps to engage your upper back muscles.

2. Take the weight off the rack and take a step backward to get into your squat position. Stand with your feet shoulder-width apart (this wide stance will allow a deeper squat, getting your glutes and hamstrings involved).

3. Slowly squat down by initiating and pushing the hips back, keeping the head up, and back straight. Lower yourself until your hips are aligned with your knees, with legs at 90 degrees (a deeper squat will be more beneficial but get the strength and flexibility first).

4. Drive your heels into the floor to push yourself explosively back up.

Deadlift (Conventional)



Primary muscles:

- ✓ Quadriceps femoris (rectus femoris, vastus medialis, vastus intermedius, and vastus lateralis)
- ✓ Gluteus maximus
- ✓ Hamstrings (semimembranosus, semitendinosus, and biceps femoris)

Primary joint actions:

- ✓ Hip extension
- ✓ Knee extension

Instructions:

1. Step up to and under a barbell with your feet angled slightly outward, at hip-width apart.

2. Bend over and grip the barbell with both hands at shoulder width.

3. Bend your knees until the bar almost touches your shins.

4. With a neutral spine, flex your butt and brace your stomach.

5. Activate the upper back muscles; don't let your shoulders fall forward.

6. Pick the bar up off the ground (it helps to think “press DOWN into the floor with your feet through your heels”).

7. Continue pressing down with your legs until the barbell passes your knees, then thrust your hips forward until you are standing up.

8. Reverse your movement until the bar returns to its starting place on the ground.

Romanian Deadlift (RDL)

Primary muscles:

- ✓ Gluteus maximus
- ✓ Hamstrings (semimembranosus, semitendinosus, and biceps femoris)
- ✓ Erector spinae

Primary joint actions:

- ✓ Hip extension

Instructions:

1. Feet should be hip width apart and hands should be grabbing the bar just wider than hip width. Hold your weight in front of your thighs, and lower it to the ground by pushing your hips back.

2. As you lower the weight, keep your shoulder blades drawn towards each other and your chest open and wide. The bar path during the RDL should be in a straight line down towards the ground. The bar should almost be contacting your legs the entire way through the movement.

3. When the weight is below your knees, thrust your hips forward and return to the starting position.

4. Depending on how tall you are your weight should stop somewhere between your knee and the middle of your shin (the taller you are, the closer to your knee). You don’t want to go too far down. It depends on your flexibility, but if you try and move through too great a range, you’ll start to bend from your back and you won’t control it with the right muscles.

5. A neutral or slightly curved spine position is key to performing a Romanian deadlift with good form, so avoid looking upwards to keep your neck in line.

Leg Press

Primary muscles:

- ✓ Quadriceps femoris (rectus femoris, vastus medialis, vastus intermedius, and vastus lateralis)
- ✓ Gluteus maximus
- ✓ Hamstrings (semimembranosus, semitendinosus, and biceps femoris)

Primary joint actions:

- ✓ Hip extension
- ✓ Knee extension

Instructions:

1. Add your desired weight and adjust the seat pad to the largest angle. Position yourself in the seat with your feet in the center of the platform about shoulder-width apart.

2. Brace your abdominal muscles as you push the platform away keeping your heels flat on the footplate.

3. While inhaling, bend your legs and slowly lower the footplate until your knees are at 90 degrees.

4. Exhale as you extend your legs and keep your head and back flat against the seat pad. Extend with slow control rather than with an explosive movement.

5. Pause at the top. Do not lock out your knees and ensure that they are not bowing out or in.

6. Inhale and return to the starting position and repeat. Keep the feet and back flat throughout.

Unilateral Lower-Body Exercises

Bulgarian Split Squat

Primary muscles:

- ✓ Quadriceps femoris (rectus femoris, vastus medialis, vastus intermedius, and vastus lateralis)
- ✓ Gluteus maximus
- ✓ Gluteus medius and gluteus minimus
- ✓ Hamstrings (semimembranosus, semitendinosus, and biceps femoris)
- ✓ Iliopsoas (minor)

Primary joint actions:

- ✓ Hip extension
- ✓ Knee extension
- ✓ Hip abduction
- ✓ Hip flexion (minor)

Instructions:

1. Hold a dumbbell in each hand and position yourself into a staggered stance with the rear foot elevated and front foot forward.

2. Keeping your chest up, lower your hips toward the floor so that your rear knee comes close to the floor. Keep the front knee in line with the foot as you perform the exercise.

3. Pause at the bottom of the movement and then drive through the front heel to extend the knee and hip to return to the starting position.

Front/Back Lunge

Primary muscles:

- ✓ Quadriceps femoris (rectus femoris, vastus medialis, vastus intermedius, and vastus lateralis)
- ✓ Gluteus maximus
- ✓ Hamstrings (semimembranosus, semitendinosus, and biceps femoris)
- ✓ Iliopsoas (minor)

Primary joint actions:

- ✓ Knee extension
- ✓ Hip extension
- ✓ Hip flexion (minor)

Instructions:

1. It is safest to perform the lunge inside a squat rack. Stand under the bar with your feet at about shoulder width apart. Position the bar so that it is resting on the muscles on the top of your back, not on the back of your neck. Now take a wide grip of the bar for stability and take the weight off the rack.

2. Take a few steps back and stabilize yourself. You are now in the starting position.

3. Step forward or backward with one leg while maintaining your balance and squat down through your hips. Keep your torso straight and head up. Don't allow your knee to track out over your toes.

4. Push yourself back to the starting position by using your heal to drive you.

5. Repeat this movement with your other leg.

Side Lunge

Primary muscles:

- ✓ Gluteus maximus
- ✓ Gluteus medius and gluteus minimus
- ✓ Quadriceps femoris (rectus femoris, vastus medialis, vastus intermedius, and vastus lateralis)
- ✓ Hamstrings (semimembranosus, semitendinosus, and biceps femoris)

Primary joint actions:

- ✓ Knee extension
- ✓ Hip extension
- ✓ Hip abduction

Instructions:

1. Start in good posture with your feet together and your toes pointed forward.

2. Take one big step to the side with your left leg.

3. Push back into your left hip while keeping your right leg straight with your toes pointed forward.

4. You should feel a stretch in your right groin muscle.

5. Push your left foot through the floor and return to the feet together position.

6. Either alternate sides or do all the reps on one side and repeat on the other.

Upper-Body Exercises

Bench Press

Primary muscles:

- ✓ Triceps brachii
- ✓ Pectoralis major
- ✓ Anterior deltoid
- ✓ Serratus anterior

Primary joint actions:

- ✓ Elbow extension
- ✓ Shoulder horizontal adduction
- ✓ Scapular protraction

Instructions:

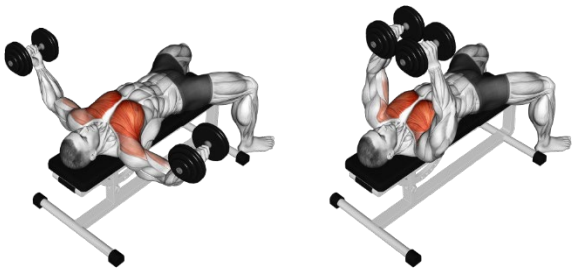
1. Lie flat on a bench and set your hands just outside of shoulder width. Set your shoulder blades by pinching them together and driving them into the bench.

2. Take a deep breath and lift the bar off the rack into the starting position (directly over chest) as you maintain tightness through your upper back. Let the weight settle and ensure your upper back remains tight after liftoff.

3. Inhale and slowly lower the bar in a straight line to the base of the sternum and touch the chest.

4. Push the bar back up in a straight line by pressing yourself into the bench, driving your feet into the floor for leg drive, and extending the elbows.

Dumbbell Fly



Primary muscles:

- ✓ Pectoralis major
- ✓ Anterior deltoid

Primary joint actions:

- ✓ Shoulder horizontal adduction

Instructions:

1. Pick up the dumbbells off the floor using a neutral grip (palms facing in). Position the ends of the dumbbells in your hip crease and sit down on the bench.

2. To get into position, lay back and keep the weights close to your chest. Once you are in position, take a deep breath, then press the dumbbells to lock out at the top.

3. Slightly retract your shoulder blades, unlock your elbows, and slowly lower the dumbbells laterally while maintaining the angle at your elbow.

4. Once the dumbbells reach chest level, reverse the movement by squeezing your pecs together and bringing the dumbbells back to their starting position.

5. Without allowing the dumbbells to touch, start the next repetition, and continue until the set is completed.

Bent-Over Row

Primary muscles:

- ✓ Posterior deltoid
- ✓ Latissimus dorsi and teres major
- ✓ Trapezius (lower and middle)
- ✓ Rhomboids

Primary joint actions:

- ✓ Shoulder horizontal abduction
- ✓ Scapular retraction

Instructions:

1. Assume a standing position while holding the bar using a double overhand grip.

2. Hinge forward (bracing your core) until your torso is roughly parallel with the floor (or slightly above) and then begin the movement by driving the elbows behind the body while retracting the shoulder blades.

3. Pull the bar towards your belly button until it touches your body and then slowly lower the bar back to the starting position under control.

Seated Row

Primary muscles:

- ✓ Posterior deltoid
- ✓ Latissimus dorsi and teres major

Primary joint actions:

- ✓ Shoulder horizontal abduction
- ✓ Scapular retraction

Instructions:

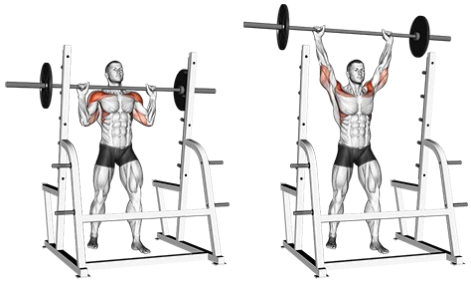
1. Place both feet on the platform as you grab the close-grip handle.

2. Get into a straight seated position and lean forward slightly.

3. Let the weight pull your shoulders forward.

4. Pull back the weight as your elbows lead the way to an upright back position making sure you are contracting the upper back muscles. Chest high and shoulders back, then return to starting position.

Shoulder Press



Primary muscles:

- ✓ Triceps brachii
- ✓ Deltoid
- ✓ Trapezius
- ✓ Levator scapulae
- ✓ Serratus anterior

Primary joint actions:

- ✓ Elbow extension
- ✓ Shoulder flexion
- ✓ Shoulder girdle upward rotation and elevation

Instructions:

1. Place the barbell on a power rack so it is in front of your shoulders. You should be able to take the bar off of the rack without standing on your tiptoes or bending down too low.

2. Stand with your feet shoulder-width apart and your hips and knees fully extended, but don't lock the knees. Hold the barbell in a front-rack position (resting on the front of your shoulders) with your elbows pointing forward and hands shoulder-width apart. This is your starting position.

3. Tighten your core, squeeze your shoulder blades together, and press the barbell overhead as you exhale.

4. Continue to press until your arms are locked out. This movement should feel like you are pressing your head through the “window” made by your arms.

5. Engage your back muscles and, with control, return the barbell to the front-rack position while inhaling.

Dip

Primary muscles:

- ✓ Triceps brachii
- ✓ Pectoralis major
- ✓ Anterior deltoid

Primary joint actions:

- ✓ Elbow extension
- ✓ Shoulder flexion

Instructions:

1. Step up on the dip station (if possible) and position your hands with a neutral grip.

2. Initiate the dip by unlocking the elbows and slowly lowering the body leaning forward with elbows wider to increase chest recruitment.

3. Control the descent to parallel and then drive back to the starting position by pushing through the palms.

Isolation Exercises

Primary Joint Action: Knee Flexion

Primary muscles:

- ✓ Hamstrings (semimembranosus, semitendinosus, and biceps femoris)

Seated Leg Curl

Instructions:

1. Set your desired weight and adjust the seat so that your knees are in line with the pivot point of the machine.

2. Grip the handles to lock your body in place as you exhale and flex your knees, pulling your ankles as close to your buttocks as you can. Keep your hips firmly on the bench.

3. Hold briefly, and inhale as you return your feet to the starting position in a slow and controlled movement.

Prone Leg Curl

Instructions:

1. Set your desired weight and adjust the ankle pad so that your knees are in line with the pivot point of the machine (i.e., your knees should hang off the edge of the bench slightly).

2. Lie face down and grip the handles to lock your body in place as you exhale and flex your knees, pulling your ankles as close to your buttocks as you can. Keep your hips firmly on the bench.

3. Hold briefly at the top, and inhale as you return your feet to the starting position in a slow and controlled movement.

Primary Joint Action: Knee Extension
Primary muscles:

- ✓ Quadriceps femoris (rectus femoris, vastus medialis, vastus intermedius, and vastus lateralis)

Leg Extension

Instructions:

1. Set your desired weight and adjust the seat so that your knees are in line with the pivot point of the machine.

2. Grip the handles to lock your body in place.

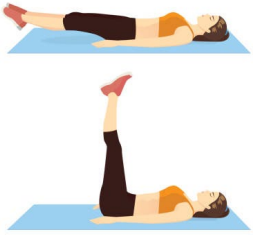
3. Extend your legs to lift the weight while exhaling until your legs are almost straight. Do not lock your knees. Keep your back against the backrest and do not arch your back.

4. Inhale and lower the weight back to the starting position.

Primary Joint Action: Hip Flexion

Primary muscles:

- ✓ Hip flexors (rectus femoris and iliopsoas)



Supine Leg Raise

Instructions:

1. Lie supine in a relaxed position with your legs straight and your hands underneath your low back for support or to the side.

2. Keeping legs straight, raise both legs toward the ceiling until hips are fully flexed, then lower back down.

3. Exhale as you lift your legs and inhale as you bring them back down.

Knee Raise

Instructions:

1. Keep your torso straight, press the lower back against the backrest, and rest your forearms on the arm pads. Make sure the arms are bent at an angle of 90 degrees.

2. Lift your knees up by flexing at your hips, while keeping the legs bent. For maximum contraction, bring your thighs past parallel and hold the position for a second.

Primary Joint Action: Hip Extension
Primary muscles:

- ✓ Hip extensors (gluteus maximus, hamstrings)

Hip Thrust

Instructions:

1. Load your desired plates on the machine's bars.

2. Secure the strap or padded bar over your hips. Position your feet shoulder-width on the foot platform. Press your back and shoulders into the back support.

3. Lift your hips up to raise the weight out of the safety rack and then disengage the safety to work your full range of motion.

4. Drop your hips until they form a 90-degree angle with your body and then push the weight up with your hips to finish the repetition.

Primary Joint Action: Hip Abduction
Primary muscles:

- ✓ Gluteus medius
- ✓ Gluteus minimus
- ✓ Tensor fascia latae

Hip Abduction

Instructions:

1. Adjust the machine to the appropriate settings by moving the pads to the center and selecting the weight.
2. Place your legs on the inside of the pads.
3. Grip the handles and push the pads out by moving your legs apart as far as possible.
4. Return with control to the starting position and repeat.

Primary Joint Action: Hip Adduction

Primary muscles:

- ✓ Adductor longus
- ✓ Adductor brevis
- ✓ Adductor magnus
- ✓ Pectineus

Hip Adduction

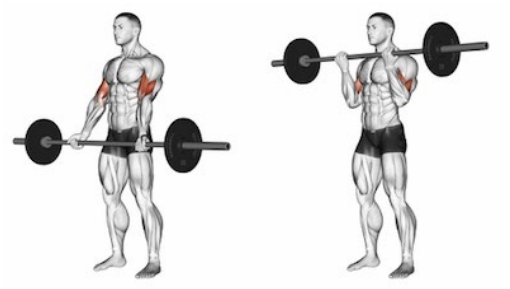
Instructions:

1. Adjust the machine to the appropriate settings by moving the pads apart and selecting the weight.
2. Place your legs on the outside of the pads making sure that you are comfortable with the stretch.
3. Grip the handles and push the pads in by moving your legs together.

4. Return with control to the starting position and repeat.

Primary Joint Action: Elbow Flexion
Primary muscles:

- ✓ Brachialis
- ✓ Biceps brachii
- ✓ Brachioradialis



Barbell Curl

Instructions:

1. Grab the bar at about shoulder-width apart or slightly wider with an underhand grip.
2. With a slight forward bend and core engaged, engage the biceps to pull the bar up to your neck.
3. Slowly lower the bar to the starting position.

Single-Arm Preacher Hammer Curl

Instructions:

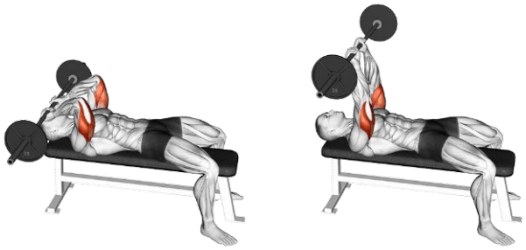
1. Start by setting up a preacher bench and then position yourself behind the bench, with a dumbbell in one hand rested over the bench and feet flat on the floor.

2. Hold the dumbbell in a neutral grip with your palms facing inward, then slowly lift the dumbbell up towards your shoulder, isolating the bicep and hold for a count.

3. Return to the starting position.

Primary Joint Action: Elbow Extension
Primary muscles:

- ✓ Triceps brachii



Skull Crusher

Instructions:

1. Add your desired weight to the EZ bar, grab the bar aligning your wrists and shoulders, and sit on the edge of a flat bench.

2. To get into position, lie on your back and keep the bar close to your chest. Once you are supine, press the weight to lockout.

3. Lower the weight towards your head by unlocking the elbows and allowing the EZ bar to drop toward your forehead or just above.

4. Once your forearms reach parallel or just below, reverse the movement by extending the elbows while flexing the triceps to lock out the weight.

Primary Joint Action: Shoulder Abduction
Primary muscles:

- ✓ Deltoid

Seated Dumbbell Lateral Raise

Instructions:

1. Grab a pair of dumbbells and sit up straight with your feet around shoulder width apart on the edge of a flat bench.

2. Hold the dumbbells down at your sides with your palms facing in. Hold the dumbbells out slightly from your body. This is the starting position for the exercise.

3. Keeping your body still, eyes facing forward, with a slight bend in your arms, slowly raise the dumbbells up to around shoulder height.

4. Pause, and then slowly lower the dumbbells back to the starting position.

Primary Joint Action: Shoulder Adduction

Primary muscles:

- ✓ Latissimus dorsi
- ✓ Infraspinatus and teres minor
- ✓ Teres major

Lateral Front Pulldown

Instructions:

1. Grab the bar, placing your hands wider than your shoulders.

2. Position yourself so that the thighs are snug under the seat pad.

3. Slightly arch the lower back as you pull the bar (leading with your elbows) down to your chin. Keep your chest up and shoulders back, away from the ears.

4. Contract lats and then slowly bring the bar up to the starting position.

Pull-Up

Instructions:

1. The pullup bar should be at a height that requires you to jump up to grab it; your feet should hang free.

2. Jump up and grip the bar with an overhand grip about shoulder-width apart.

3. Fully extend your arms so you are in a dead hang. Bend your knees and cross your ankles for a balanced position. Take a breath at the bottom.

4. Exhale while pulling yourself up so your chin is level with the bar. Pause at the top.

5. Lower yourself (inhaling as you go down) until your elbows are straight.

6. Repeat the movement without touching the floor.

Primary Joint Action: Shoulder Flexion

Primary muscles:

- ✓ Anterior deltoid
- ✓ Pectoralis major

Seated Dumbbell Front Raise

Instructions:

1. Choose a dumbbell and sit on the end of a flat bench or a bench with a backrest with a straight back and feet close together.

2. Hold the dumbbell in your left hand at your side with your arm extended using a neutral grip (palm facing the bench). This is the starting position.

3. Begin by raising your left arm and twisting the dumbbell so that you are now using an overhand grip, and your palm is facing the floor. Keep a slight bend in your elbow.

4. Moving only at the shoulder and keeping your body as still as possible, continue raising the dumbbell out in front of you until your arm is just above parallel to the floor.

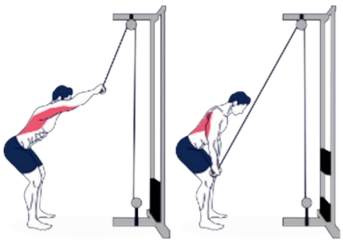
5. Pause for a moment at the top of the movement, and slowly lower the dumbbell back to the starting position twisting it back to a neutral grip as it nears the height of the bench.

6. Repeat for desired reps and then repeat the movement with your right arm.

Primary Joint Action: Shoulder Extension

Primary muscles:

- ✓ Latissimus dorsi and teres major
- ✓ Posterior deltoid



Straight Arm Lat Pulldown

Instructions:

1. Attach a wide grip handle to a cable stack and assume a standing position.

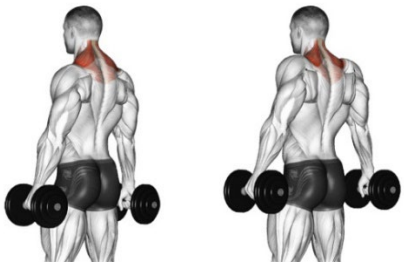
2. Grasp the handle with a pronated grip (double overhand) at roughly shoulder width and lean forward slightly by hinging at the hips.

3. Keep the elbow slightly flexed and initiate the movement by depressing the shoulder blades and extending the shoulders.

4. Pull the bar to your thigh until the lats are fully contracted and then slowly lower under control.

Primary Joint Action: Shoulder Girdle Elevation
Primary muscles:

- ✓ Upper fibers of the trapezius
- ✓ Levator scapulae



Dumbbell Shrug

Instructions:

1. Grab a pair of dumbbells and hold them at your sides with a slight bend in the elbows. Feet should be shoulder-width apart.

2. Grip the floor with your feet to create a stable foot position with slightly bent knees.

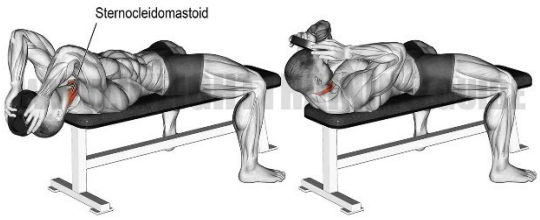
3. Pre-tense your shoulders, hips, and engage your core.

4. While maintaining a neutral head and neck position, keep your arms long and slowly raise your shoulders straight up toward your ears.

5. Pause at the top of the movement and slowly lower your shoulders back to the starting position.

Primary Joint Action: Neck Flexion
Primary muscles:

- ✓ Sternocleidomastoid



Supine Weighted Neck Flexion

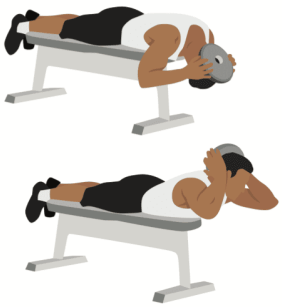
Instructions:

1. Position yourself such that your head and neck will be off the bench when you are in the supine position.
2. Place a towel between the weight and your forehead.
3. Slowly lower your head below the bench until you feel a gentle stretch; this is your starting position.
4. From the starting position, lift your head up and tuck your chin in toward your chest as you raise the weight, using your hands to stabilize the plate.
5. Slowly lower the head back to the starting position.

Primary Joint Action: Neck Extension

Primary muscles:

- ✓ Splenius capitis
- ✓ Semispinalis capitis



Prone Weighted Neck Extension

Instructions:

1. Position yourself such that your head and neck will be off the bench when you are in the prone position.
2. Place a towel between the weight and your head.

3. Once in position, slowly lower your head below the bench until you feel a gentle stretch; this is your starting position.

4. From the starting position, lift your head up and back toward your feet as you raise the weight, using your hands to stabilize the weight plate.

5. Slowly lower the head back to the starting position and repeat.

Chapter 3 - Resistance Training

3.1 Learn strength training the proper way.

Introduction

A lot of people do not realize that dieting alone has never proven to be an effective intervention for permanent weight loss and sustained weight management; and the exercise program should not be limited to only aerobic activity (e.g., walking, running, and cycling) [61]. In fact, a sensible combination of diet, aerobic activity, and strength training can produce simultaneous fat loss and muscle gain [61]. While muscular strength is suggested to be a critical attribute for many athletic disciplines, it is also an essential component of functionality in daily living. In this section, we will focus on strength training, specifically its benefits, influential factors, and methods.

Strength Training Benefits

Muscle is very active tissue that makes up about half of the body's lean weight (i.e., muscle, bone, blood, skin, organs, and connective tissue). The number one thing that you should understand is that muscle plays a major role in metabolism and weight management. Muscle tissue is constantly active. Even during sleep, resting skeletal muscles handle more than 25% of the body's caloric expenditure [6]. Furthermore, strength training raises your resting metabolic rate (RMR) and results in more calories burned daily. Strength trained muscle burns about 50% more calories/day compared to non-strength trained muscle. Additionally, it is critical that you make strength training a regular component of an active lifestyle. Physical capacity decreases dramatically with age in non-strength training adults due to an average 5-lb. (2.3 kg) per decade loss of muscle tissue, known as disuse atrophy [6]. This phenomenon can be avoided with regular strength training. Numerous strength-training studies have shown that several weeks of traditional strength training result in about 3 lbs. (1.4 kg) more muscle and 4 lbs. (1.8 kg) less fat in adults and older adults, and this rate of body-composition improvement appears to continue for several months [6]. There are several benefits associated with strength training [61].

Strength training is effective for:

- ✓ Increasing muscle mass
- ✓ Raising resting metabolic rate (RMR)
- ✓ Reducing body fat
- ✓ Increasing bone density
- ✓ Enhancing insulin sensitivity and glycemic control
- ✓ Reducing resting blood pressure
- ✓ Improving blood lipid profiles
- ✓ Enhancing vascular condition
- ✓ Improving cognitive function
- ✓ Increasing self-esteem
- ✓ Reducing depression
- ✓ Decreasing musculoskeletal discomfort
- ✓ Reversing specific aging factors
- ✓ Facilitating physical function

Training Variables

There are several training variables that affect the rate and degree of strength development and should be considered before starting a strength training regimen. These variables are frequency, speed, volume, intensity, rest intervals, and exercise selection/order.

Frequency. Training frequency is inversely related to both training volume and training intensity. In other words, high-volume/high-intensity strength workouts produce more muscle microtrauma, require more time for tissue remodeling, and therefore must be performed less often for optimal results [6]. The microtrauma-repair and muscle-remodeling processes require at least 72 hours following a challenging strength training session [6]. Studies with advanced lifters indicate that optimal muscle remodeling occurs between 72 and 96 hours after a challenging strength training session [61]. The following table provides general training frequency guidelines for beginner, intermediate, and advanced lifters.

Table 3-1. General Training Frequency Guidelines.

Experience Level	Sessions Per Week
Beginner (not currently training or just beginning with minimal skill)	2-3
Intermediate (basic skill)	3-4
Advanced (advanced skill)	4-7

Data from: Baechle, T.R. & Earle, R.W. (2008). *Essentials of Strength Training and Conditioning* (3rd ed.). Champaign, III.: Human Kinetics.

Speed. Resistance exercise should be performed with both controlled lifting (concentric) and controlled lowering (eccentric) movements to maximize muscle activation throughout each repetition. Research indicates that moderate-to-slow repetition speeds provide more muscle tension, more continuous muscle force, less momentum, and less tissue trauma than fast movement (jerking) speeds [61]. Each exercise should be performed slowly and controlled so that the concentric and eccentric phases each take about 2-3 seconds to complete with more emphasis placed on the eccentric phase [61].

Volume. Training volume is usually lower in strength training regimens (i.e., 2-6 sets and ≤6 repetitions per set), because the focus is on improving the muscle's ability to maximally recruit fibers to generate higher amounts of force to lift heavy weight loads [6]. Muscular strength can be significantly increased through either single-set or multiple-set training. Due to the lack of consensus regarding the optimum number of training sets, novice lifters should perform one good set of each exercise and more experienced lifters, who desire greater volume, can perform two or more sets [61].

Intensity. Muscular strength is measured by the heaviest weight load that can be lifted one time through a full range of motion (ROM), with correct technique, and with controlled speed. This is referred to as the one-repetition maximum (1-RM). Strength training programs are typically designed around this number. The 1-RM is the intensity (i.e., the weight lifted). For optimal strength development, most authorities recommend weight loads between 80 and 90% of the 1-RM [6]. Exercises with near-maximal weight loads that allow 1-3 repetitions with more than 90% of maximal resistance are highly effective for developing muscular strength [6]. Because these are relatively heavy weight loads, a periodized approach that progressively increases the training intensity over several weeks is recommended. Muscle strength can also be developed effectively by working the target muscle to fatigue within the body's anaerobic energy system. This is about 50-70 seconds of continuous muscle work with 75% of the 1-RM [6]. This number can be estimated without doing an all-out lift; the weight that can be lifted 10 times to fatigue is approximately 75% of maximum resistance.

Rest Intervals. The heavier the load, the longer the rest interval needed for recovery, because a high effort set reduces the muscle's internal energy stores of creatine phosphate [6]. These energy stores replenish quickly, with 50% renewal within the first 30 seconds, 75% renewal within the first minute, and 95% renewal within the first 2 minutes [6]. Longer rest intervals allow the use of relatively heavy weight loads throughout the training session. Therefore, lifters interested in maximizing muscular strength usually take 2-5 minutes of rest between sets of the same exercise [6].

Exercise Selection/Order. Generally, linear exercises that involve multiple muscle groups are the preferred method for increasing total-body strength. These exercises include squats, deadlifts, or leg presses for the squat pattern; step-ups and lunges for the lunge pattern; bench presses, incline presses, shoulder presses, and bar dips for the push pattern; and seated rows, lat pull-downs, and pull-ups for the pulling pattern [6]. Rotary exercises that isolate specific muscle groups (e.g., leg extensions, leg curls, hip adductions, hip abductions, lateral raises, chest crossovers, pull-overs, arm extensions, arm curls, trunk extensions, and trunk curls) should not be excluded from muscular-strength workouts, but these typically play a lesser role than the movement-based exercises that challenge multiple muscles at the same time [6].

The Basics of Strength Programming for the Beginner

Exercises. To develop a solid strength foundation, the focus of the beginner program is on the squat, press, bench press, and deadlift [50]. These four basic exercises have been used for many decades by strong men and women to improve basic strength, and no substitutes exist for them [50]. After a few weeks or once the basic strength and motor skills have developed enough, the power clean can be added to the program because it is considered a core exercise for most sports [50]. Once the basic exercises have been mastered, chin-ups can be added into training. Chin-ups (pull-ups with an underhand grip) are a beneficial upper-body assistance movement to also include in a beginner's program. Chin-ups work the entire arm and upper back muscles, and chin-up strength is closely related to pressing strength. Improving a weak chin-up will improve the pressing movements [50]. Back extensions or glute-ham raises can also be added in place of pulling for a break from pulling every workout [50]. Squats, presses, deadlifts, and chin-ups all provide enough work for the abdominals, so it is unnecessary to include dedicated abdominal exercises in the program because it can be a waste of time [50].

Strength in each exercise will progress differently, due to differences in the amount of muscle mass involved and in the sensitivity of the movement to technique problems [49]. The more muscle mass involved in an exercise, the faster the exercise can get strong and the stronger it has the potential to be [49]. The deadlift improves rather quickly for most people, and the press goes up rather slowly [49]. In a trained athlete, the deadlift will be stronger than the squat, the squat stronger than the bench press, the bench press and the power clean close to each other (with the bench usually a little stronger), and the press lighter than the other four [49].

Reps and sets. For the beginner, sets of 5 repetitions work best. Fives are close enough to the strength end of the continuum to provide tremendous increases in strength and are also enough repetitions to develop a tolerance for elevated work levels and provide for a good amount of hypertrophy [50]. Fives effectively stimulate strength gains and other forms of progress without producing sufficient muscular or neuromuscular exhaustion to cause technique deterioration at the end of the set [50]. The number of sets depends on the experience level, level of soreness from the previous workout, needing more technical practice, or the exercise being performed. For example, deadlifts are hard enough at 5RM that one work set is plenty for most people [50]. As a general

rule, work sets for squats, bench presses, and presses should be three sets of the same weight across for beginners [50].

Warming up. The total number of sets per exercise is the sum of the warm-ups and the work sets. Warm-up sets are done as necessary, more if the trainee is sore, inflexible, or in need of movement practice, fewer if the trainee is already warm from previous exercises. As a general rule, warm-up set volume is controlled by tapering toward doubles and singles before the work sets [50]. It is best to start with an empty bar (e.g., standard 45-lb. bar) and to divide the difference between 45 lbs. and the work-set weight into even increments [49]. Some examples are provided in Table 3-2 below. As the warm-ups progress from the empty bar up through heavier weights, the rest time between sets should increase a little. The time between sets should be sufficient to recover from the previous set, so that fatigue from the prior set does not limit the next set. The heavier the set, the longer the break should be [49].

Table 3-2. Example Distributions of Warm-Up Sets and Work Sets [49].

Squat	Weight	Reps	Sets	Bench Press	Weight	Reps	Sets
	45	5	2		45	5	2
	95	5	1		85	5	1
	135	3	1		125	3	1
	185	2	1		155	2	1
Work sets	225	5	3	*Work sets*	175	5	3
Deadlift	**Weight**	**Reps**	**Sets**	**Press**	**Weight**	**Reps**	**Sets**
	135	5	2		45	5	2
	185	5	1		75	5	1
	225	3	1		95	3	1
	275	2	1		115	2	1
Work sets	315	5	1	*Work sets*	135	5	3
Power Clean	**Weight**	**Reps**	**Sets**				
	45	5	2				
	75	5	1				
	95	3	1				
	115	2	1				
Work sets	135	5	5				

Note: Weights are in pounds.

Scheduling. Since adaptation to a new training load occurs within 48 to 72 hours for a beginner, a three day-per-week training schedule is warranted [50]. Three days per week yields a training session every 48 hours with one 72-hour interval at the end of the week. A Monday/Wednesday/Friday schedule is the most obvious for most people. Monday and Wednesday tend to be the busiest days in all gyms everywhere; so, depending on the facility, it may be better to use a Tuesday/Thursday/Saturday or Sunday/Tuesday/Thursday schedule. Additionally, depending on individual scheduling flexibility, recovery ability, and personal preference, a trainee might decide to use an every-other-day schedule, where each week is different but each break between workouts is the same 48 hours [50].

Workloads. Beginners must learn first, and then load. The first task is to learn the movement pattern without having to worry about how heavy it is. When learning a new exercise, the beginner trainee should start with an empty bar (the bar may need to be a lighter one than the standard 20-kg/45-lb type for some). Most of the time, the trainee will learn the movement well enough that the load can be increased during the first workout [50]. After the first workout has established the trainee's starting point, subsequent workouts should

progressively increase the work-set weights of all the exercises; and this should happen at every workout until it cannot be done anymore [49, 50]. Weight is the only variable that is adjusted. The goal is to use sets of five to induce the physiological effects produced by five repetitions. So, it is necessary to be able to make incremental increases while holding the reps constant, and this requires that the increments be small enough that an adaptation can occur during the time allotted [50].

The Starting Strength Model

For the beginner, the strength training program starts with three or four basic whole-body exercises. The program consists of two workouts that alternate across the Monday/Wednesday/Friday schedule (see Table 3-3). The exercises should be done in listed order. Squats are performed first, the upper body pressing movement is performed second, and the pulling movement is performed third. This sequence allows the squat to get everything warmed up for the next exercise; then the upper-body exercise allows the legs and back to rest and recover for the pulling movement to be done third. The beginner trains the deadlift at every workout for the first two weeks or until the deadlift becomes comfortable and is established well ahead of the squat (the deadlift should be stronger than the squat). Once the deadlift is learned, then the power clean is introduced. After two or three more weeks, back extensions and chin-ups are added as assistance exercises. The squat, press, and bench press are performed for 3 sets of 5 repetitions; the deadlift is performed for 1 set of 5 reps; the power clean is performed for 5 sets of 3 reps; and the back extensions and chin-ups are performed for 3 sets of 10-15 reps. The back extensions should be done unweighted in the beginning; the trainee can add weight to the back extensions if desired later on once strength has improved. Unweighted chin-ups are performed to failure for all 3 sets; if the trainee can complete more than 15 reps per set, then weight can be added. When the prescribed sets and reps are completed for the main strength exercises at the assigned weight, the load is increased for the next workout; and this continues until the trainee seizes to make progress. For most people this schedule works well, and progress can be made for months before the program is adjusted.

Table 3-3. Beginner Strength Training Program [50].

Week	Monday	Wednesday	Friday
1	Squat Press Deadlift	Squat Bench Press Deadlift	Squat Press Deadlift
2	Squat Bench Press Deadlift	Squat Press Deadlift	Squat Bench Press Deadlift
3	Squat Press Deadlift	Squat Bench Press Power Clean	Squat Press Deadlift
4	Squat Bench Press Power Clean	Squat Press Deadlift	Squat Bench Press Power Clean
5	Squat Press Deadlift	Squat Bench Press Back Extensions Chin-ups	Squat Press Power Clean
6	Squat Bench Press Back Extensions Chin-ups	Squat Press Deadlift	Squat Bench Press Back Extensions Chin-ups

Strength Programming for the Advanced Beginner

Back-Off Periods

The back-off method is an important tool that will be used throughout the lifter's career. The basic concept is rest but avoid detraining. The length of the back-off period is proportionate to the length of training and level of fatigue. The longer the training history, then the longer the back-off period will have to be. At some point, progress will stall due to three basic scenarios: 1) an unavoidable absence from training, 2) one in which the trainee does everything right but still fails to stimulate further progress, and 3) progress stalls or regresses because of greed for faster-than-possible increases, or because of a lifestyle factor that affects recovery [50].

Missed Workouts

Training plans do not always go according to plan. Life happens, people get sick, and unexpected travel often forces missed training. Missed training sessions are often negatively compounded by the weight loss and poor nutrition that results from illness, missed meals due to travel, and the physical and emotional stress that accompanies events that forces schedules to change [50]. A short absence of one or two training sessions does not require any remedial action. However, if more than one week has gone by, there will be a detraining effect, and a reset must be implemented into the training program [50]. One solution is to redo the previous two weeks' worth of training, set by set, rep by rep. This approach will work, but it can be more time-consuming than it needs to be. A more efficient solution is to start back at about 10% less than the last workout prior to the layoff. It can be as high as 20% if the layoff was due to severe illness, or in the case of a very emotionally stressful event such as the death of a family member.

Table 3-4 shows how to approach a reset after returning from vacation. In this example, the lifter initially was using 5-lb. incremental jumps. Progress is generally faster the second time, so it is very likely to go up by 10 lbs. each workout in the first week back from vacation. It is generally a good idea to repeat the weight that was used in the final workout before the break. So, in the second week back from vacation, the lifter starts up where he left off. Afterwards, normal 5-lb. incremental jumps can resume.

Table 3-4. Missed Training Due to Being Away on Vacation [50].

Last full week before vacation		
Squat, 305 x 5 x 3	Squat, 310 x 5 x 3	Squat, 315 x 5 x 3
First week back from vacation		
Squat, 285 x 5 x 3	Squat, 295 x 5 x 3	Squat, 305 x 5 x 3
Second week back from vacation		
Squat, 315 x 5 x 3	Squat, 320 x 5 x 3	Squat, 325 x 5 x 3

Note: Format for specifying training loads, weight x reps x sets (e.g., 305 x 5 x 3 means 305 lbs. x 5 reps x 3 sets). Weights are in pounds.

In this next example (Table 3-5), the lifter missed training due to being severely ill with the flu and was out for about 10 days. It can be assumed that he was not eating or sleeping well during this period and that the detraining effect is greater than in the previous example. He re-entered the program at a 23% reduction from where he left off, followed by 16%, and then 10%. He was able to make a 10-lb. jump from there but had to revert back to 5-lb. increments before reaching his previous weight.

Table 3-5. Missed Training Due to Illness [50].		
Last full week before illness		
Squat, 305 x 5 x 3	Squat, 310 x 5 x 3	Squat, 315 x 5 x 3
First week back after 10 days off		
No workout	Squat, 245 x 5 x 3 (23% reduction)	Squat, 265 x 5 x 3 (16% reduction)
Second week back after 10 days off		
Squat, 285 x 5 x 3 (10% reduction)	Squat, 295 x 5 x 3	Squat, 300 x 5 x 3
Third week back after 10 days off		
Squat, 305 x 5 x 3	Squat, 310 x 5 x 3	Squat, 315 x 5 x 3

Note: Format for specifying training loads, weight x reps x sets (e.g., 305 x 5 x 3 means 305 lbs. x 5 reps x 3 sets). Weights are in pounds.

Legitimately Stuck

This second scenario assumes that the trainee is properly applying the progression principles, correct exercise technique, and adequate attention to recovery, sleep, and nutrition. This may be a bit of a stretch given the level of experience of beginners because few beginners execute all parts of the plan flawlessly. The trainee should be able to add weight to the bar at every workout for quite some time if he correctly executes all parts of the plan. However, at some point, the weight will cause missed reps in one workout (usually in the last set), followed by more missed reps across sets for multiple workouts in a row. At that point, the trainee would need to implement a back-off period.

The following example illustrates a hypothetical example of a trainee who stalls out on all five lifts at the same time. This scenario is very unlikely, and this example is only presented for illustrative purposes. The example in Table 3-6 shows how a trainee can stall out, reset, and set new personal records (PRs) in 5 weeks.

Table 3-6. Method for Resetting After Legitimately Stalling [50].			
Week	**Monday**	**Wednesday**	**Friday**
1	Squat, 255 x 5 x 3 Bench, 170 x 5 x 3 Deadlift, 300 x 5 x 1	Squat, 260 x 5 x 3 Press, 110 x 5 x 3 Power Clean, 150 x 3 x 5	Squat, 265 x 4,3,3 Bench, 172 x 4,4,3 Deadlift, 305 x 3 x 1
2	Squat, 265 x 4,3,3 Press, 112 x 4,3,3 Power Clean, 152 x 3,3,2,2,2	Squat, 245 x 5 x 3 Bench, 160 x 5 x 3 Deadlift, 275 x 5 x 1	Squat, 250 x 5 x 3 Press, 100 x 5 x 3 Power Clean, 152 x 3,3,3,2,2
3	Squat, 255 x 5 x 3 Bench, 165 x 5 x 3 Deadlift, 285 x 5 x 1	Squat, 260 x 5 x 3 Press, 105 x 5 x 3 Power Clean, 140 x 3 x 5	Squat, 265 x 5 x 3 Bench, 170 x 5 x 3 Deadlift, 295 x 5 x 1
4	Squat, 270 x 5 x 3 Press, 110 x 5 x 3 Power Clean, 145 x 3 x 5	Squat, 275 x 5 x 3 Bench, 172 x 5 x 3 Deadlift, 300 x 5 x 1	Squat, 280 x 5 x 3 Press, 112 x 5 x 3 Power Clean, 150 x 3 x 5
5	Squat, 285 x 5 x 3 Bench, 175 x 5 x 3 Deadlift, 305 x 5 x 1	Squat, 290 x 5 x 3 Press, 115 x 5 x 3 Power Clean, 152 x 3 x 5	Squat, 295 x 5 x 3 Bench, 177 x 5 x 3 Deadlift, 310 x 5 x 1

Note: Format for specifying training loads, weight x reps x sets (e.g., 255 x 5 x 3 means 255 lbs. x 5 reps x 3 sets). Weights are in pounds.

Impatience and Greed

In this scenario, progress stalls because of impatience with a slow, steady pace of incremental increase. Here, the trainee has regressed. The build-up of fatigue is more pronounced. The following example (Table 3-7) illustrates how a trainee gets himself into trouble by being too aggressive, and subsequently digging himself into a recovery deficit. In this example, the trainee makes an enormous programming mistake when he attempts to push ahead and add weight even when he was failing to make all 3 sets of 5 reps. This scenario generally takes longer to get into and longer to get out of.

Table 3-7. Method for Resetting After Getting Greedy [50].

Week	Monday	Wednesday	Friday
1	Squat, 255 x 5 x 3 Bench, 170 x 5 x 3 Deadlift, 300 x 5 x 1	Squat, 260 x 5 x 3 Press, 110 x 5 x 3 Power Clean, 150 x 3 x 5	Squat, 265 x 4,3,3 Bench, 172 x 5,3,3 Deadlift, 305 x 3 x 1
2	Squat, 265 x 5,3,2 Press, 112 x 4,3,3 Power Clean, 152 x 3,3,2,2,2	Squat, 270 x 3,2,2 Bench, 175 x 3,2,2 Deadlift, 310 x 1 x 1	Squat, 270 x 2 x 1 Press, 115 x 3,2,1 Power Clean, 155 x 2,2,1,1,1
3	Squat, 240 x 5 x 1 Bench, 145 x 5 x 1 Deadlift, 280 x 5 x 1	Squat, 250 x 5 x 1 Press, 95 x 5 x 1 Power Clean, 140 x 3 x 1	Squat, 250 x 5 x 3 Bench, 150 x 5 x 1 Deadlift, 290 x 5 x 1
4	Squat, 255 x 5 x 3 Press, 100 x 5 x 1 Power Clean, 140 x 3 x 5	Squat, 260 x 5 x 3 Bench, 155 x 5 x 3 Deadlift, 300 x 5 x 1	Squat, 265 x 5 x 3 Press, 100 x 5 x 3 Power Clean, 145 x 3 x 5
5	Squat, 270 x 5 x 3 Bench, 160 x 5 x 3 Deadlift, 305 x 5 x 1	Squat, 275 x 5 x 3 Press, 105 x 5 x 3 Power Clean, 150 x 3 x 5	Squat, 280 x 5 x 3 Bench, 165 x 5 x 3 Deadlift, 310 x 5 x 1
6	Squat, 285 x 5 x 3 Press, 110 x 5 x 3 Power Clean, 152 x 3 x 5	Squat, 290 x 5 x 3 Bench, 170 x 5 x 3 Deadlift, 315 x 5 x 1	Squat, 295 x 5 x 3 Press, 112 x 5 x 3 Power Clean, 155 x 3 x 5
7	Squat, 300 x 5 x 3 Bench, 172 x 5 x 3 Deadlift, 320 x 5 x 1	Squat, 305 x 5 x 3 Press, 115 x 5 x 3 Power Clean, 157 x 3 x 5	Squat, 310 x 5 x 3 Bench, 175 x 5 x 3 Deadlift, 325 x 5 x 1

Note: Format for specifying training loads, weight x reps x sets (e.g., 255 x 5 x 3 means 255 lbs. x 5 reps x 3 sets). Weights are in pounds.

Advanced Beginner Programming

When progress stalls and a back-off period becomes necessary, the advanced beginner can make some additional adjustments to their program by manipulating the intensity, volume, and frequency. The following methods illustrate these adjustments.

This is a rough outline of the first three to nine months of training for most beginners. Starting with three work sets, the weight increases steadily until progress stalls. The weight drops 10% to get unstuck, the exercises are changed slightly, and progress is made again until another plateau occurs. Finally, the point is reached where the amount of work needed to disrupt homeostasis exceeds that which the trainee can recover from between workouts, and more elaborate programming is needed. The key to the beginner level of training advancement is the workout-to-workout increases that are possible during these first months. The trainee has made rapid progress and is now much stronger in a much shorter period of time than he would have been had simple linear

progression not been used. At this point, the beginner becomes an advanced beginner and can make the following adjustments.

Advanced Starting Strength Model 1

In this example (Table 3-8), the squat can go from 3 days of increasing load per week to 2 days, with the introduction of lighter squats at 60-80% of Monday's work set weight. This approach provides a break in the intensity, which helps to prolong linear increases. Deadlifts are still done for one set of five. Deadlifts are very easy to overuse; they are important for basic strength, but too many sets make recovery difficult because of the weights that can be used and the amount of stress they can produce cumulatively. Chin-ups should have improved, or at least kept pace with added bodyweight. If chin-up reps are consistently above 10 on all of the three sets, they should be done every other workout with weight added, either hung from a belt or with a dumbbell held in the feet, so that failure happens at 5 to 7 reps. This will increase the reps on bodyweight-only days and increase arm and shoulder strength for the presses.

Table 3-8. 3x5 Method with Lighter Squat Days [50].

Week	Monday	Wednesday	Friday
1	Squat, 390 x 5 x 3 Bench Press, 295 x 5 x 3 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	Light Squat, 275 x 5 x 3 Press, 180 x 5 x 3 Deadlift, 430 x 5 x 1	Squat, 395 x 5 x 3 Bench Press, 300 x 5 x 3 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3
2	Squat, 400 x 5 x 3 Press, 185 x 5 x 3 Power Clean, 210 x 3 x 5	Light Squat, 280 x 5 x 3 Bench Press, 305 x 5 x 3 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	Squat, 405 x 5 x 3 Press, 190 x 5 x 3 Deadlift, 435 x 5 x 1
3	Squat, 410 x 5 x 3 Bench Press, 310 x 5 x 3 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	Light Squat, 285 x 5 x 3 Press, 195 x 5 x 3 Deadlift, 440 x 5 x 1	Squat, 415 x 5 x 3 Bench Press, 315 x 5 x 3 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3
4	Squat, 420 x 5 x 3 Press, 200 x 5 x 3 Power Clean, 215 x 3 x 5	Light Squat, 290 x 5 x 3 Bench Press, 320 x 5 x 3 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	Squat, 425 x 5 x 3 Press, 205 x 5 x 3 Deadlift, 445 x 5 x 1
5	Squat, 430 x 5 x 3 Bench Press, 325 x 5 x 3 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	Light Squat, 295 x 5 x 3 Press, 210 x 5 x 3 Deadlift, 450 x 5 x 1	Squat, 435 x 5 x 3 Bench Press, 330 x 5 x 3 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3
6	Squat, 440 x 5 x 3 Press, 215 x 5 x 3 Power Clean, 220 x 3 x 5	Light Squat, 300 x 5 x 3 Bench Press, 335 x 5 x 3 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	Squat, 445 x 5 x 3 Press, 220 x 5 x 3 Deadlift, 455 x 5 x 1

Note: Format for specifying training loads, weight x reps x sets (e.g., 390 x 3 x 3 means 390 lbs. x 3 reps x 3 sets).
Weights are in pounds.
BW = Body Weight.

Advanced Starting Strength Model 2

At the very end of the beginner progression, the trainee will exhaust his ability to do 3 sets of 5 reps across on the squat, bench press, and press. The next option is to continue to try and hit a new 5RM at every session, but

for only one set, keeping the light squat day in the middle. It is a good idea to try and add in two back-off sets of 5 after the 5RM, at about a 5-10% reduction. The advanced beginner can also benefit from a reduction in training frequency. For the trainee who has been training Mon-Wed-Fri, he can prolong his beginner progression for quite some time by reducing frequency to a "one on, two off" schedule (see Table 3-9). In this set up, the trainee would train on Monday, then again on Thursday, and then again on Sunday. If he had a light squat day in his schedule, he would continue to squat light every other squat workout. This will mean that a heavy squat workout is only done once every 6 days, with a light squat day in between. It has been observed that the back-off method works better with squats.

Table 3-9. 5RM Method with Back-Off Sets and Frequency Reduction [50].

Week	Monday	Thursday	Sunday
1	Squat, 390 x 5 x 1, 370 x 5 x 2 Press, 180 x 5 x 1, 170 x 5 x 2 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	Light Squat, 275 x 5 x 2 Bench Press, 295 x 5 x 1, 280 x 5 x 2 Power Clean, 210 x 2 x 4	Squat, 395 x 5 x 1, 375 x 5 x 2 Press, 185 x 5 x 1, 175 x 5 x 2 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3
	Wednesday	**Saturday**	
2	Light Squat, 280 x 5 x 2 Bench Press, 300 x 5 x 1, 285 x 5 x 2 Deadlift, 430 x 3-5 x 1	Squat, 400 x 5 x 1, 380 x 5 x 2 Press, 190 x 5 x 1, 180 x 5 x 2 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	
	Tuesday	**Friday**	
3	Light Squat, 285 x 5 x 2 Bench Press, 305 x 5 x 1, 290 x 5 x 2 Power Clean, 215 x 2 x 4	Squat, 405 x 5 x 1, 385 x 5 x 2 Press, 195 x 5 x 1, 185 x 5 x 2 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	
	Monday	**Thursday**	**Sunday**
4	Light Squat, 290 x 5 x 2 Bench Press, 310 x 5 x 1, 295 x 5 x 2 Deadlift, 435 x 3-5 x 1	Squat, 410 x 5 x 1, 390 x 5 x 2 Press, 200 x 5 x 1, 190 x 5 x 2 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	Light Squat, 295 x 5 x 2 Bench Press, 315 x 5 x 1, 300 x 5 x 2 Power Clean, 220 x 2 x 4
	Wednesday	**Saturday**	
5	Squat, 415 x 5 x 1, 390 x 5 x 2 Press, 205 x 5 x 1, 195 x 5 x 2 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	Light Squat, 300 x 5 x 2 Bench Press, 320 x 5 x 1, 305 x 5 x 2 Deadlift, 440 x 3-5 x 1	
	Tuesday	**Friday**	
6	Squat, 420 x 5 x 1, 400 x 5 x 2 Press, 210 x 5 x 1, 200 x 5 x 2 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	Light Squat, 305 x 5 x 2 Bench Press, 325 x 5 x 1, 310 x 5 x 2 Power Clean, 225 x 2 x 4	

Note: Format for specifying training loads, weight x reps x sets (e.g., 390 x 5 x 2 means 390 lbs. x 5 reps x 2 sets).
Weights are in pounds.
BW = Body Weight.

Advanced Starting Strength Model 3

Another option is to reduce the 3 x 5 method to 3 x 3 (see Table 3-10). This slight tapering effect will also allow the trainee to continue to progress linearly for a few more weeks. It has been observed that the 3 x 3 method works better with bench presses and presses.

Table 3-10. 3x3 Method with Frequency Reduction [50].

Week	Monday	Thursday	Sunday
1	Squat, 390 x 3 x 3 Press, 180 x 3 x 3 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	Light Squat, 275 x 3 x 3 Bench Press, 295 x 3 x 3 Power Clean, 210 x 2 x 4	Squat, 395 x 3 x 3 Press, 185 x 3 x 3 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3
	Wednesday	**Saturday**	
2	Light Squat, 280 x 3 x 3 Bench Press, 300 x 3 x 3 Deadlift, 430 x 3-5 x 1	Squat, 400 x 3 x 3 Press, 190 x 3 x 3 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	
	Tuesday	**Friday**	
3	Light Squat, 285 x 3 x 3 Bench Press, 305 x 3 x 3 Power Clean, 215 x 2 x 4	Squat, 405 x 3 x 3 Press, 195 x 3 x 3 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	
	Monday	**Thursday**	**Sunday**
4	Light Squat, 290 x 3 x 3 Bench Press, 310 x 3 x 3 Deadlift, 435 x 3-5 x 1	Squat, 410 x 3 x 3 Press, 200 x 3 x 3 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	Light Squat, 295 x 3 x 3 Bench Press, 315 x 3 x 3 Power Clean, 220 x 2 x 4
	Wednesday	**Saturday**	
5	Squat, 415 x 3 x 3 Press, 205 x 3 x 3 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	Light Squat, 300 x 3 x 3 Bench Press, 320 x 3 x 3 Deadlift, 440 x 3-5 x 1	
	Tuesday	**Friday**	
6	Squat, 420 x 3 x 3 Press, 210 x 3 x 3 Back Extensions, BW x 10 x 3 Chin-ups, BW x 10 x 3	Light Squat, 305 x 3 x 3 Bench Press, 325 x 3 x 3 Power Clean, 225 x 2 x 4	

Note: Format for specifying training loads, weight x reps x sets (e.g., 390 x 3 x 3 means 390 lbs. x 3 reps x 3 sets).
Weights are in pounds.
BW = Body Weight.

At some point, usually between the third and ninth month of training, the standard variations on linear progression will have been exhausted, and training will need to be organized into weekly periods instead of the workout-to-workout periods that characterize the beginner phase. At this point, the trainee can be considered an intermediate.

Strength Programming for the Intermediate

Exercises. At this stage in a lifter's training career, exercise selection will depend on the choice of sport or training emphasis [50]. If powerlifting is the sport of choice, training will be based around the squat, bench press, and deadlift; if it is weightlifting, practicing the snatch and the clean and jerk will be emphasized in the program along with the basic strength movements [50]. Athletes training for heavy field events will incorporate power exercises such as clean, jerk, and snatch variants into the basic strength program [50]. Those interested primarily in hypertrophy will use more isolation exercises with higher reps and shorter rest intervals along with the basic strength program [50].

Assistance exercises are more valuable at the intermediate level than they are at any other level [50]. The best assistance movements are those that mimic their parent movements in both performance of the lift and in load [50]. Some of the most useful barbell-based exercises are done inside of a power rack for the purpose of training a very specific range of motion or initiating the movement from a very specific starting point. For the bench press and the squat, the lifter can do dead-stop sets where each repetition is started at the bottom of the movement where leverage is the least advantageous. For presses and deadlifts, partial rack presses, rack bench presses, and rack pulls can be very powerful tools for working the lockout portion of both presses and deadlifts. The close-grip bench press or the snatch-grip deadlift mimic the parent lift very closely, but slightly change the mechanics of the lift so that the range of motion can be manipulated to alter the stress [50]. In addition to chin-ups, Romanian deadlifts (RDLs) and barbell rows can be added at the intermediate level. Lower back specific exercises such as glute-ham raises and heavy abdominal work (like weighted sit-ups) can be used by intermediate trainees to improve trunk stability for the basic movements [50].

Barbell exercises are very stressful, so there are times when non-barbell-based assistance exercises are appropriate. Dumbbell presses at all angles (flat, incline, and seated) can be useful tools to add mass to the shoulder girdle. Performing 3-5 sets of 10 repetitions after heavy barbell work can be a powerful stimulant for growth [50]. Isolation triceps work is good for lifters who are focused on building up bench and pressing strength and can be done with EZ curl bars, dumbbells, or machines for multiple sets of 10-12 reps. For the lower body, exercises like glute-ham raises and back extensions can add a little work without the stress of heavy stiff-leg deadlifts, RDLs, or good mornings [50].

The important point to remember is that rack presses and rack pulls are far more taxing on the lifter than things like isolation triceps work or weighted back extensions [50]. Careful planning must be used when programming these types of very stressful assistance movements. Adding 2-3 sets of light weighted back extensions after a deadlifting workout or 2-3 sets of cable triceps pressdowns after presses usually interferes with nothing. A well-conditioned lifter will be able to add this additional workload without any disruption to the program and get the extra work he/she needs. However, haphazardly adding in sets of 500+ lb. rack pulls to any already heavy pulling schedule will throw the lifter's program completely off course [50].

Sets and reps. The bulk of the work should be focused on the core lifts, which produce the majority of the physiological effects [50]. Strength work needs up to 5 sets of 1-5 reps on the core lifts. Power cleans and snatches are performed with 5-10 sets of 1-3 reps. Assistance exercises are usually performed with 3-5 sets of 10-15 reps [50].

Scheduling. At the intermediate level, the weekly schedule conforms to the trainee's individual needs with regard to continued progress [50]. Most intermediate training programs follow a 3- or 4-day training schedule. The various intermediate training models will be presented in this section.

Intensity. For the beginner, the weight (or intensity) is increased at every subsequent workout. In contrast, the intermediate increases the intensity during each subsequent week. As the trainee adapts to the stresses of training, he/she becomes capable of applying enough stress in one workout that he/she will not recover from it before the next one [50]. A heavy load for an athlete at the intermediate level is relatively more stressful on the body than a heavy load for a beginner [50]. As a result, this requires a longer recovery period. This involves training periods that include more than one workout, i.e., enough work to accumulate into sufficient stress to constitute an overload event and enough built-in recovery time to allow adaptation to take place [50]. At the intermediate level of adaptation, training organized in week-long periods functions well for this purpose [50].

The methods covered include the Texas Method, the Split Routine Model, and the HLM Model. The following examples show possible interpretations of basic weekly programming for the intermediate trainee.

The Texas Method

The Texas Method is usually the first program to use when simple linear progression does not work anymore [50]. This method varies the volume and intensity of training between the beginning and end of the week. High volume at moderate intensity is used at the beginning of the week, a lighter workout is performed in the middle of the week, and a low volume at high intensity workout is performed at the end of the week [50]. See Table 3-11 for a program example.

Table 3-11. Example Texas Method Program [50].

Monday	Wednesday	Friday
Squat, 5 x 5 (90% of Fri.)	Squat, 2 x 5 (80% of Mon.)	Squat, 5RM
Bench Press, 5 x 5 (90% of Fri.)	Press, 3 x 5	Bench Press, 5RM
Power Clean, 5 x 3	Power Snatch, 4 x 2	Deadlift, 5RM

Note: Format for when weights are not specified, sets x reps (e.g., 5 x 3 means 5 sets of 3 reps).
5RM = 1 set of 5 reps; 5-repetition maximum.

Nevertheless, the Texas Method is an extremely tiring and demanding program, especially after the first several weeks of beginning it. The volume day in particular becomes very difficult to complete. Two-hour sessions on volume days are common, and the heavier weight at the end of the week is a genuine test of the lifter's mental and physical toughness [50]. Therefore, it cannot be stressed enough that the Texas Method is a program for serious strength training and competition in barbell sports [50]. This style of programming requires that time outside of the gym is spent focusing on rest and recovery. Trying to couple Texas Method-style programming with sports conditioning, practice, and field competition is likely to lead to poor performance in both the weight room and in competition [50]. For the competitive athlete, and indeed for most people, transitioning from beginner programming to intermediate programming is best done through the split routine model, which is discussed next [50]. To learn more about strength training programming using the Texas Method, please read Chapter 7 *The Intermediate* in "Practical Programming for Strength Training" by Mark Rippetoe and Andy Baker (source [50]).

The Split Routine Model

A very strong trainee will usually need 2-2.5 hours to complete a very difficult volume day training session using the Texas Method [50]. The vast majority of people cannot commit this amount of time to a strength training session, nor do they have the ability to recover from it [50]. As an alternative, splitting long workouts up over multiple days by body part is often the best solution [50]. There are many ways to organize or split up the training routine. Most of the time, the routine is split up into four days where pressing exercises are performed on the first and third days, and squatting and pulling exercises are performed on the second and fourth days (see Tables 3-12 and 3-13). The assistance exercises can also be organized a couple of different ways. One way is to perform all upper-body movements on pressing days and lower-body movements on squat/pull days (see Table 3-12).

Table 3-12. Four-Day Split Routine [50].

Monday	Tuesday	Thursday	Friday
Bench or Press Chest/Shoulder Assistance Lats Arms	Squats Pulls	Bench or Press Chest/Shoulder Assistance Lats Arms	Squats Pulls

The second way is to fluctuate the stress distribution by having two easy days and two hard days as shown in Table 3-13. Fluctuation in stress throughout the week is a good way to ensure long-term progress [50]. Moreover, this fluctuation can be maximized by placing all lat and upper-back work on the lower-body day. The back is heavily involved in all pulling exercises, so this makes sense. This also allows more time and energy to be spent on triceps assistance exercises on the other two days to improve the pressing movements.

Table 3-13. Four-Day Split Routine with Easy and Hard Days [50].

Monday - Easy	Tuesday - Hard	Thursday - Hard	Friday - Easy
Bench or Press Chest/Shoulder Assistance Triceps Assistance	Squats Pulls (Deadlift, Power Clean, etc.) Upper Back Assistance (Pull-ups, Rows, etc.)	Bench or Press Chest/Shoulder Assistance Triceps Assistance	Squats Pulls (Deadlift, Power Clean, etc.) Upper Back Assistance (Pull-ups, Rows, etc.)

Many competitive powerlifters use a training schedule like the one shown in Table 3-14.

Table 3-14. Competitive Powerlifting Split Routine [50].

Monday	Tuesday	Thursday	Friday
Bench press and related exercises	Squatting and deadlifting exercises	Bench press and related exercises	Squatting and deadlifting exercises

The bench press is best trained the day before the squat so that it is not affected by the fatigue produced by squatting and deadlifting [50]. As functionally/anatomically related movements, squatting and pulling exercises can be combined [50]. With the focus on very heavy weights and the use of squat suits, bench press shirts, and wraps in competitive powerlifting, these two lifts cannot be trained heavy more than once per week by most competitive lifters [50]. Since the same basic muscle groups are used on squat/pull days, powerlifters will organize their weekly schedule to have one heavy squat/light deadlift workout and one light squat/heavy deadlift workout [50].

Four-Day Texas Method

The Four-Day Texas Method is a modification of the Texas Method using the Split Routine Model. It keeps the same pattern of high volume/lower intensity at the beginning of the week and works towards low volume/higher intensity training at the end of the week. In Table 3-15 below is a brief overview of what the Four-Day Texas Method looks like in the context of a four-day split where the volume and intensities of the bench press and press are trained on alternating weeks.

Table 3-15. Basic Four-Day Texas Method Split [50].

Week	Monday	Tuesday	Thursday	Friday
1	Volume Bench Bench Press, 5 x 5 Bench Assistance	Volume Squat/Pull Squat, 5 x 5 Power Clean, 5 x 3	Intensity Bench/Light Press Bench Press, 1 x 5, 2 x 3, 3 x 2, 5 x 1 Light Press, 3 x 5	Intensity Squat/Pull Squat, 1 x 5, 2 x 3, 3 x 2, 5 x 1 Deadlift, 1 x 5, 1 x 3, 1 x 2, 1 x 1
2	Volume Press Press, 5 x 5 Press Assistance	Volume Squat/Pull Squat, 5 x 5 Power Clean, 5 x 3 (Or Power Snatch 6-8 x 2)	Intensity Press/Light Bench Press, 1 x 5, 2 x 3, 3 x 2, 5 x 1 Light Bench Press, 3 x 5	Intensity Squat/Pull Squat, 1 x 5, 2 x 3, 3 x 2, 5 x 1 Deadlift, 1 x 5, 1 x 3, 1 x 2, 1 x 1

Note: Format for when weights are not specified, sets x reps (e.g., 5 x 3 means 5 sets of 3 reps).

When using the program in Table 3-15, the trainee would follow the same patterns of the very basic version of the Texas Method. Starting in the first week, the trainee would try to set new five repetition maximums (5RMs) on the intensity day for as long as possible. As progress for each lift begins to fade, he/she would continue to add weight to the bar while dropping the reps down to two sets of triples, then 2-3 sets of doubles and ultimately singles. In Table 3-16 below is a brief overview of how 6 weeks of a cycling program would be structured (using the squat and press as an example).

Table 3-16. Four-Day Texas Method 6-Week Cycling Program for the Squat and Press [50].

Week	Monday	Tuesday	Thursday	Friday
1	Squat, 5 x 5	Press, 5 x 5	Squat, 2 x 3	Press, 2 x 3
2	Squat, 5 x 5	Press, 5 x 5	Squat, 3 x 2	Press, 3 x 2
3	Squat, 5 x 5	Press, 5 x 5	Squat, 5 x 1	Press, 5 x 1
4	Squat, 5 x 5	Press, 5 x 5	Squat, 2 x 3	Press, 2 x 3
5	Squat, 5 x 5	Press, 5 x 5	Squat, 3 x 2	Press, 3 x 2
6	Squat, 5 x 5	Press, 5 x 5	Squat, 5 x 1	Press, 5 x 1

Note: Format for when weights are not specified, sets x reps (e.g., 5 x 3 means 5 sets of 3 reps).

Dynamic Effort Sets. The dynamic effort (DE) method is a valuable training tool that is used to train the efficiency of motor unit recruitment [50]. The most common way is to use maximal weights (i.e., 3, 2, or 1RMs), but the problem with using maximal weights is that it is extremely taxing and hard to recover from. Heavy weights must be used properly and sparingly, or chronic injuries can develop. Tendinitis, ligament injuries, bursitis, tendon avulsion, cartilage damage, and long-term changes in bony anatomy can accompany the misuse of heavy weights at low reps [50]. DE sets also increase neuromuscular efficiency by teaching the neuromuscular system to recruit a large number of motor units on demand [50]. This can be done between 50 and 75 percent of 1RM weight that is moved as fast as possible [50]. If not using powerlifting gear, or bands and chains that alter the load, DE percentages work well between 60 and 70 percent of 1RM [50]. The advantages to the DE

method are that it allows far more reps to be performed, practice with, and recovered from, and it can be used for long periods of time without injury due to the lighter weights involved and the reduced stress on joints and connective tissue [50]. A proven way to use the DE method is with timed sets, usually done with about 10 sets of 2 or 3 reps with a short, controlled rest between the sets, moving the bar as fast as possible with each rep being faster than the previous one [50]. A 65 percent weight is of no use moved slowly, but when moved explosively for 20 reps in 10 minutes (i.e., 10 sets of 2 reps), it becomes a very powerful tool for the development of strength and power [50].

Table 3-17 shows a six-week snapshot of a lifter using DE sets and pushing towards limit attempts in the final three weeks of phase I and transitioning into phase II. The goal of phase I is to set new personal records (PRs) on the 5 x 5 work for as long as possible while fine-tuning the dynamic effort (DE) sets on intensity days. Once progress stalls, phase I transitions into phase II (as seen in Table 3-17 with the lifter's 5 x 5 maximum attempts); the lifter switches volume days to DE sets with slightly higher percentages. Intensity days will use heavy singles across for as many weeks of progress as possible, ultimately culminating in new 1RMs. The lifter can run either phase for as long as he/she is making progress [50].

Table 3-17. Six-Week Program Sample for Powerlifting or Power Sports [50].

Week	Monday	Tuesday	Thursday	Friday
Phase I: 5 x 5 sets for volume, DE sets for intensity.				
1	Bench Press, 315 x 5 x 5 Weighted Dips, 2 x 10-12 Triceps Pressdowns, 3 x 10-15	Squat, 425 x 5 x 5 Goodmornings, 3 x 5 Lat Pulldowns, 4 x 10	Bench Press, 225 x 3 x 10 Press, 3 x 5 Lying Triceps Extensions, 3 x 8-10	Squat, 300 x 2 x 10 Deadlift, 385 x 1 x 10, 455 x 1, 515 x 1 Barbell Rows, 4 x 10
2	Bench Press, 320 x 5 x 5 Weighted Dips, 2 x 10-12 Triceps Pressdowns, 3 x 10-15	Squat, 430 x 5 x 5 Goodmornings, 3 x 5 Lat Pulldowns, 4 x 10	Bench Press, 245 x 3 x 10 Press, 3 x 5 Lying Triceps Extensions, 3 x 8-10	Squat, 325 x 2 x 10 Deadlift, 405 x 1 x 10, 475 x 1, 525 x 1 Barbell Rows, 4 x 10
3	Bench Press, 325 x 5,5,5,4,4 Weighted Dips, 2 x 10-12 Triceps Pressdowns, 3 x 10-15	Squat, 435 x 5,5,5,4,3 Goodmornings, 3 x 5 Lat Pulldowns, 4 x 10	Bench Press, 265 x 3 x 10 Press, 3 x 5 Lying Triceps Extensions, 3 x 8-10	Squat, 350 x 2 x 10 Deadlift, 425 x 1 x 10, 485 x 1, 535 x 1 Barbell Rows, 4 x 10
Phase II: DE sets for volume, 1-5RMs for intensity.				
4	Bench Press, 235 x 3 x 10 Press, 3 x 5 Triceps Pressdowns, 3 x 10-15	Squat, 315 x 2 x 10 Stiff-Leg Deadlift, 3 x 5 Lat Pulldowns, 4 x 10	Bench Press, 355 x 1 x 5 Dumbbell Bench Press, 3 x 6-8 Lying Triceps Extensions, 3 x 8-10	Squat, 475 x 1 x 5 Deadlift, 550 x 1-2 Barbell Rows, 4 x 10
5	Bench Press, 255 x 3 x 10 Press, 3 x 5 Triceps Pressdowns, 3 x 10-15	Squat, 340 x 2 x 10 Stiff-Leg Deadlift, 3 x 5 Lat Pulldowns, 4 x 10	Bench Press, 365 x 1 x 5 Dumbbell Bench Press, 3 x 6-8 Lying Triceps Extensions, 3 x 8-10	Squat, 485 x 1 x 5 Deadlift, 555 x 1-2 Barbell Rows, 4 x 10
6	Bench Press, 275 x 3 x 10 Press, 3 x 5 Triceps Pressdowns, 3 x 10-15	Squat, 365 x 2 x 10 Stiff-Leg Deadlift, 3 x 5 Lat Pulldowns, 4 x 10	Bench Press, 375 x 1 x 5 Dumbbell Bench Press, 3 x 6-8 Lying Triceps Extensions, 3 x 8-10	Squat, 495 x 1 x 5 Deadlift, 560 x 1-2 Barbell Rows, 4 x 10

Note: Format for specifying training loads, weight x reps x sets (e.g., 265 x 3 x 10 means 265 lbs. x 3 reps x 10 sets).
Format for when weights are not specified, sets x reps (e.g., 5 x 3 means 5 sets of 3 reps).
Weights are in pounds.

One Lift Per Day

The simplest version of any split routine is to train one lift per day, performing each lift once per week with no light day and no separate volume/intensity workouts [50]. Since load increases and PRs happen weekly for the intermediate lifter, it is crucial for the lifter to create enough stress during each session for adaptation to occur, so that performance increases the following week for each lift. If the lifter is unable to do this with just one weekly session, then the program should change to training the lift more than one weekly session. Many lifters who are training just one lift per day are doing a high volume of assistance work along with the main lift, which adds sufficient stress to result in progress the following week. For the general strength trainee who also wants to add muscle mass and improve their physique, the following program might be appropriate.

Monday – Bench Day + Assistance (shoulders and triceps)
Tuesday – Squat Day + Assistance (hamstrings and back)
Thursday – Press Day + Assistance (chest and triceps)
Friday – Light Squat* + Deadlift + Assistance (back)

The trainee should focus on completing the primary barbell exercise first, and if he/she has time and energy, then he/she can complete the assistance work.

*Since deadlifts are generally performed for less volume than the other three major barbell lifts, it is a good idea to add a second light squat session, if possible, into the schedule.

In the program below (Table 3-18), the rep range fluctuates for each primary lift from the beginning to the end of the week. This avoids having a week where the lifter must perform heavy singles on all four training days. In week one, the bench press and squat are done for fives; the press and deadlift are done for singles. In week two, the bench press and squat are done for triples; the press and deadlift are done for fives. In week three, the bench press and squat are done for singles; the press and deadlift are done for triples.

Table 3-18. One Lift Per Day Intermediate Program [50].

		Week 1	Week 2	Week 3
Monday	Bench Press	5 x 5	5 x 3	5 x 1
	Seated Dumbbell Press	3-5 x 10-12	3-5 x 10-12	3-5 x 10-12
	Seated Triceps Extensions (French Press)	3-5 x 10-12	3-5 x 10-12	3-5 x 10-12
Tuesday	Squat	5 x 5	5 x 3	5 x 1
	Stiff-Leg Deadlift	2-3 x 8-10	2-3 x 8-10	2-3 x 8-10
	Lat Pulldowns	3-5 x 10-12	3-5 x 10-12	3-5 x 10-12
Thursday	Press	5 x 1	5 x 5	5 x 3
	Weighted Dips or Dumbbell Bench Press	3-5 x 10-12	3-5 x 10-12	3-5 x 10-12
	Lying Triceps Extensions	3-5 x 10-12	3-5 x 10-12	3-5 x 10-12
Friday	Light Squat (80% of 5s)	3 x 5	3 x 5	3 x 5
	Deadlift	1RM	5RM	3RM
	Barbell Rows	3-5 x 10-12	3-5 x 10-12	3-5 x 10-12

Note: Format for when weights are not specified, sets x reps (e.g., 5 x 3 means 5 sets of 3 reps).
5RM = 1 set of 5 reps; 5-repetition maximum.

The Heavy-Light-Medium Model

The HLM Model calls for three training days per week with a variation in workload, i.e., one Heavy day, one Light day, and one Medium day [50]. In this model, the whole body is worked every day using many of the same exercises. For the intermediate, the goal of any model is to induce an adaptation response by disrupting homeostasis through the cumulative stress of training days [50]. The light day is an absolutely essential component of the program because it is a recovery day [50]. Avoid increasing the percentages on light days. **You do not get strong by lifting weights. You get strong by recovering from lifting weights.** Recovery begins immediately after each workout as the body begins to repair the damage done by the stress; and significant damage is done during the heavy workouts [50]. The light days of the HLM Model do not add to the damage, but rather aid recovery by increasing blood flow to the sore areas, working the joints through the range of motion, and alleviating fatigue [50].

The best way to operate an HLM training program is with three full-body workouts on a three day a week, Monday/Wednesday/Friday type schedule [50]. Each session would consist of a squat, a pressing exercise, and a pulling exercise [53]. The exact exercises are selected per the individual's preferences based on their goals and level of advancement [50].

Squatting. Three squat sessions are best because squats have a positive hormonal impact on the system as a whole and will accelerate gains in both strength and muscle mass [50]. The squat is a technical lift that requires practice, which means that doing the lift three times per week allows the trainee to hone perfect form and technique [50]. To start, set the light day 10-20% lower than the heavy day, and set the medium day 5-10% lower than the heavy day [50]. Stronger lifters will use the higher percentage offset, and weaker lifters (older trainees, women, etc.) will use the lower percentage offset [50].

Pressing. The bench press should always be performed on heavy days, and the press should be performed on light days [50]. For medium days, the trainee can choose from a number of exercises. The first option is the close-grip bench press, which overloads the triceps and will have tremendous carryover to the press or the bench press [50]. The second option is the push press, which would be a possible choice for many sport athletes, strongman competitors, or anyone who wanted to make overhead lockout strength the top priority [50]. A third option is the incline press, which can be considered a hybrid of the first two options, and it will have carryover to both the press and bench press [50]. For a trainee who wants to focus on mass and physique, inclines are better [50]. The trainee does not have to pick only one exercise and stick with it for any length of time. In fact, it is a good idea to rotate the three movements every few weeks or months [50].

Pulling. Deadlifts are a great strength builder and should be done once per week on heavy days. Performing deadlifts three times per week is difficult for most athletes to recover from [50]. For the general strength trainee, a good model would be to deadlift on heavy days, power clean on light days, and perform a stiff-legged deadlift, Romanian deadlift, or a goodmorning on medium days [50]. Some lifters can become mentally and physically fatigued from doing conventional deadlifts every single week, leading to a stall in progress [50]. A common variation would be to alternate week to week between a heavy 5-rep set of rack pulls and an 8-rep set of halting deadlifts to introduce some fluctuation in loading [50].

The following examples show how the HLM Model can be used in practice. Table 3-19 shows an overview of the 12-week sample progression in Table 3-20.

Table 3-19. HLM Model – General Strength Training or Powerlifting Program 1 [50].

Monday – Heavy Day	Wednesday – Light Day	Friday – Medium Day
Squat, 5 x 1-5	Squat, 3 x 5 (80% of Mon.)	Squat, 3 x 5 (90% of Mon.)
Bench Press, 5 x 1-5	Press, 3 x 5	Close-Grip Bench, 3 x 5
Deadlift, 1 x 1-5	Power Clean, 3 x 3	Stiff-Leg Deadlift, 3 x 5

Note: Format for when weights are not specified, sets x reps (e.g., 3 x 5 means 3 sets of 5 reps).

Table 3-20. 12-Week Sample Progression for Program 1 [50].

Week	Monday	Wednesday	Friday
1	Squat, 350 x 5 x 5 Bench, 275 x 5 x 5 Deadlift, 415 x 5	Squat, 280 x 5 x 3 Press, 155 x 5 x 3 Power Clean, 205 x 3 x 3	Squat, 315 x 5 x 3 Close-Grip Bench, 225 x 5 x 3 Stiff-Leg Deadlift, 325 x 5 x 3
2	Squat, 355 x 5 x 5 Bench, 280 x 5 x 5 Deadlift, 420 x 5	Squat, 285 x 5 x 3 Press, 160 x 5 x 3 Power Clean, 210 x 3 x 3	Squat, 320 x 5 x 3 Close-Grip Bench, 230 x 5 x 3 Stiff-Leg Deadlift, 330 x 5 x 3
3	Squat, 360 x 5 x 5 Bench, 285 x 5 x 5 Deadlift, 425 x 5	Squat, 290 x 5 x 3 Press, 165 x 5 x 3 Power Clean, 215 x 3 x 3	Squat, 325 x 5 x 3 Close-Grip Bench, 235 x 5 x 3 Stiff-Leg Deadlift, 335 x 5 x 3
4	Squat, 365 x 5 x 5 Bench, 290 x 5 x 5 Deadlift, 430 x 5	Squat, 295 x 5 x 3 Press, 170 x 5 x 3 Power Clean, 220 x 3 x 3	Squat, 330 x 5 x 3 Close-Grip Bench, 240 x 5 x 3 Stiff-Leg Deadlift, 340 x 5 x 3
5	Squat, 370 x 3 x 5 Bench, 295 x 3 x 5 Deadlift, 435 x 5	Squat, 300 x 5 x 3 Press, 175 x 5 x 3 Power Clean, 225 x 3 x 3	Squat, 335 x 5 x 3 Close-Grip Bench, 245 x 5 x 3 Stiff-Leg Deadlift, 345 x 5 x 3
6	Squat, 375 x 3 x 5 Bench, 300 x 3 x 5 Deadlift, 440 x 5	Squat, 305 x 5 x 3 Press, 177.5 x 5 x 3 Power Clean, 227.5 x 3 x 3	Squat, 340 x 5 x 3 Close-Grip Bench, 247.5 x 5 x 3 Stiff-Leg Deadlift, 350 x 5 x 3
7	Squat, 380 x 3 x 5 Bench, 305 x 3 x 5 Deadlift, 445 x 5	Squat, 310 x 5 x 3 Press, 180 x 5 x 3 Power Clean, 230 x 3 x 3	Squat, 345 x 5 x 3 Close-Grip Bench, 250 x 5 x 3 Stiff-Leg Deadlift, 355 x 5 x 3
8	Squat, 385 x 3 x 5 Bench, 310 x 3 x 5 Deadlift, 450 x 5	Squat, 315 x 5 x 3 Press, 182.5 x 5 x 3 Power Clean, 232.5 x 3 x 3	Squat, 350 x 5 x 3 Close-Grip Bench, 252.5 x 5 x 3 Stiff-Leg Deadlift, 360 x 5 x 3
9	Squat, 390 x 3 x 5 Bench, 315 x 3 x 5 Deadlift, 455 x 5	Squat, 320 x 5 x 3 Press, 185 x 5 x 3 Power Clean, 235 x 3 x 3	Squat, 355 x 5 x 3 Close-Grip Bench, 255 x 5 x 3 Stiff-Leg Deadlift, 365 x 5 x 3
10	Squat, 395 x 1 x 5 Bench, 320 x 1 x 5 Deadlift, 460 x 5	Squat, 325 x 5 x 3 Press, 187.5 x 3 x 3 Power Clean, 237.5 x 2 x 4	Squat, 360 x 5 Close-Grip Bench, 257.5 x 5 x 3 Stiff-Leg Deadlift, 370 x 5 x 3
11	Squat, 400 x 1 x 5 Bench, 325 x 1 x 5 Deadlift, 465 x 5	Squat, 330 x 3 x 3 Press, 190 x 3 x 3 Power Clean, 240 x 2 x 4	Squat, 365 x 5 Close-Grip Bench, 260 x 5 x 3 Stiff-Leg Deadlift, 375 x 5 x 3
12	Squat, 405 x 1 x 5 Bench, 330 x 1 x 5 Deadlift, 470 x 5	Squat, 335 x 3 x 3 Press, 192.5 x 3 x 3 Power Clean, 242.5 x 2 x 4	Squat, 370 x 5 Close-Grip Bench, 262.5 x 5 x 3 Stiff-Leg Deadlift, 380 x 5 x 3

Note: Format for specifying training loads, weight x reps x sets (e.g., 280 x 5 x 3 means 280 lbs. x 5 reps x 3 sets).
Weights are in pounds.

In Program 1 (Table 3-20), the trainee begins with sets of 5 across on all exercises, except the power clean. As the weight on the bar increases over time, the heavy day will change from 5 x 5 to 5 x 3 to accommodate the heavier weight. Eventually the 5 x 3 drops down to 5 x 1. The light and medium days stay at 3 x 5 until doing so makes those days no longer light or medium. In this case, the light day was dropped to 3 x 3, and the medium day was done for just 1 x 5. Additionally, the press and the power clean were reduced to 3 x 3 and 4 x 2 respectively, in order to keep putting weight on the bar week after week.

This next example (Table 3-21) is a 6-week snapshot of a slight variation of the routine in Table 3-20.

Table 3-21. 6-Week Sample Progression for Program 2 [50].

Week	Monday	Wednesday	Friday
1	Squat, 350 x 5 x 5 Bench, 275 x 5 x 5 Deadlift, 415 x 5	Squat, 280 x 5 x 3 Press, 155 x 5 x 3 Power Clean, 205 x 3 x 3	Squat, 315 x 5 x 3 Close-Grip Bench, 225 x 5 x 3 Stiff-Leg Deadlift, 325 x 5 x 3
2	Squat, 355 x 5 x 5 Bench, 280 x 5 x 5 Rack Pull, 465 x 5	Squat, 285 x 5 x 3 Press, 160 x 5 x 3 Power Clean, 210 x 3 x 3	Squat, 320 x 5 x 3 Rack Bench, 260 x 1 x 10 Stiff-Leg Deadlift, 330 x 5 x 3
3	Squat, 360 x 5 x 5 Bench, 285 x 5 x 5 Deadlift, 425 x 5	Squat, 290 x 5 x 3 Press, 165 x 5 x 3 Power Clean, 215 x 3 x 3	Squat, 325 x 5 x 3 Close-Grip Bench, 235 x 5 x 3 Stiff-Leg Deadlift, 335 x 5 x 3
4	Squat, 365 x 5 x 5 Bench, 290 x 5 x 5 Rack Pull, 475 x 5	Squat, 295 x 5 x 3 Press, 170 x 5 x 3 Power Clean, 220 x 3 x 3	Squat, 330 x 5 x 3 Rack Bench, 265 x 1 x 10 Stiff-Leg Deadlift, 340 x 5 x 3
5	Squat, 370 x 3 x 5 Bench, 295 x 3 x 5 Deadlift, 435 x 5	Squat, 300 x 5 x 3 Press, 175 x 5 x 3 Power Clean, 225 x 3 x 3	Squat, 335 x 5 x 3 Close-Grip Bench, 245 x 5 x 3 Stiff-Leg Deadlift, 345 x 5 x 3
6	Squat, 375 x 3 x 5 Bench, 300 x 3 x 5 Rack Pull, 485 x 5	Squat, 305 x 5 x 3 Press, 177.5 x 5 x 3 Power Clean, 227.5 x 3 x 3	Squat, 340 x 5 x 3 Rack Bench, 270 x 1 x 10 Stiff-Leg Deadlift, 350 x 5 x 3

Note: Format for specifying training loads, weight x reps x sets (e.g., 280 x 5 x 3 means 280 lbs. x 5 reps x 3 sets).
Weights are in pounds.

Program 2 in Table 3-21 offers a little bit more variety with the addition of rack pulls to the pulling program and dead-stop rack bench presses to the pressing program. Rack pulls for 1 set of 5 reps are alternated weekly with deadlifts, which are also performed for 1 set of 5 reps. Rack bench presses are alternated weekly with close-grip bench presses. Using the dynamic effort method, ten singles with 30-60 second rest periods are used for the rack bench presses, since this particular exercise is best done for singles only [50].

For those who are mostly focused on training for physique or who may be a little older, the following (Table 3-22) general HLM program may be appropriate because it excludes the use of Olympic lifts [50].

Table 3-22. General Heavy-Light-Medium Program [50].

Monday	Wednesday	Friday
Squat, 5 x 5	Squat, 3 x 5	Squat, 3 x 5
Bench Press, 4 x 5	Press, 4 x 5	Incline Press, 4 x 5
Barbell Row, 4 x 8	Deadlift, 1 x 5	Chins/Pull-ups, 3-5 x 5-8

Note: Format for when weights are not specified, sets x reps (e.g., 3 x 5 means 3 sets of 5 reps).

Additional Considerations

Safety. Adherence to correct exercise form is critical, otherwise risk of muscle, tendon, and connective tissue injury may be increased, and improvement potential may be decreased. Another important aspect of strength training is making sure that you train muscle antagonists [61]. Training one muscle without training its opposing muscle will lead to a muscle imbalance, which will, in time, compromise joint integrity because one muscle will become disproportionately stronger than its antagonist. More safety considerations include proper warmups and breathing techniques. Warming up increases internal body temperature, which, in turn, enhances muscle elasticity and extensibility; therefore, individuals who warm up before engaging in strength training should be less prone to muscle, tendon, and connective tissue injury [61]. Examples of warmup activities include stationary cycling, jogging in place, calisthenics, and performing lighter lifting sets prior to doing the heavier sets. Holding your breath while strength training may create an undesirable "Valsalva maneuver." This can be avoided with a proper breathing pattern while training, i.e., inhaling during the eccentric phase and exhaling during the concentric phase of each repetition [64]. Other safety considerations include using a well-trained spotter, wearing proper clothing, and effectively managing muscle soreness [61].

Adaptation Principle. Given enough time, the training stimulus can either have a positive or negative impact on the human body. In other words, there exists a threshold at which the body's positive adaptation or overcompensation will seize, and any added stress on the body will have a negative effect, known as overtraining [5]. If the stress is too high during a training session (i.e., high levels of tissue microtrauma occurrence), the muscles could react negatively. It is common to experience several days of muscle weakness, fatigue, and discomfort, known as Delayed Onset Muscle Soreness (DOMS); however, this may not lead to enhanced muscle size and strength [5]. Conversely, when muscles are systematically stressed in a progressive way where the training stress is adequately high, the resulting low levels of tissue microtrauma elicit muscle-remodeling processes that lead to larger and stronger muscles [5].

Positive adaptation is dependent on a few factors [5]:

- ✓ Perform each exercise through a full range of motion (ROM).
- ✓ Muscular adaptation happens faster than tendons and ligaments, therefore, the latter requires more training time to respond adequately and reduce injury risk.
- ✓ To develop the strength of arms and legs, it is necessary to develop the trunk (i.e., core).
- ✓ The primary muscles work better when the muscle stabilizers are strong.
- ✓ Recovery time is proportional to the stress intensity.
- ✓ Periodization training is based on the adaptation principle.

ROM. Performing each exercise through a full range of motion (ROM) will develop full-range strength, enhance joint flexibility, and make you less prone to injuries [61]. Strength training will not make you "musclebound" [61]. Furthermore, full-range muscle strength is especially important for people with low back pain, therefore, full ROM resistance exercise should be performed whenever possible [61].

Reversibility. Muscle reversibility is the phenomenon of gradually losing muscle size and strength due to detraining (ceasing resistance exercise). If you stop performing resistance exercise, you will lose strength at about one-half the rate that it was gained [6]. In other words, if you increased your squat strength by 50% over a 10-week training period, you would lose half of that strength gain after 10 weeks of no resistance training and all your strength gain after 20 weeks of no resistance training. Detraining also results in reversal of many health and fitness benefits associated with regular resistance training [61]. Therefore, if you wish to keep your gains, it is in your best interest to make resistance training a regular component of an active lifestyle.

Conclusion

Many assume that muscle and bone loss, metabolic slowdown, and fat gain are inevitable consequences of the aging process. This is simply not true. Research demonstrates that by performing strength training consistently and properly, men and women of all ages can add muscle, rebuild bone, recharge metabolism, and reduce fat [61]. However, without incorporating basic strength training into a daily or weekly regimen, you will lose up to 10% of your muscle mass and up to 30% of your bone mass per decade [61]. Nobody wants this, and it's never too late to start. We hope that this overview has provided you with a solid foundation on the basics of strength training.

3.2 Learn hypertrophy training the proper way.

Introduction

Muscular hypertrophy is the physiological process of muscle-fiber enlargement that results from progressive resistance exercise [6]. Hypertrophy occurs when muscle protein synthesis exceeds muscle protein breakdown. This can be achieved with both resistance training and protein ingestion [31]. In other words, protein intake alongside resistance training is a potent stimulus for muscle protein synthesis [31]. Three major factors are emphasized in the conventional hypertrophy model: mechanical tension, metabolic stress, and muscle damage [31]. Progressive mechanical tension overload is considered one of the major factors of muscle growth and changes in muscle architecture, which are attained by increasing resistance training intensity of effort [31]. Resistance training with high-loads (>85% 1RM), and a low number of repetitions (1−5) as well as long rest intervals (3−5 min) is largely oriented toward a greater magnitude of mechanical tension, which primarily develops strength, while muscle hypertrophy is compromised [31]. Implementation of training with moderate number of repetitions (6−12), multiple sets (3−6), moderate loads (70−85% 1RM), and short rest intervals (60 s) between sets elicits greater metabolic stress (in contrast with high-loads), which appears to be a potent stimulus for inducing muscle hypertrophy [31].

General Guidelines

To facilitate muscular hypertrophy, exercise sessions that favor relatively high training volumes and relatively brief rest periods between sets are recommended [6]. A general guideline for hypertrophy training is shown in the table below.

Table 3-23. General Training Guidelines for Hypertrophy.

Training Goal	Sets	Repetitions	Rest Interval	Intensity
Hypertrophy	3-6	6-12	30-90 seconds	70-85% 1-RM

The American College of Sports Medicine (ACSM) recommends the following:

Table 3-24. Hypertrophy Training Guidelines According to Experience Level.

Experience Level	Sets	Repetitions	Rest Interval	Intensity	Frequency
Beginner	1-3	6-12	30-90 sec.	70-85% 1-RM	2-3 days/week
Intermediate	1-3	6-12	30-90 sec.	70-85% 1-RM	4 days/week
Advanced	3-6	1-12	30 sec. – 3 min.	70-100% 1-RM	4-6 days/week

Volume. Training volume has been suggested to be one of the most important variables for muscle hypertrophy, whereby greater training volumes elicit greater increases in muscle size [23]. Higher volume (e.g., 28-30 sets/muscle/week) is associated with greater increases in hypertrophy compared to lower volume (e.g., 6-10 sets/muscle/week) in both untrained and trained individuals [31]. Bodybuilders typically perform 3-6 sets of each exercise and ≥4 different exercises per major muscle group [6]. As a result, each muscle group can be trained for 12-24 sets of 6-12 reps, which constitutes a relatively high-volume training protocol that seems to be especially effective for increasing muscle size [6].

Rest Interval. For most exercises, bodybuilders will rest 30-90 seconds between consecutive sets in an attempt to induce and maintain a muscle pump, which appears to facilitate muscle hypertrophy [6].

Frequency. The most common training frequency for muscular hypertrophy is the split-routine [6]. Most bodybuilding routines feature a six-day split, working one or two major muscle groups during each session [6]. An example of such a split is pushing exercises (i.e., chest, shoulders, and triceps) on Mondays and Thursdays, pulling exercises (i.e., back and biceps) on Tuesdays and Fridays, and trunk and legs on Wednesdays and Saturdays [6]. It is critical to give each muscle group 72 hours of recovery and remodeling time between successive training sets [6]. Working each major muscle group twice a week is an excellent training protocol for enhancing muscle hypertrophy, as it provides two weekly workouts for each muscle group and provides at least 72 hours of recovery-remodeling time between similar training sessions [6]. Accordingly, training a muscle group more than twice per week does not elicit additional hypertrophic benefits [23].

At higher levels of competitive bodybuilding, each body part is trained with very high-volume workouts just one day a week [6]. For example, these athletes may work legs on Mondays, chest on Tuesdays, upper back on Wednesdays, shoulders on Thursdays, arms on Fridays, and trunk on Saturdays [6].

The most commonly cited and recognized recommendations are those provided by the American College of Sports Medicine (ACSM). For novice individuals whose goal is to achieve muscular hypertrophy, the ACSM guidelines recommend a resistance training frequency of 2-3 days per week using a total body routine [23]. For intermediate individuals (i.e., individuals with at least 6 months of resistance training experience), a frequency of 4 days per week using an upper/lower body split routine is considered ideal [23]. For advanced individuals, a training frequency of 4-6 days per week is recommended, in which 1-3 muscle groups are trained per session using a split body routine [23].

Intensity. The recommended training intensity for hypertrophy is about 70-85% of maximal resistance (1-RM) [6]. However, several studies have found that training with low loads (i.e., 30-60% of 1-RM) results in similar hypertrophic gains compared to training with moderate and high loads (i.e., >60% of 1-RM) when volitional fatigue (momentary muscle failure) is achieved [31]. Reaching volitional fatigue is not necessary to make significant gains in muscular hypertrophy, especially when training with high loads [30]. In fact, evidence indicates that significant muscle growth occurs when the majority of training sets are performed with approximately 3-4 reps in reserve with moderate to high loads [31].

Exercise Type. Most bodybuilders use a combination of free weights and machines to target all of their muscle groups with an emphasis on isolation exercises [6]. Although bodybuilders perform many multi-muscle exercises, they also attempt to isolate each muscle to intensify the training stimulus and enhance the hypertrophy response [6]. For example, bodybuilders generally perform barbell squats and leg presses to concurrently work the quadriceps, hamstrings, and gluteus maximus muscles against heavy weight loads [6]. However, to train these muscles individually, they typically perform leg extensions (quadriceps), leg curls (hamstrings), hip extensions (gluteus maximus), and hip adductions for the hip adductor muscles and hip abductions for the hip abductor muscles [6].

In addition to free weights and machines, bodybuilders frequently perform a variety of cable exercises for purposes of muscle isolation and intensification [6]. It is not uncommon for bodybuilders to finish a training routine with bodyweight exercises such as pull-ups, bar dips, push-ups, and bench dips to fully fatigue the targeted muscles [6]. Lastly, split routine and full-body routine training appear to result in similar increases in upper and lower limb muscle mass [16].

Exercise Order. Current ACSM guidelines recommend performing multiple-joint exercises early in a resistance training session followed by single-joint exercises [3]. The reason for this recommendation is based on the premise that performance of multiple-joint exercises is impaired when the involved muscles are prefatigued by prior single-joint exercises [3]. However, data suggests that both sequences are effective for inducing muscle hypertrophy over a 6-week period of resistance training [3]. Furthermore, there is a possibility of a beneficial hypertrophic effect for performing exercises in a manner that progresses from multiple-joint to single-joint movements [3].

Warming Up. Warm-up sets are done for the first exercise of each cold muscle group. Keep warm-up reps at six or below to avoid excessive lactic acid release, which can hinder the work set(s). An example warm-up routine would look like this:

- ✓ Warm-up Set 1: 50% 10-RM = 95 lbs. x 6 reps
- ✓ Warm-up Set 2: 80% 10-RM = 150 lbs. x 4 reps
- ✓ Planned Work Sets: 3 sets of 8-10 reps @ 185 lbs.

Additional Considerations

One can achieve muscle hypertrophy by giving the right stimulus to a muscle or muscle group alone [5]. However, when muscles are trained with the same stimulus while in an anabolic environment, the hypertrophic response is greater [5]. Studies have shown that the physiological elevation in anabolic hormones, such as growth hormone and testosterone, create an anabolic environment that further stimulates muscle hypertrophy of different muscles [5]. One study conducted by Ronnestad et al. (2011) evaluated the chronic effects of training an arm alone and training the other arm immediately after a leg session on separate days [5, 52]. After performing 5 sets of 10-RM on leg press and 3 sets of knee extension and flexion on a super-set model, individuals had a large increase in cross sectional area of the thighs, although with the anabolic environment, the arm that trained after the legs, had a greater increase in muscle mass than the arm that was trained alone [5]. Madarame et al. (2008) also trained the arms of individuals in two different conditions [5, 34]. Both arms executed 3 sets of 10 reps at 50% of 1-RM on separate days, but one of them was followed by occlusion training for the lower limbs [5]. Only the arm followed by occlusion training increased in cross sectional area [5].

Conclusion

There are a number of factors that determine the rate and extent of skeletal muscle hypertrophy achieved through resistance training. Non-training variables such as genetic background, age, and gender have been shown to govern the hypertrophic response to a training protocol [6]. Furthermore, it becomes progressively more difficult to increase lean muscle mass as one gains training experience, which emphasizes the importance of periodized cycles within an exercise program [6]. Apart from individual factors, available research suggests that maximal gains in muscle hypertrophy are achieved by training regimens that use a repetition range of 6 to 12 repetitions per set with rest intervals of 60 to 90 seconds between sets [6]. Multiple-set training appears to produce superior hypertrophic results. Of the multiple sets, at least some should be performed to the point of muscular failure [6]. Resistance training should be periodized so that muscle growth culminates in a brief period of higher volume overreaching followed by a taper to allow for optimal gains in muscle tissue [6].

Please see Appendix B for example hypertrophy programs.

3.3 Maximize muscle hypertrophy with advanced training techniques.

It's a well-known fact that following years of training, it becomes difficult to induce further muscle hypertrophy. Therefore, individuals seek advanced resistance training techniques, which are outlined below [16]. **The following methods should be used by advanced level individuals with over 2 years of training experience.**

Multiple Set Methods

Multiple set methods consist of completing all exercise sets first before moving on to the next exercise [5]. Training in this way requires rest periods between sets due to the repetition of sets of the same exercise [5]. Multiple sets demand greater local endurance than the super-set 2 and split bi-set methods, but not when compared to the localized bi-set, tri-set, and super-set 1 methods [5].

Multiple Sets. In the 1940s, training enthusiasts hypothesized that performing multiple sets of an exercise would lead to greater increases in strength and hypertrophy [5]. As such, they would perform a few sets with increasing loads and then stabilize the load for a few more sets [5]. As a result, the multiple set method originated, and today, it consists of performing multiple sets of an exercise with a constant load [5].

Pyramid Training. This training method was developed by power lifters and later became popular among bodybuilders due to the variation in training stimulus within the exercise [5]. The pyramid method consists of performing multiple exercise sets where loads are increased or decreased [5]. The first is used for hypertrophy followed by maximal strength, whereas the second is used for hypertrophy followed by muscle definition [5].

Super Slow. The super slow method leads to greater exercise-induced muscle damage, and this method can be performed in more than one way: slow eccentric contraction, slow concentric contraction, or both [5]. A good starting point for those who are not accustomed to slow training is to perform slow eccentric contractions with normal concentric contractions (5s eccentric and 1s concentric), which produces a good protein synthesis response with low cortisol secretion [5].

6/20. This method combines both high (80-85% of 1-RM) and low (30-40% of 1-RM) intensity in the same exercise, which increases muscle stimulus and metabolic stress, resulting in greater hypertrophic gains [5]. The most effective number of repetitions for stimulating the strength fibers of the muscles, which are the myofibrils, is 6 reps. The heaviest bodybuilding reps can be performed for 6 reps. Fewer reps will build strength but not necessarily the corresponding size or muscularity. Sets of 20 stimulate growth by working the endurance fibers that are not affected by low reps. Sets of 20 also provide a maximum pump that builds capillaries, which are those avenues that bring oxygen and muscle building nutrients to the cells. Capillaries also carry lactic acid waste away from the muscle. Not only does the growth efficiency of the muscle improve, but these additional components add more muscular mass.

Perform 6 reps at the high intensity immediately followed by 20 reps at the low intensity [5]. You effectively perform four sets per exercise. After the warmup set with the first exercise, go to your heaviest set of 6. After completing this set, reduce the weight by 40-50% and immediately do a set of 20 reps. For your third set, reduce the heavy weight by 20-25% for another 6 reps and then conclude the exercise with another 20 reps on your fourth and final set. For maximum definition, progressively decrease your rest periods between sets. Then hold and squeeze in the contracted position for one-half second to achieve deep muscle separation. The following table illustrates a sample routine for each body part.

Table 3-25. 6/20 Sample Routines for Each Body Part.

Body Part	Exercise	Sets x Reps
Triceps	Close Grip Triceps Pushdown	4 x 6, 20, 6, 20
	Seated Pulley French Press	4 x 6, 20, 6, 20
Biceps	Dumbbell Curl	4 x 6, 20, 6, 20
	Close Grip Spider Curl	4 x 6, 20, 6, 20
Chest	Incline Dumbbell Press	4 x 6, 20, 6, 20
	Pec Deck Fly	4 x 6, 20, 6, 20
	Decline Dumbbell Press	4 x 6, 20, 6, 20
	Cable Crossover	4 x 6, 20, 6, 20
Back	Lat Pulldown	4 x 6, 20, 6, 20
	Behind the Neck Pulldown	4 x 6, 20, 6, 20
	Seated Row	4 x 6, 20, 6, 20
	Weighted Back Extension	4 x 6, 20, 6, 20
Quads	Leg Press	4 x 8, 20, 8, 20
	Hack Squat	4 x 8, 20, 8, 20
	Leg Extension	4 x 6, 20, 6, 20
Hamstrings	Lying Leg Curl	4 x 8, 20, 8, 20
	Seated Leg Curl	4 x 6, 20, 6, 20
Shoulders	Pulley Front Raise	4 x 6, 20, 6, 20
	Lateral Raise	4 x 6, 20, 6, 20
	Behind the Neck Press	4 x 6, 20, 6, 20
	Rear Delt Machine	4 x 6, 20, 6, 20
Calves	Donkey Calf Raise on Machine	4 x 10, 20, 10, 20
	Seated Calf Raise	4 x 10, 20, 10, 20
	Standing Calf Raise	4 x 8, 20, 8, 20

Rest-Pause. This method does not work from sets, but rather from established intensity and reps [5]. The rest-pause method consists of performing sets to volitional fatigue with 10-30 seconds of rest until the established number of reps is completed [5]. This method should not be performed at every workout, because it will result in overtraining due to its high intensity. It is recommended that this method be incorporated into the workout every third week or when progress has stalled. One way to implement rest-pause is to perform the first set as you normally would with your given 6-10 repetition weight. Once you reach failure, set the weight down. Take 10-30 seconds of deep breaths, pick the weight back up, and rep to failure again. Repeat the last step as many times as you would like, but most people do it twice. If you have a rep goal of 20 reps, then repeat this process until you reach the rep goal. Complete one or two rest-pause sets per exercise. In other words, perform 1 rest-pause set per exercise if you are completing 8 different exercises and 2 rest-pause sets per exercise for 4 total exercises.

To implement the rest-pause method into every workout, you can train efficiently not to failure. This can be accomplished by performing 8 reps with a weight that could be lifted a maximum of 10 times. By doing so, 2 reps are left in reserve, therefore not training to failure on the initial set. Similarly, after each pause, you would continue to perform a few more reps while still keeping 2 reps in reserve. This training technique could cut training time in half and build muscle just as fast with 1 set than with 3 normal sets.

Occlusion Training. This method involves the use of an apparatus (e.g., a pressure cuff or elastic bands) to induce blood flow restriction [5, 31]. The idea behind this method is that the restriction device results in an

accumulation of metabolic products distal to the restriction and when coupled with resistance training, drastically increases metabolic stress, which leads to a great hypertrophic stimulus with very low impact [5, 31]. However, this method is limited only to the limb muscles [31]. The most common set and repetition scheme involves 1 set of 30 reps followed by 3 sets of 15 reps with 30 second rests in between with 20-30% of 1-RM, which results in a growth hormone response up to 70% greater than traditional hypertrophic training [5, 31].

FST-7. Fascia Stretch Training-7 (FST-7) consists of performing seven intense sets for the final exercise of a target body part with rest periods between sets of 30-45 seconds while sipping water [5]. FST-7 is based on stretching the muscle from the inside out by volumizing it. This method assumes that the fascia stretch will promote more blood flow to the muscles after the session, which will allow the muscle to swell and grow [5]. The following table illustrates a sample routine for each body part.

Table 3-26. FST-7 Sample Routines for Each Body Part.

Body Part	Exercise	Sets	Reps
Triceps	Close Grip Bench Press	3-4	8-12
	Weighted or Machine Dip	3	8-12
	Overhead Cable Extension or Skull Crusher	7	8-12
Biceps	Alternate Dumbbell Curl	3-4	8-12
	Machine Preacher Curl	3	8-12
	EZ Bar Curl	7	8-12
Chest	Incline Dumbbell Press	3-4	8-12
	Incline Dumbbell Fly	3	8-12
	Flat Hammer or Dumbbell Press	3	8-12
	Pec Deck or Cable Crossover	7	8-12
Back	Neutral Grip Chin-Up	3	Failure
	Wide Grip Pulldown	3	8-12
	Barbell Row	3	8-12
	Hammer Strength Row	3	8-12
	Machine or Cable Pullover	7	8-15
Quads	Leg Extension	3-4	8-15
	Squat	4	8-12
	Hack Squat or Leg Press	3	8-15
	Leg Extension or Leg Press	7	8-15
Hamstrings	Lying Leg Curl	3-4	10-15
	Stiff Leg Deadlift	3-4	10-12
	Single Leg Curl (each leg)	3-4	10-15
	Seated Leg Curl	7	10-15
Shoulders	Seated Dumbbell Press	4	8-12
	Barbell or Dumbbell Front Raise	3	8-12
	Dumbbell Lateral Raise	3	8-12
	Lateral Raise Machine	7	8-12
Traps	Dumbbell Shrug	3-4	8-12
	Machine Shrug	7	8-12
Rear Delts	Dumbbell Rear Lateral Raise	3-4	12-15
	Reverse Pec Fly or Cable	7	12-15
Calves	Standing Calf Raise	4	10-12
	Seated Calf Raise	4	15-20
	Leg Press or Calf Sled Raise	7	10-12

Super-Set Methods

Supersets most commonly consist of two or more exercises for the same muscle group, agonist-antagonist muscles, or alternating upper and lower body muscle groups performed with little rest between sets [5, 6, 31]. Various super-set methods are described below.

Localized Bi-Set. This method, also called compound set method, targets the same muscle group by performing two exercises consecutively with no rest [5, 6]. The goal of this method is to optimize training volume on the muscle and increase local high-intensity endurance [5]. An example of a localized bi-set would be to alternate three sets of triceps pushdowns and three sets of bench dips to push the triceps to a high level of fatigue and muscle pump [6]. The super-set session must have a greater density when compared to traditional multiple set training [5]. For example, if one performs multiple sets with one-minute rest intervals, performing a localized bi-set with two-minute rest intervals would yield the same density [5].

Tri-Set. Like the localized bi-set method, the tri-set method targets the same muscle group, but it consists of three exercises without rest instead of two [5].

Super-Set 1. This progression targets the same muscle group by performing four exercises consecutively with no rest [5]. One strategy can be to alternate the muscle by origin and insertion [5]. This can be applied only to muscles that move two joints, and these muscles generally will be able to withstand this super-set method [5]. An example sequence for a hamstring super-set would be the deadlift, roman chair hyperextension, stiff-leg deadlift, and leg curl. The deadlift and stiff-leg deadlift focus on hip extension, whereas the roman chair hyperextension and leg curl focus on knee flexion.

Super-Set 2. This method targets the agonist-antagonist muscles (e.g., triceps and biceps, hamstrings, and quadriceps) by performing two exercises consecutively without rest [5]. A rest interval is taken after the two exercises are performed back-to-back. An example of an agonist-antagonist muscle super-set would be to alternate four sets of leg extensions with four sets of leg curls, moving quickly between the leg extension machine and leg curl machine [6]. The density of this method promotes high exercise-induced metabolic acidosis, but it also increases the strain to a particular joint [5].

Split Bi-Set. This method alternates between upper and lower body muscle groups without a rest interval between them. However, combining two different body parts does not support a great training stimulus on the muscle itself but more so on the metabolic stress [5]. This method can be used by those who are interested in increasing tolerance to exercise-induced metabolic acidosis [5].

For further hypertrophic stimulation or to overcome training plateaus, these methods can be manipulated in the following ways.

Pre-Exhaustion

The pre-exhaustion technique is commonly used by bodybuilders looking to enhance the muscle growth of target muscles [31]. Pre-exhaustion involves performing a single-joint exercise first, which fatigues the muscle in isolation [31]. This is followed by a multi-joint exercise, which would place greater stress on the already fatigued muscle, thereby increasing its activation during the multi-joint exercise and potentiating its hypertrophy [31].

Drop Sets

Drop sets involve performing a set to volitional fatigue (momentary muscle failure) with a given load and then immediately reducing the load by about 20% and continuing the exercise until subsequent volitional fatigue [31]. This is repeated 4-5 times until all motor units have been recruited and fatigued [5]. This technique is thought to induce high metabolic stress due to the high number of reps performed with short rest intervals [31]. This technique should be used on the last set of an exercise [5].

Studies that have investigated the chronic effects of drop sets did not show a superior hypertrophy response when compared with traditional sets [31].

Sarcoplasmic Stimulation Training Technique

Like drop sets, sarcoplasmic stimulation training (SST) aims to induce high metabolic stress [31]. The technique consists of 3 total sets with 20 second rest intervals performed at 70-80% of 1-RM to volitional fatigue [31]. The next step is to reduce the external load by 20% and perform another set to volitional fatigue with a 4/0/1/0 tempo that corresponds to the duration (in seconds) of the phases of movement (i.e., eccentric, transition, concentric, transition) [31]. Following another 20 second rest interval, 20% of the external load is reduced again and another 4/0/1/0 tempo set is completed to volitional fatigue [31]. In the final set, the load is further decreased by 20% and after its completion, following a 20 second rest interval, a static hold is performed (e.g., at 90 degrees of elbow flexion) to volitional fatigue [31].

A variation of SST involves the performance of 8 sets at 70-80% of 1-RM to volitional fatigue with programmed rest intervals between subsequent sets (45, 30, 15, 5, 5, 15, 20, and 45 s) without reducing the load [31].

Partial Reps

This method aims to increase the time under tension and strain during a set [5]. After performing a maximal set with proper form and full range of motion until failure, a few more reps can be performed with a shortened range of motion (i.e., partial reps). This should be done only after proper completion of a maximal set [5].

Assisted/Forced Reps

With this technique, the exerciser trains to muscular fatigue, after which a trainer or training partner manually assists on the lifting phase for 3-5 post-fatigue reps [6]. Because people are about 40% stronger on eccentric muscle actions than on concentric muscle actions, the trainee does not receive assistance on the lowering phase. When the trainee can no longer perform the lowering action, the post-fatigue reps are ended [6]. This technique should be used on the last set of an exercise [5].

3.4 Understand muscle clocks and timing.

There are over 600 skeletal muscles in the human body, and each one has its own internal molecular time clock, termed a **muscle clock**, that helps muscles learn to anticipate upcoming training sessions. Muscle clocks are one of many internal biological clocks, including the master clock in the brain, that have the body on a 24-hour, daily rhythm. Muscle clocks use specific cues to monitor time intervals and coordinate the molecular actions associated with resistance training outcomes to anticipate workouts [2].

The discovery of muscle clocks demonstrates how the timing of workouts is critical because it helps avoid interference or competition between modes of exercise. Resistance training and cardiovascular training are competing modes of exercise that initiate different muscle molecular actions and confuse muscles. When cardiovascular and resistance training are performed within a single session or even within the same day, muscle performance can be adversely affected. This is because muscles look for consistent cues to know which molecular actions to turn on. The molecular actions associated with different types of exercise outcomes are unique and seek different cues. When cues are dissimilar, such as jogging and a squat, and occur within an hour of each other, muscles don't know what to do, so they shut down, and performance is negatively affected [2].

Molecular Interference and Muscle Confusion

Molecular Competition. Molecular competition occurs when competing modes of exercise are performed within a single session (i.e., concurrent training) or the same day. Molecular competition has been studied in the context of interference theory, which is the scientifically backed idea that the long-term physiological adaptations associated with muscle growth, strength, and power versus aerobic endurance outcomes compete during individual workout sessions and over time. Therefore, it can be counterproductive to train for cardiovascular endurance and muscle hypertrophy, strength, and power within the same training session or even the same day [2].

When training is chaotic or poorly designed, muscles get confused and don't know which actions to activate. So, they shut down, and all outcomes are adversely affected. The mechanisms of aerobic endurance and strength improvements compete, diminishing the positive effects of training. Under chaotic, unscheduled training conditions, muscles cannot anticipate what will be required of them. If resistance training is done at 11 a.m. one day and randomly at 6 p.m. a couple of days later and then at 8 a.m. later that week, muscles cannot use their internal 24-hour clocks to anticipate what's next. They don't know when they should prepare the molecular actions associated with muscle hypertrophy, strength, and power versus aerobic endurance outcomes [2].

Interference Mechanisms

It is widely accepted that the long-term muscle adaptations associated with resistance versus cardiovascular endurance training compete during sessions. As science continues to evolve and examine the interference phenomenon, suggested mechanisms have emerged, including short-term chemical changes, long-term changes in muscle structure or morphology, and changes in metabolic or biochemical processes. These interference mechanisms include muscle contractility (metabolic), delayed-onset muscle soreness (structural and metabolic), testosterone levels (metabolic), and cortisol and blood lactate levels (metabolic) [2].

Muscle Contractility. Prolonged cardiovascular exercise interferes with a muscle's ability to contract, and decreased contractility diminishes the likelihood of positive muscle growth, strength, and power outcomes.

Prolonged cardiovascular training, such as jogging, can adversely affect a muscle's ability to contract efficiently, which supports the idea that when resistance training is done after cardiovascular training, strength is adversely affected [2].

Delayed-Onset Muscle Soreness (DOMS). DOMS causes a series of events, including microscopic damage to muscle fibers, that can have a negative effect on the muscle's ability to contract optimally and yield strength improvements. There are also metabolic factors contributing to interference, such as substrate depletion and increased protein breakdown. Substrate depletion is the reduced availability of adenosine triphosphate (ATP), phosphocreatine (PCr), muscle glycogen, and blood glucose. The depletion of these substrates compromises muscle functions during training. Protein breakdown during prolonged muscle work also causes DOMS and protein is needed to build muscle. Therefore, when the substrates and protein are depleted, hypertrophy, strength, and power performance are adversely impacted [2].

Testosterone Levels. Testosterone levels are directly related to muscle growth, strength, and power outcomes. The greater the testosterone level, the greater the muscle growth, strength, and power improvements. Researchers measured testosterone concentrations during three different modes of training: strength training only, concurrent training (both cardiovascular and strength), or cardiovascular training only. The major finding was that testosterone levels increased in the strength only group. As expected, testosterone levels decreased in both the cardiovascular only and concurrent training groups [2].

Cortisol and Blood Lactate Levels. Blood lactate and cortisol levels are additional metabolic factors that determine the efficacy (or lack thereof) of concurrent training. Where it is desirable that testosterone levels be high to yield muscle hypertrophy, strength, and power improvements, the opposite is true of blood lactate and cortisol concentrations. These levels should be low, or they interfere with increases in muscle and strength. Cardiovascular training before strength training interferes with muscle hypertrophy, strength, and power by elevating blood lactate and cortisol levels, which interfere with molecular adaptations associated with the desired performance outcomes [2].

Avoiding Interference

It has been established that interference happens, and that cardiovascular training gets in the way of muscle hypertrophy, strength, and power improvements. The problem is that both cardiovascular and muscle endurance are required for conditioning. Therefore, the solution lies in the strategic use of a variety of factors that include type, frequency, and duration of cardiovascular exercise relative to resistance training [2].

Frequency. Resistance and cardiovascular training need to be scheduled differently to avoid interference. If a program includes strength and cardiovascular endurance goals, it is best to schedule each mode of exercise on alternate days. However, that does not just mean doing resistance and cardiovascular training on different days and the problem is solved. Alternating days is only the beginning of the programming puzzle. It is a good start and an easy programming suggestion, but, when the data are examined closely, the suggested frequency of each mode of training is more complex. When training more than once per 24-hour period, guidelines suggest a minimum of 3 hours rest after any workout before beginning another workout and at least 6 hours, up to 24 hours, rest between cardiovascular endurance training and resistance training [2].

The frequency of cardiovascular training is one of the main culprits for interference theory. Programming suggestions are to limit cardiovascular exercise frequency to less than 3 days per week to minimize the adverse effects on strength. Duration of cardiovascular training should not exceed 40 minutes. However, more

conservative estimates suggest keeping cardiovascular training volume at no more than 20 minutes, with 30 minutes maximum. The type of cardiovascular exercise is critical to influencing the degree that cardiovascular training affects hypertrophy, strength, and power outcomes. Research shows that jogging or running has a greater negative effect on muscle contractility than cycling. Cycling does not include eccentric action, which is known to cause more microscopic damage to muscle fibers, hence contributing more to resistance training interference. Also, cycling loads muscles in a resistance training manner. The mechanical resistance from the parts of the bike during pedaling can act like an external weight (i.e., pushing a big gear is like doing a weighted lunge). Therefore, cycling is recommended for concurrent training programs instead of jogging or running [2].

Intensity. The intensity of cardiovascular endurance training has an impact on the extent of muscle force impairment. Specifically, moderate- to high-intensity cardiovascular training reduces the effectiveness of strength training. Therefore, the suggested intensity of cardiovascular sessions should be low (40% - 50% maximum heart rate) if hypertrophy, strength, and power are primary training goals [2].

Baseline Strength Recovery. General guidelines suggest that muscles need about 48 hours of rest after high-intensity resistance training (anything above 80% of 1-RM) to recover to baseline strength. However, too much rest is a bad thing. Rest periods should not exceed 96 hours, because after that the physiological processes of detraining begin [2].

Upper- Versus Lower-Body Training. Most of the data collected on the effects of concurrent training on muscle strength analyzed lower-body strength. In most cases, a 1-RM squat is used to measure lower-body strength. However, one study examined the effects of lower-body sprint interval training on upper-body hypertrophy and strength. Results showed that sprint interval training combined with resistance training adversely affected upper-body hypertrophy and strength. This finding is interesting because it shows that the effects of concurrent aerobic endurance and resistance training are not muscle-use specific. Lower-body sprint interval training had a negative effect on upper-body strength performance. The results showed that the effects of endurance training influence nonworking muscles. Hence, the data demonstrated that the mechanisms responsible for interference cannot be avoided by using different muscle groups for aerobic endurance and strength training [2].

Physiological Cues

Physiological cues are biological markers inside the body that internal clocks recognize as time cues. They are biochemical changes that reflect the time of day and changes in muscle activity, such as training and rest patterns, type of scheduled exercise, and naturally fluctuating hormone levels. Physiological cues include things like testosterone, human growth hormone (HGH), cortisol levels, and muscle pliability. Biochemical levels and natural patterns of highs and lows are influenced by both endogenous (inside the body) and exogenous (outside the body) factors. An example of an endogenous biological marker is the natural fluctuating testosterone levels throughout the day, while an exogenous factor is cortisol release caused by exercise [2].

Testosterone. Testosterone levels naturally fluctuate throughout the day. Testosterone levels are highest in the morning and begin to level off between 4 and 6 p.m., decreasing after that. Although testosterone levels naturally change throughout the day in a pattern consistent with most people, testosterone levels can be manipulated by factors such as resistance training. Resistance training influences testosterone levels during and after a workout session. Research has shown that testosterone levels remain elevated up to 30 minutes after resistance training [2].

Human Growth Hormone (HGH). HGH is a biochemical, like testosterone, that is critical to muscle growth and strength and power development. Just like testosterone, HGH levels fluctuate naturally. During sleep, 75% of HGH is released, with the majority released during the first hour of sleep. The fact that HGH is released during sleep emphasizes the critical role of rest in muscle recovery and performance. HGH release during sleep, specifically during the first hour of sleep, is an example of the body's natural rhythms and how they are synchronized to activity-rest cycles during a 24-hour period. Just like testosterone, HGH is released into the bloodstream during exercise. Compound exercises such as squats and deadlifts, which use multiple joints and large muscle groups, are the most effective in releasing HGH. In addition, eccentric contractions cause more HGH release than concentric contractions [2].

Muscle Pliability. Tissue pliability is an indication of the natural elasticity of muscle, and it varies significantly from the time someone wakes to when he or she goes to bed. In accordance with body temperature changes throughout the day, muscle tissue is the least pliable first thing in the morning, but as the day goes on, the natural elasticity of muscle increases, peaking between 4 and 6 p.m., indicating that muscles will be most flexible during that time of day. Time of day that a muscle is most pliable is an important time cue for muscle clocks and a factor in muscle performance because muscles generate their greatest force just beyond resting length. A slightly stretched muscle generates the most strength and power [2].

Eating Habits. The timing of eating relative to any form of exercise is important to muscle performance and recovery. The nutrient makeup of meals and overall caloric intake are critical as well. Timed eating and muscle glucose uptake are cues that muscle clocks recognize, helping them determine the time of day and regularly occurring events [2].

Cortisol. Because exercise is a stressor (a positive one), it stimulates the release of cortisol, a stress hormone, into the bloodstream. Generally, cortisol is released in response to emotional stress (such as pain, anger, and fear) and physical work (such as scheduled resistance training). Like most of the body's chemicals, cortisol also has its own natural daily rhythm. Natural cortisol levels are at their highest around 8 a.m. and lowest at 3-4 a.m. Like other biochemical markers in the body, such as testosterone and HGH, cortisol levels fluctuate throughout the day but also increase or decrease in response to their environment. For optimal muscle performance during resistance training, blood lactate and cortisol levels should be low, or they interfere with muscle growth, strength, and power improvements. Cardiovascular training before strength training also interferes with muscle hypertrophy, strength, and power by elevating blood lactate and cortisol levels, which interfere with the molecular adaptations associated with the desired performance outcomes [2].

Consistently high levels of cortisol create a dilemma because cortisol has been correlated to a decrease in skeletal muscle mass. Too much cortisol interferes with amino acid uptake that is critical to muscle growth. In addition to potentially decreasing muscle mass, cortisol increases free-floating glucose in the body, which ultimately leads to more fat mass. Too much fat combined with less muscle is highly undesirable for performance. Therefore, cortisol levels must be controlled, and scheduled exercise plays an important role in stabilizing those levels. Elevated levels of cortisol for an extended time cause a series of negative effects. However, resistance training can increase cortisol at scheduled times as a muscle clock entrainment cue and then decrease cortisol over time, leading to improved muscle function and possibly contributing to decreased fat mass, both of which are significant to improved performance [2].

Exercise Training and Programming

Successful resistance training programming relies on strategic timing. Muscle clocks use exercise training and programming cues to help regulate muscle performance and synchronize muscles with other body systems. The timing cues muscles look for are programming variables that all sport and fitness practitioners are familiar with, including mode, frequency, volume, duration, intensity, and rest periods. The only difference is that instead of being strictly programming variables, these same concepts are now viewed as muscle clock entrainment tools as well [2].

Forced Exercise and Clock Entrainment. The difference between forced versus voluntary exercise is that forced exercise is programmed or scheduled and voluntary exercise is recreational, by choice, spur-of-the-moment physical activity, such as a pickup basketball game. Scheduled exercise is powerful. It can override the natural light-dark cycle of biological clocks. Scheduled training is a cue that helps give muscles autonomy and flexibility in responding to the demands of their unique environment. It can teach muscles to turn on the associated actions of muscle performance at the desired time of day ahead of training, improving the effectiveness of training, reducing the likelihood of interference, and providing muscles with information about when to perform and when to recover. Regularly scheduled exercise at a set time of day over the course of weeks and months helps muscle clocks set an internal 24-hour rhythm and coordinate skeletal muscle tissue to anticipated resistance training sessions [2].

Training Frequency. Interference happens when cardiovascular and resistance training are performed too close together in time; however, interference can be avoided by allowing enough time to elapse between the two modes of exercise. Ideally, there should be 4 to 6 hours between cardiovascular and resistance training, and training sessions should never be within 30 minutes of one another. To provide consistent cues, cardiovascular training should be performed on alternate days from resistance training. Determining a day-to-day training schedule that alternates cardiovascular training with resistance training tells muscles when to be ready to turn on the molecular actions associated with cardiovascular versus resistance training outcomes [2].

Exercise Mode. The mode of exercise is the type of exercise performed. Interference occurs when cardiovascular exercise is performed less than 3 hours before resistance training. Research has clearly demonstrated that resistance training should be done before cardiovascular training to avoid interference when done in the same session or within 3 hours of one another. Additionally, when cardiovascular and resistance training are done within the same session, protein synthesis can be disrupted, leading to little or no muscle fiber size change and thus decreasing strength-related performance. Therefore, making sure that cardiovascular and resistance training are clearly distinguished and separated is important, because the mode of exercise is a cue for muscles to learn when to anticipate cardiovascular or resistance exercise and turn on the associated actions [2].

Biomechanical Similarity. Pairing exercises that use similar joint actions establishes biomechanical similarity, providing an important exercise and training cue for muscle clocks. Biomechanical similarity is a training method that pairs two exercises that are alike. Biomechanically similar exercises work the same or similar muscles, but they activate those muscles in different ways. Different movement patterns use different bundles of muscle fibers within the same muscle. For example, both a back squat and leg press train the muscles of the legs and hips. However, each exercise activates slightly different bundles of muscle fibers within the same muscles. The end programming result is a more comprehensive workout for the entire muscle group [2].

Intensity. The intensity of exercise is a critical factor for clock entrainment. The higher the intensity of exercise, the more testosterone, cortisol, and HGH are released into the bloodstream. All these biochemical events are timing cues that contribute to muscle clock entrainment; when released on a regular schedule within 24-hour periods, intensity-related biomechanical muscle changes can contribute to phase-shifting of muscle clocks [2].

Intensity-Rest Cycles. Another example of timing sessions is intensity-rest cycles. The amount of rest required for recovery from one set of an exercise to another varies by the intensity of the exercise, determined by the volume of muscle mass used, the percent of 1-RM, and the speed of muscle contraction. This is a key point because intensity is generally higher for lower-body exercises, and thus the length of rest required to recover is longer. Muscles monitor all cues related to exercise mode, frequency, and timing; therefore, intensity-rest cycles give them another cue about what to anticipate and when [2].

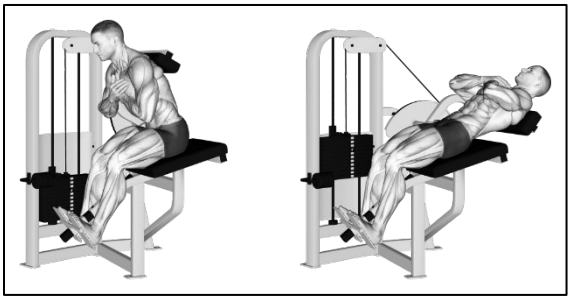
Conclusion

Muscle clocks are internal timekeepers monitoring environmental and physiological signals that affect muscles. The muscle clocks learn over time what to expect, when, and how to respond by paying attention to a wide range of cues, including time of day from the master clock in the brain, regularly occurring physiological changes in local muscle tissue, and scheduled exercise programming and training cues. With the right time cues, muscle clocks are able to develop their own 24-hour daily rhythms that allow them to anticipate upcoming training sessions and activate in advance the molecular actions associated with muscle performance and recovery, improving resistance training outcomes.

Chapter 4 - Gym Equipment & Accessories

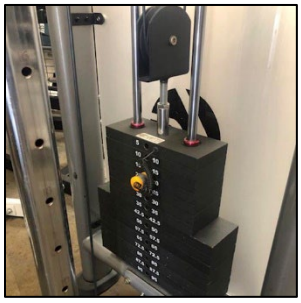
4.1 Gym Equipment.

Selectorized (Pin-Loaded) Machines



Trunk Extension

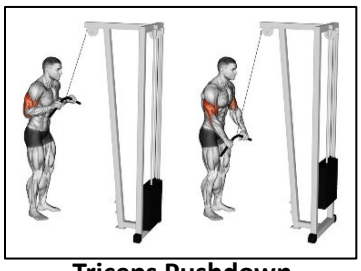
Seated Leg Curl



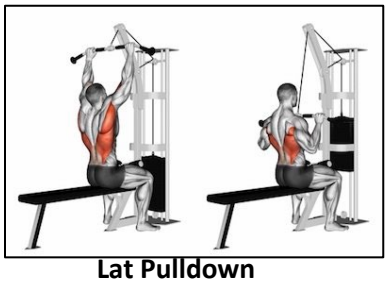
Pin and Stack

Description. Selectorized machines isolate muscles in the upper and lower body and provide resistance in a fixed plane of motion [53]. These machines utilize a pulley system and typically have one or more weight stacks that always move vertically to provide a consistent resistance force throughout the lifting and lowering actions [6, 53]. Pin-loaded machines are the most common, whereby the user inserts a pin into the weight stack to select a desired weight. Because of their controlled and predictable movement paths, selectorized machines are well-suited for beginners that are learning to exercise and gauge the strength of their bodies [6, 53]. That said, these machines can be very effective in building muscle and strength in intermediate and advanced exercisers too. Well-designed and properly engineered selectorized machines provide safe, time-efficient, and highly effective resistance exercise that facilitates strength development in the prime mover muscles [6]. Exercises particularly well-suited to selectorized resistance machines include trunk flexion, trunk extension, trunk rotation, knee flexion, knee extension, hip adduction, and hip abduction, as it is difficult to isolate these joint actions with free weights [6].

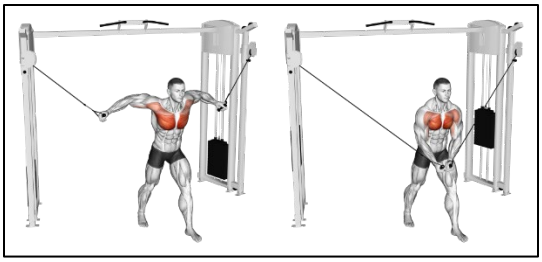
Cable Machines



Triceps Pushdown



Lat Pulldown



Chest Crossover

Description. Like selectorized machines, cable machines are also pin-loaded and are attached to weight stacks (utilizing a pulley system) that move vertically against the force of gravity keeping the resistance force constant throughout the exercise repetition [6]. Unlike selectorized machines, cables permit considerable freedom of movement and typically require contraction of many stabilizer muscles to maintain proper posture and positioning during the exercise being performed [6]. The pulley height is adjustable and different attachments or grips can be clipped onto the cable depending on the exercise, making cable machines quite versatile to target all parts of the body. Some of the more popular cable exercises include triceps pushdowns, lat pulldowns, and chest crossovers [6].

Plate-Loaded Machines

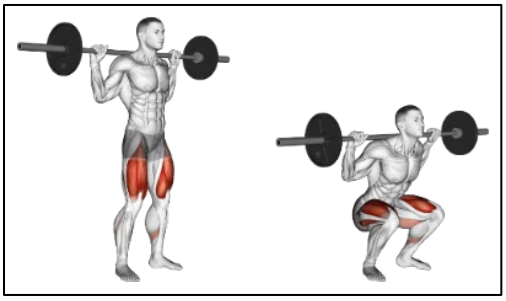
Leg Press

Hip Thrust

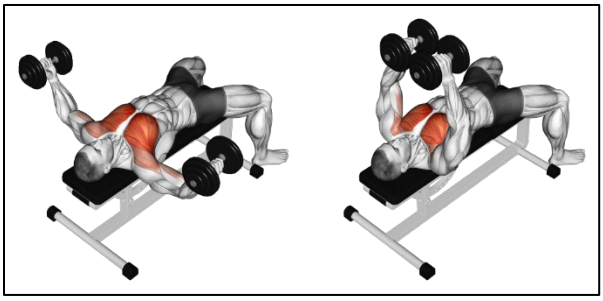
Back Row

Description. Plate-loaded machines require the use of external resistance via conventional free-weight plates, which are manually loaded onto the machine. Plate-loaded machines are often capable of supporting more weight and offer a smoother movement pattern versus selectorized machines because of the diminished frictional resistance [57]. One of the more popular plate-loaded machines is the plate-loaded leg press.

Free Weights



Barbell Back Squat

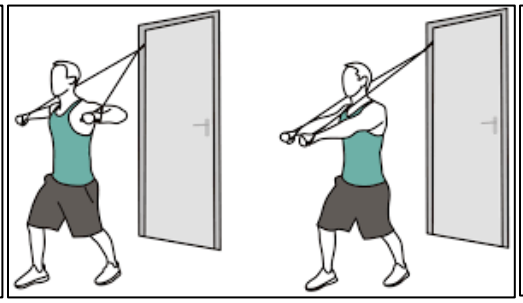


Dumbbell Chest Fly

Description. Unlike machine equipment, free-weight equipment such as barbells and dumbbells allow unrestricted multi- and single-joint movement in all planes of motion [6, 57]. Barbell exercises (e.g., barbell squats and bench presses) permit heavier weight loads that are usually supported by weight racks. Barbells require either a fully pronated or fully supinated wrist position and can be leveraged to favor one side, which is not ideal. Therefore, the user must first develop the stability and awareness to avoid favoring one side when performing the exercise such as a squat, bench press, or deadlift [6, 57]. Conversely, dumbbell exercises require equal force application from both arms, joint stability, and permit various wrist positions [6]. In the case of an overhead press, performing alternating dumbbell presses provides excellent resistance exercise for the deltoid muscles with less potential for shoulder impingements than barbell presses [6]. The numerous combinations of barbell and dumbbell exercises make free-weight training a relatively comprehensive and highly versatile means of developing muscular strength and size [6].

Elastic Resistance

Resistance Bands

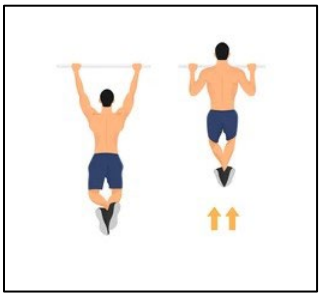


Chest Press with Band/Tubing

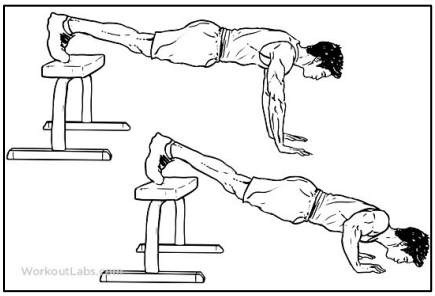
Resistance Tubing

Description. Elastic bands and rubberized tubing provide a softer form of resistance that can be easily adapted to almost any exercise. Elastic bands and tubing are inexpensive and take up little space, making it particularly accommodating for resistance training when traveling [6]. Elastic bands work especially well for pushing exercises (e.g., chest presses, shoulder presses, and squats), because the bands provide greater resistance force as they are stretched, and the muscles (working together) produce greater force as the pressing movement nears completion [6].

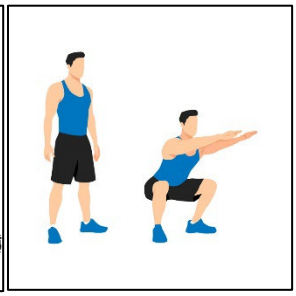
Body Weight



Pull-Up



Decline Push-Up



Squat

Description. The most practical resistance to use is body weight. A select few body weight exercises can be performed without equipment (e.g., squats, planks, and push-ups), and others require only a chair (e.g., chair dips), parallel bars (e.g., bar dips), or an overhead bar (e.g., chin-ups). With body weight, progression is accomplished by performing more repetitions rather than by adding resistance. The progressive-repetition

approach works well until the exercise set exceeds 100 seconds, after which the strength-building stimulus diminishes [6]. One way to enhance body weight exercises is to wear a weighted vest; another way would be to strap on one or more weight plates by means of a rope over the hips or dip belt (see accessories). This works well for bar dips and chin-ups. Other ways to vary the amount of body weight resistance used in an exercise involve pushing and pulling the body at different angles such as in a decline push-up or a handstand push-up [6].

4.2 Accessories.

Weightlifting Belt

Description. A weightlifting belt is a type of assistive equipment designed to enhance performance during weightlifting [8, 49, 55]. Wearing a belt allows you to lift more weight than you would without one. The lifting belt acts as a tool to increase intra-abdominal pressure by giving your core muscles something to brace against as the abdominal wall expands [49]. Increasing intra-abdominal pressure is similar to inflating a balloon inside your abdominal cavity [55]. The pressure inside the abdominal cavity pushes on the spine to support it from the inside, while the core muscles in the abdominal wall and lower back push on the spine from the outside. This inside and outside pressure acts to stabilize the spine and reduce the stress it receives when lifting heavy weights [55]. Increased pressure against the spine is necessary for the safety and efficiency of the lift (i.e., squat or deadlift) [49]. Contrary to conventional wisdom, a lifting belt will not prevent your trunk from becoming and staying strong [49]. Under a 600-lb. squat, there is not one single relaxed muscle group in the entire human body. Your muscles do not go to sleep all of a sudden when you put on the belt. What actually happens is that the abs contract harder against the external resistance provided by the belt than they would without it, in the same way that your arms contract harder when you curl a barbell versus a broomstick [49].

Weightlifting belts also create better body biomechanics [55]. Research shows that when lifting boxes, wearing a lifting belt reduces the amount of spinal flexion (forward bend at the spine), spinal extension (bending back of the spine), and lateral flexion of the spine (bending side to side), but increases the amount of flexion at the hips and knees [55]. A belt forces you to lift more with your legs than your back, which is precisely the biomechanical position you want to be in when lifting something from the ground. These are also the biomechanics you want to use during deadlifts and squats with a barbell. In fact, research has shown that wearing a lifting belt during squats increases the muscle activity of the quadriceps and hamstrings muscles [55].

Recommendation. A properly designed belt is the same width, usually 4 inches, all the way around [49]. For the belt to function properly, it must act around the complete circle (i.e., there is no reason for it to be wider in the back than in the front). Thickness is important in that a very thick, laminated suede belt feels very good under heavy weight. The belt must be worn in the right place at the right tightness to be effective. Put it on around your natural waist (higher than your pants) at a comfortable tightness, take your squat stance (without any weight), and squat down into the bottom position. The belt will adjust to the position it wants to settle into. Stand back up and tighten the belt to the point where it adds a little pressure to the gut. This is the correct placement. When performing the squat, use your abs the way you would without the belt, and do not push the stomach out against the belt as this will result in spinal flexion, which is what the belt is meant to prevent [49].

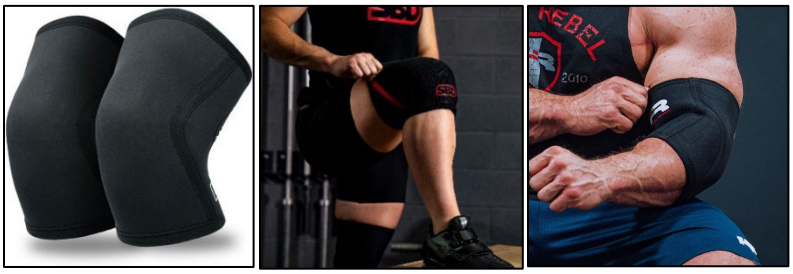
Squatting Shoes



Description. Squatting shoes are used in both Olympic Weightlifting and Powerlifting [46]. The main purpose of the squat shoe is to allow more forward movement of the knees while keeping the heel planted. This is incredibly important in Olympic Weightlifting as it allows for a more upward torso while catching a clean or snatch. But when it comes to Powerlifting, the main focus is on the forward knee travel which may allow for deeper squats and more quadriceps involvement [46]. Most squat shoes have metatarsal straps to increase lateral stability, provide some very important arch support, and suck the foot back into the heel of the shoe to reduce intra-shoe movement [49]. The primary beneficial feature of a squat shoe is its lack of heel compressibility [49]. The drive out of the bottom starts at the floor, where the feet start the kinetic chain [49]. If the contact between the feet and the floor is the squishy gel or air cell of a running shoe, a percentage of the force of the drive will be absorbed by the compression of the cell. This compression reduces power transmission efficiency and foot stability [49]. Unstable footing interferes with the reproducibility of the movement pattern, rendering virtually every squat a whole new experience and preventing the development of good technique. Squatting in running shoes is like squatting on a bed [49]. Weightlifting (i.e., squatting) shoes are the most important personal equipment a lifter can own. They provide solid contact with the floor and eliminate sole compressibility and the instability of squishy footing [49].

Recommendation. You want a shoe with a solid base (e.g., hardened plastic or wood) that creates a surface to catch weight on. You want the shoe to have a raised heel, which often helps people find a more comfortable position in the bottom of a squat, specifically addressing those who have issues with ankle mobility. Avoid shoes with heels higher than 1 inch because these are difficult to use for pulls from the floor. Added fastening systems like Velcro straps provide more security and safety while lifting, so you will want shoes that have metatarsal straps to increase lateral stability [49].

Knee and Elbow Sleeves



Description. Knee and elbow sleeves are used primarily to provide warmth. The main benefit to knee and elbow sleeves is the compression they provide to the knee or elbow joint. Compression increases blood flow to the area, allowing the joint to stay warm during a workout. This improves joint mobility, reduces stiffness, and makes you less susceptible to injuries and joint pain [19].

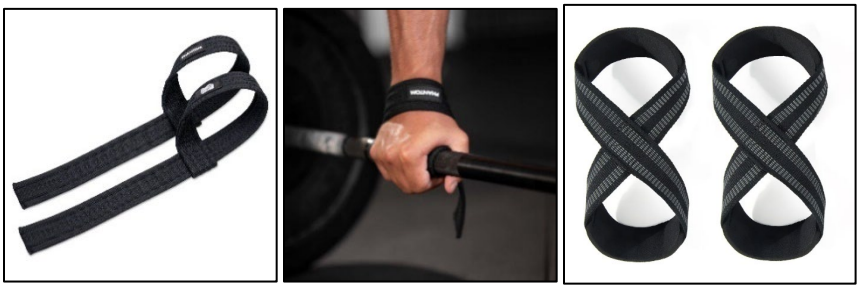
Recommendation. Look for sleeves made from high-quality materials such as neoprene or nylon blend fabric. Neoprene provides excellent compression while retaining heat around the joints [19]. Nylon blends are more flexible and breathable but still offer adequate support. Different workouts require different types of sleeves with different levels of support and flexibility. If you engage in dynamic movements like CrossFit, opt for 5 mm neoprene knee and elbow sleeves that offer compression and flexibility [19]. For heavy lifting or pressing exercises, prioritize thicker and sturdier 7 mm neoprene sleeves for superior support [19].

Knee and Elbow Wraps

Description. Knee and elbow wraps improve support and stability during heavy lifts for lifters with minor injuries because wraps provide capsular support to the knee or elbow joint and can be very helpful if used correctly [49]. If you have an old ligament injury that has healed as well as it is going to, wraps are useful to add some compression and stability to the joint [49]. Wraps can also enhance strength gains for weightlifters by helping lifters generate more power at the bottom of the lift (e.g., squat or bench press) [19]. This is called the rebound effect, in which the wraps act as a coiled spring at the bottom of the movement, storing energy that later is released during the upward phase, significantly augmenting your lifting power [19].

Recommendation. Look for wraps made from high-quality materials such as cotton with elastic or neoprene with elastic. The elastic material stores energy to give the power and momentum to complete the lift. Wraps are typically 3 inches wide and can vary in length depending on your compression preference. Select shorter lengths for optimal compression or longer lengths for maximum compression [19].

Lifting Straps



Description. Lifting straps are a weightlifting accessory typically made of nylon, leather, or canvas that wraps around your wrist and around the barbell. Lifting straps are mainly used for barbell and dumbbell movements, as they make it much easier to hold onto heavy weights. Lifting straps can help you develop a better mind-muscle connection and train your target muscles closer to failure to encourage hypertrophy. As a result, they are great for exercises where you typically struggle to work the target muscles because your grip gives out before your target muscles do. For example, many people will use lifting straps for things like deadlifts, shrugs, heavy rows, or even pull-ups and lat pulldowns [48].

Recommendation. Figure 8 lifting straps and normal lifting straps are two popular types [19]. Figure 8 lifting straps are known for their exceptional grip strength enhancement and superior lifting support, which is why elite weightlifters prefer them [19]. Normal lifting straps are more versatile and are suitable for the general population. While they provide reliable support, they may not offer the same level of grip enhancement as figure 8 lifting straps. However, for most weightlifting exercises, normal lifting straps are strong enough and highly effective [19].

Lifting Chalk

Description. Lifting chalk helps absorb moisture, and in the context of barbell lifts, absorbing sweat improves the connection between your hands and the barbell, preventing blisters and effectively strengthening your grip [11]. Chalk becomes beneficial when performing the deadlift and any type of pulling movement (e.g., rows and pull-ups) [11]. Chalk also comes in handy for squats and any other lifts you might perform with the bar on your back (e.g., goodmornings and lunges). For example, to ensure that the bar sits securely on your back when performing the low bar squat, you have two options to apply chalk. One is to have a friend chalk your shirt where the bar will go, and two is to apply chalk to your hands and then chalk to the bar where it will come in contact with your upper back. This is a helpful alternative to lifting straps, but the cruel reality is that chalk is not welcome at many gyms because of how messy it is.

Recommendation. The most commonly used forms are block chalk, loose chalk, liquid chalk, and chalk balls. Block chalk, often a large lump of solid chalk, is popular for its longevity and cost-effectiveness. Loose chalk is block chalk that has been crushed into a powder and is favored for its easy application. Liquid chalk, a blend of chalk and alcohol, is praised for its mess-free application and longer-lasting effects. Lastly, chalk balls are small sacks filled with chalk that reduce waste and prevent excessive dust. The chalk is up to your preference, but if you go to a commercial gym that does not allow chalk, you may be able to get away with liquid chalk.

Dip Belt

Description. Dip belts are accessory tools that are used to overload your body weight. It is a thick belt with a chain and carabiner, which enables you to hang weight plates, dumbbells, or kettlebells from your waist to add resistance. A dip belt can be used for dips, pull-ups, chin-ups, calf raises, and belt squats.

Recommendation. Look for dip belts made from high-quality materials so that they last. Neoprene dip belts are a popular choice for those looking to add extra weight to their bodyweight exercises. The width of the belt is also important, because a wider belt will provide better support and distribute weight more evenly.

Bench Block

Description. A bench block is designed to train the sticking point of the bench press and offers a durable and dependable option for weightlifters. Users can use the bench block to work on form through half repetitions or if they just want to reduce shoulder rotation and keep the tension in the pectoral and triceps muscles as they bench. The reduced range of motion can help lifters overcome strength plateaus by allowing them to lift more weight than they normally would without the bench block. It can also be used to limit the range of motion for users who are rehabbing from an existing chest or shoulder injury.

Recommendation. The bench block shown above is very easy to use. Simply slip it onto the center of the barbell using one of the pre-made slots and it will secure tightly to the bar. It comes with multiple slots so that you can adjust the preferred height and range of motion.

Chapter 5 - Sleep

5.1 Understand the importance of sleep.

What is Sleep?

Sleep is defined as the natural, periodic state of immobility where the individual is relatively unaware of the environment and unresponsive to external sensory stimuli [22]. When asleep, nearly all voluntary muscles become inactive and metabolic rate is reduced [22]. The brain, however, is far from inactive [22]. Sleep occurs in 90-minute cycles switching between two main types of sleep phases called non-rapid eye movement sleep (NREM) and rapid eye movement sleep (REM) [37]. There are also two other phases known as the falling asleep and light sleep phases [37]. During the NREM and REM phases, the brain is very active. During the NREM phase, the brain experiences a sensory blackout (i.e., it no longer receives signals that normally become conscious perceptions) and transfers memories from the short to long-term memory, imprinting the prior day's new experiences and knowledge learned in its memory [37]. During the REM phase, the brain integrates new information with old memories to create an overall more accurate understanding of the world, which is a critical process to developing new insights and solving problems [37]. Dreaming also happens in the REM phase. Losing out on either NREM or REM sleep can have serious health and life longevity implications [37].

How Much Sleep Do We Need?

The actual amount of sleep required is genetically determined and therefore varies between people. It is generally considered that the optimal amount of sleep for human adults is between 7 and 8 hours per night in a single consolidated period because this allows us to benefit most from alertness, improved mood, sound memory, and good health [22]. Too little or too much sleep over prolonged periods can be detrimental, and both are associated with increased mortality as shown in Figure 5-1 below [22].

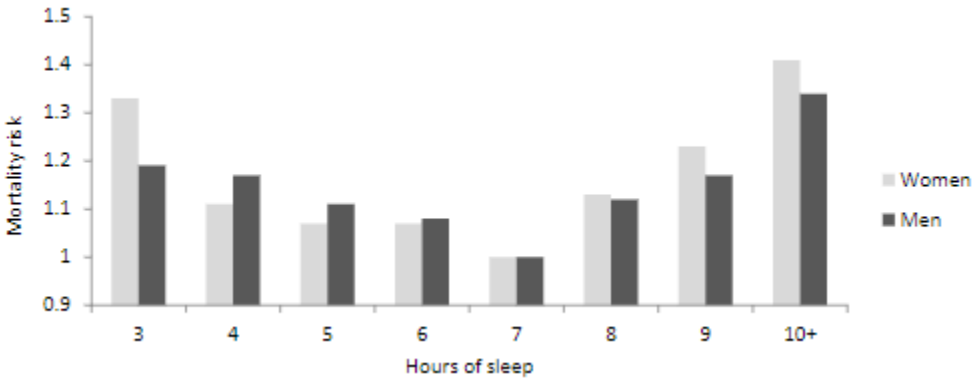


Figure 5-1. Relationship between sleep duration and mortality risk in women and men.
Data from: Green, A., Westcombe, A., (2012). *Sleep: Multi-Professional Perspectives*. Jessica Kingsley Publishers.

The required amount of sleep changes throughout our lifespan [22]. As seen in Table 5-1 below, newborns and young children require more sleep so that they can develop and function normally [22]. Adolescents also require more sleep, and their sleep timing tends to be delayed compared with children and young adults [22]. As the years progress through adulthood, sleep duration tends to shorten and sleep occurs earlier, particularly in old

age [22]. Although the consolidated nighttime sleep appears much reduced in the elderly, it is often made up by daytime naps [22].

Table 5-1. Average sleep requirements throughout the lifespan.

Age or Condition	Average Sleep Required (hours)
Newborn	Up to 18
1-12 months	14-18
1-3 years	12-15
3-5 years	10-13
5-12 years	9-11
Adolescents (12-19 years)	9-11
Adults (19-65 years)	6-8
Elderly (65+ years)	6-8

Data from: Green, A., Westcombe, A., (2012). *Sleep: Multi-Professional Perspectives*. Jessica Kingsley Publishers.

Generally, women and men have similar sleep requirements, but women's sleep alters with the menstrual cycle, pregnancy, and menopause [22]. This is because the secretion of certain hormones, such as estrogens and androgens, affects sleep [22]. These hormonal changes can, for example, cause premenstrual and post-menopausal insomnia, increased NREM sleep during early pregnancy and during lactation [22].

Maintaining a regular daily schedule strengthens the circadian rhythm making sleep easier to achieve at the chosen bedtime [22]. Disruption of the circadian rhythm by keeping a chaotic sleep schedule, by doing night shift work or by regularly switching time zones can make sleeping difficult [22]. This is clearly demonstrated by the effects of jet lag [22]. Similarly, the process of being aroused, anxious, or alert may overcome either of the sleep promoting processes and is one of the main mechanisms involved in the complaint of insomnia [22].

What Are the Consequences of Inadequate Sleep?

Inadequate sleep affects all aspects of our physiology including cognitive impairment, mood changes and hormonal abnormalities, and exacerbating certain mental and physical disorders [22]. When people regularly sleep for less than 6 or 7 hours a night, they become more vulnerable to a whole host of serious health problems.

- ✓ Sleep deprivation (even 1-2 hours less than the requirement) leads to increased cortisol levels and elevates heart rate and blood pressure, which increases the risk of developing and/or dying from heart disease by 45 percent [37].
- ✓ Increased cortisol levels encourage fat storage. Feeling tired from inadequate sleep reduces willpower and increases the urge to eat calorie-dense foods for a quick energy fix. As a result, this leads to weight gain. And over time, the ability to regulate blood sugar is markedly impaired, intensifying the risk of Type 2 diabetes [37, 51].
- ✓ Reduced sleep destroys our immune system, which releases cells that remove toxic elements from our bodies. One night of no sleep results in a 70 percent loss of these killer cells that help fight off toxic elements that cause disease [37]. In fact, regularly sleeping less than 6 hours increases your risk of developing cancer by 40 percent [37].

- ✓ A lack of sleep is associated with a heightened risk of developing Alzheimer's disease and other diseases associated with dementia [51].
- ✓ Inadequate sleep contributes to psychiatric conditions like depression and anxiety and significantly reduces the ability to experience pleasure and positive emotions [51].
- ✓ Sleeplessness also affects our sexual energy. After one week of sleeping 4-5 hours a night, men have been found to have the testosterone levels of someone ten years older [51]. Sleep is also vitally important for women's health and sexuality. For one thing, women need to restore the body in different ways as it transforms throughout the menstrual cycle. Scientists have found that for every hour of sleep that a woman loses, she has about a 14 percent decrease in her desire to be physically intimate with her partner [51].

How to Get Adequate Sleep?

Assess and Prioritize Your Sleep. Focus on giving yourself a long enough sleep opportunity each night, because it takes time for most people to fall asleep and people are often wakeful at certain points during the night [37]. Therefore, factor in that lost sleep time when figuring out your bedtime. It is generally considered that the optimal amount of sleep for human adults is between 7 and 8 hours per night [22]. If your alarm clock wakes you up, you haven't slept enough [37]. Ideally, you should wake up a little before your alarm goes off [37]. You can start by giving yourself at least eight and a half hours in bed each night [37]. Thirty minutes to fall asleep and eight hours to sleep. You can also set an alarm for when to start your bedtime routine; consider starting your routine an hour before getting into bed [37].

Set a Regular Schedule. Go to bed at the same time and wake up at the same time; no matter whether it's the weekday or the weekend. Regularity will reinforce your circadian rhythm, anchor your sleep, and improve the quality and quantity of that sleep [22, 51].

Keep Your Room Cool. Your body needs to drop its core temperature by about 2-3 degrees Fahrenheit to initiate sleep and to stay asleep. It's the reason why you will always find that it is easier to fall asleep in a room that is too cold than too hot. So, aim for a bedroom temperature of around 65 degrees Fahrenheit or 18 degrees Celsius, which will be the optimal temperature for the sleep of most people [37, 51].

Limit Bedtime Food and Fluid Intake. Digesting food, especially highly processed, high fat and carbohydrate-rich foods can prevent you from being able to fall or stay asleep [37]. Healthy late-night snacks such as fruit can also provide bursts of energy that hinder sleep as well as eating too few calories during the day [37]. Eat a balanced diet during the day and stop at least two hours before you go to sleep [37]. Drinking water or other liquids within a couple of hours before bed can mean nighttime bathroom trips. Each time you wake up to use the bathroom, your sleep quality and quantity are impacted. Sugary or caffeinated evening drinks will further hinder sleep by providing energy. Avoiding food too close to bedtime will help limit liquid since we tend to drink to wash down food.

Limit Caffeine in the Afternoon and Evening. It is normal to have a drop in energy in the afternoon, and it typically passes in a couple of hours. Rather than refueling with caffeine, use this time for low level activities or, if possible, take a nap or go for a walk [37]. Caffeine has a quarter life of twelve hours, which means one quarter of one cup of coffee at 12 p.m. will still be in your brain at 12 a.m. [51]. Even if you fall asleep and stay asleep, caffeine can decrease the amount of NREM deep sleep by 15-20 percent [51].

Avoid Sleeping Pills. Sleeping pills do not promote true sleep. They cause sedation and interfere with the natural NREM and REM sleep cycles [37]. The brain's important nighttime work is suppressed and, although you might not be awake during the nighttime hours, you are suffering the effects of your brain's inability to perform its essential tasks. Sleeping pills often lead to grogginess the next day, which can lead to more caffeine dependency [37].

Avoid Alcohol. Alcohol often causes fragmented sleep [51]. Avoid alcohol unless you have nothing you need to do the next day. Like sleeping pills, alcohol is a sedative. It may help you fall asleep, but it will not help you stay asleep. It can cause bouts of waking up, feeling hot, sweaty, and dehydrated with your heart racing [37]. The tiredness felt the day after drinking can lead to excessive caffeine and high-calorie foods to help boost the body's energy levels [37]. While this is fine and fun on occasion, it can have negative consequences if you need to rely on your brain to perform optimally the next day.

Limit Electronic Devices Close to Bedtime. Most electronic devices emit blue LED light, which fools the brain into thinking that it's still daytime and delays the release of melatonin, making it harder to fall asleep [37, 51]. Indoor lighting can also hinder the production of melatonin [51]. A few solutions to this problem are as follows. Avoid electronics at night and dim/turn down the lights in your home when your alarm alerts you that it's time for bed [37, 51]. Install blackout curtains to block out streetlights or the morning sunrise [37, 51]. If you are going to use electronic devices close to bedtime, wear screen glasses designed to reduce the amount of blue light that hits your retinas [37]. Lower your television's brightness setting. Use the dark mode option on your devices. Switch off notifications after a certain time or even better switch off notifications for everything that you don't need to be notified about in the evening, such as work emails. You can also purchase smart bulbs that have color options and use the red setting during the evening [37].

Exercise Consistently. Consistent exercise can improve sleep quantity and quality [10, 37]. Studies have shown that exercise can increase REM sleep, sleep continuity, and sleep efficiency [10]. Furthermore, engaging in regular resistance exercise improves the quality of sleep and can reduce the time required to fall asleep [10]. It is also important to note that key measures of fitness and body composition are associated with poor sleep quality [10]. Exercising regularly helps regulate hormones, chemicals, and appetite; and therefore, is an effective intervention for improving body composition and fitness, which in turn will improve sleep quality and quantity [10, 37].

Conclusion

We spend a large proportion of our time sleeping, and there is a legitimate reason why we do. Inadequate sleep affects all aspects of our physiology. When we don't get enough sleep, our cognition becomes impaired, we experience mood changes and hormonal imbalances, and our cortisol levels rise leading to weight gain. Therefore, it is crucial that we try our best to do everything we can to prioritize getting 7-8 hours of sleep each night. Follow the recommendations outlined above, and you will live a longer and happier life as a result.

Chapter 6 - Recovery

6.1 Learn how to recover.

If exercise is increased to an intensity beyond that which is normally accomplished, it usually results in soreness that starts at about the first day after exercise and peaks at the third day after exercise [47]. This soreness, called delayed onset muscle soreness or DOMS, is characterized by a decreased range of motion of the joints, cellular inflammation, and decreased muscle strength [47]. This chapter discusses the various means and methods that can be implemented to better recover from DOMS and exercise-induced fatigue.

Heat and Cold Exposure

Both heat and cold exposure are effective in reducing DOMS (i.e., muscle damage, soreness, stiffness, and strength loss) due to strenuous exercise. However, the timing of each modality is important. Heat exposure immediately after exercise results in the least muscle damage and soreness [47]. Furthermore, to preserve muscle strength after strenuous exercise, heat applied soon after exercise is best [47]. In fact, the application of heat resulted in only a 4 percent strength reduction on the day after exercise compared to a 24 percent loss of strength without the application of heat [47].

If applied 24 hours later, cold is better than heat for reducing DOMS [47]. Please note that the regular use of cold water immersion (but not cold showers) immediately after resistance training has a negative impact on the adaptations associated with strength and hypertrophy [13, 28]. Cold water blunts the processes that contribute to muscle strength and hypertrophy if immersion takes place shortly after resistance training. This does not mean that cold exposure right after resistance training will result in no muscular adaptations, but rather it will result in less adaptations compared to waiting several hours or not using cold exposure at all [13]. Fortunately, cold water immersion does not appear to negatively impact aerobic exercise adaptations or performance, so taking a plunge after a jog or indoor cycling session will not be a problem [13]. A good strategy is to reserve cold water immersion for cardio or rest days, and if you want to use cold exposure on the same day as a resistance training session, experts like Andrew Huberman, PhD, recommend doing it beforehand or waiting at least 4 hours (it is better to wait 6-8 or more hours) post-exercise that way you do not blunt your gains [13, 28].

Heat exposure modalities. Sauna is an effective recovery tool. The temperature should be set in the range of 80-100 degrees Celsius (176-212 degrees Fahrenheit) [28]. Your personal heat tolerance should determine the actual temperature. Your sauna session should last 5-20 minutes per session [28]. On average, you can spend 12-13 minutes in the sauna after your resistance training workouts to promote recovery. Make sure to drink at least 16 ounces of water for every 10 minutes you spend in the sauna [28]. It is recommended to use the sauna during the afternoon/evening to align with your natural circadian rhythm to aid in falling asleep at night [28].

An alternative to the sauna is to immerse yourself up to the neck in a hot bath post-exercise for about 15-30 minutes. The key here is to make it hot enough so that you start sweating after a few minutes (not so hot that it becomes intolerable). Just like with the sauna, draw up a bath closer to bedtime rather than early in the day to promote a good night's sleep. For an added benefit, add Epsom salt to your bath. Epsom salt promotes body relaxation, healing, and reduces soreness and pain. Use 2 cups of Epsom salt for a standard size bathtub. Make sure to drink water as Epsom salt can dehydrate you by drawing water out of your body.

Cold exposure modalities. Cold water immersion is a highly effective recovery tool. Short interval (< 5 min.) cold water immersion has positive outcomes for perceived recovery and decreased muscle soreness. A science-backed protocol is doing deliberate cold exposure (i.e., cold water immersion) for a minimum of 11 minutes per week total [28]. This can be 2-4 sessions lasting 1-5 minutes each distributed across the week. The water temperature should be uncomfortably cold yet safe to stay in for a few minutes [28]. Temperatures can range from 45 degrees Fahrenheit to 60 degrees Fahrenheit, because some people tolerate the cold better than others [13, 28]. The colder the stimulus, the shorter the amount of time is needed for cold exposure. After cold exposure, the body's core temperature increases, which tends to wake you up [28]. Conversely, a decreased body temperature tends to shift you toward a sleepy state [28]. Therefore, it is recommended to use deliberate cold exposure early in the day and not too close to bedtime, because it may interfere with your sleep.

Active Recovery

When you lift weights, you create microtears in your muscle tissue, which results in DOMS. The soreness and muscle pain that you experience after an intense workout is a sign that you are doing something right and inciting change in your body [14]. To recover faster and to reach your training goals more quickly, you should always schedule some days for active recovery. Active recovery involves low-impact movement that should raise your heart rate, require you to move through a full range of motion, and move fresh blood into your muscles without breaking them down significantly [14]. Optimal recovery occurs when metabolic waste is removed and replaced with fresh blood that delivers nutrients to help repair and rebuild damaged muscle tissue [14]. In addition to improved muscle recovery, active recovery provides a mental break [9]. Intense lifting sessions without recovery days can also exhaust you mentally, which can negatively impact your performance. For those who like to train every day, active recovery days can temper your training anxiety somewhat by letting you train (at a lower intensity) on your off days [9]. And finally, active recovery can help prevent injury by increasing blood circulation thereby acting as a preventative measure against future injuries [9].

The exercises during an active recovery session do not have to be specific, complex, or even performed in a certain order to elicit positive results [14]. The exercise routine can be a combination of any of the following methods [1, 35]:

- ✓ Low intensity steady state cardio (e.g., cycling, walking, jogging)
- ✓ Low intensity weight training
- ✓ Swimming
- ✓ Foam rolling or massage
- ✓ Mobility and core training
- ✓ Yoga and stretching

You should always choose an active recovery method that is consistent with your goals and that does not send the wrong signals to your body [14]. For example, if you are trying to build large muscles, you would not engage in active recovery that uses a lot of eccentric loading, which may impair recovery [14]. To be specific, the day after you train legs, you will wake up and perform about ten 30-second sprints on a recumbent bike using moderate tension with a 1-minute rest between sprints. This works to pump blood into your muscles without breaking them down and without inciting an endurance stimulus [14]. Pushing and pulling a Prowler sled is also a good active recovery method that gets your heart rate up, moves your lower body through a significant range of motion, and drives a lot of blood into the muscles and joints [14]. You can also do something as simple as swinging your arms in an exaggerated manner during your walks, moving them from the shoulder joints to engage and stiffen the core [14].

Active recovery days should be just as much a part of your program as your regular lifting days. By making them a structured part of your routine, prioritizing mobility, flexibility, and short bouts of steady state cardio, you will be keeping your body safe from overtraining and setting yourself up for success [9].

Sleep, Nutrition, and Hydration

Optimal recovery also depends on sleep, nutrition, and hydration. How much and how well you sleep will affect how well you recover and grow. Numerous research supports this idea, so make sleep a priority (revisit Chapter 5). Second, your diet is proportional to your recovery. In other words, the better your diet is, the better your recovery will be. Providing your body with a good dose of nutrients better enables it to repair tissues and get you back to the gym faster. Third, proper hydration is imperative for both performance and recovery, enhancing protein synthesis, accelerating nutrient delivery, and improving heart rate recovery (revisit Chapter 1).

Intentional Undertraining (Deloading)

Intentional undertraining or deloading is a recovery method that should be implemented into your exercise program or routine to avoid overtraining syndrome (OTS), which is a condition characterized by reduced performance, extreme fatigue, loss of motivation, chronic muscle soreness, delayed recovery, poor sleep, and depression [2, 14]. A deload period is when you lower the intensity of your training for a short amount of time by either lifting lighter weights or reducing the volume. This period is spent focusing on physical and mental recovery, allowing you to hit your next training cycle harder and heavier.

The following general guidelines present the adjustments to be made during the deload period based on information gathered from coaches in strength and physique sports. These guidelines can also be applied to muscular strength and hypertrophy.

Training frequency. Training frequency will typically remain unchanged, but some practitioners might consider a reduction in training days [4].

Training volume. Reduce training volume by approximately 30-50 percent, which can be achieved through a decrease in either repetitions per set or by a reduction in the number of sets per training session (or in some cases, both). Volume can be reduced in all exercises per session or by reducing the number of accessory exercises [4].

Intensity of effort. Reduce the intensity of effort by increasing proximity to muscular failure, e.g., by adding 1-3 repetitions in reserve for each set performed, by removing repetitions per set while maintaining absolute load, or by reducing the absolute load (e.g., by 10%) while keeping the number of repetitions constant. Additionally (or in combination with an increase in proximity to muscular failure), a decrease in relative loading (e.g., 6 repetitions at 80% of 1-RM rather than 3 repetitions at 90% of 1-RM) can be implemented to facilitate the necessary reduction in the intensity of effort [4].

Exercise selection. The deload period provides an opportunity to vary exercise selection as appropriate. Typically, sport-specific muscle groups and movements will remain in the training program or should be exchanged for similar exercise movements. This will provide the athlete with some novelty and reduce monotony but maintain a level of training specificity. It should be noted that excessive changes in exercise

selection might result in unwanted muscle soreness, therefore, caution should be taken when making large alterations in programming [4].

Duration. Most deloads will last 5-7 days [4].

Periodicity. For pre-planned training programs, deloading can be scheduled every 4-8 weeks depending on the training demands of the mesocycle. Periodicity of deloading is, in part, related to the preceding block of training, i.e., deloading will be likely required after a period of overreaching but less likely during prolonged periods of continuous training where the overall training demand is relatively constant [4].

If you are overtrained, you are also likely under fueled. Your body may be depleted of vitamins, minerals, and calories; so, getting your nutrition back on track can help reverse many, if not most, of the overtraining signs you are experiencing. Overtraining is easily reversed. First, take some time off from exercise and give yourself a mental and physical break. Often 2-3 weeks does the trick. You can also reduce your training volume by cutting back on your number of days, reducing your load, or doing fewer sets/reps. You should also take a look at your overall workout program. Make sure your intense workouts are spaced appropriately within your week and ensure that you are varying your training weeks and months, continually changing things up so your body and brain have plenty of new stimuli.

Massage

Massage is another modality that can improve recovery after physical exercise. It has been shown that massage performed immediately or up to 4 hours after exercise effectively reduces DOMS for up to 96 hours [12, 62]. Massage intervention can reduce soreness by more than 30 percent as long as it is performed post-exercise but before DOMS develops [62]. Massage is beneficial in reducing DOMS and swelling associated with high-intensity eccentric exercise. However, recreational athletes and sports professionals who use massage should be aware of the fact that no positive effects of massage on muscle function recovery (i.e., strength and range of motion) can be expected [62]. Other noteworthy benefits to massage include 1) increased blood circulation, which brings nutrients to damaged tissue, and 2) promotion of relaxation and improved sleep.

There are different types of massage that can assist with recovery after exercise. These types of massage are similar but may have slightly different approaches and goals. The first type is called sports massage, which is used to treat common sports injuries and can include soft tissue massage, deep tissue massage, and whole-body massage techniques. Next, deep tissue massage is focused on addressing the deeper levels of muscle and fascia. The purpose of deep tissue massage is to release the tension and tightness held deeply in your muscles and your connective tissues. Another type is called remedial massage, which is used to prevent or correct and rehabilitate movement patterns and mobility using deep tissue massage, trigger point therapy, myofascial release, and stretching techniques. Finally, relaxation massage is lighter work to loosen muscles and reduce stress and anxiety.

Massage oftentimes induces relaxation and sleepiness, so it is better to get one as late in the day as possible so that you can go home afterwards. It is also better to receive massage after you have exercised, so that the effects of massage can help you recover faster. The frequency of your massage treatments depends on how you are feeling and what you can afford. There is no standard requirement for how often you should be getting a massage. It takes 48 hours for the body to rebalance after a deep massage, so you should at least wait two days between massages. The frequency of sports massage depends on your training schedule. For general tune-ups,

consider scheduling a massage every 4-6 weeks. If you have a chronic condition or specific areas of strain and tension, consider scheduling a massage every 1-3 weeks.

Chiropractic Care

Chiropractic is a licensed health care profession that emphasizes the body's ability to heal itself [58]. Treatment usually involves manual therapy that often includes spinal manipulation [58]. Chiropractors treat problems related to the musculoskeletal system [58]. The manual treatment methods used by chiropractors range from stretching and sustained pressure to specific joint manipulations, which are usually delivered by hand and involve a quick and gentle thrust [58]. The purpose of the manipulations is to improve joint motion and function [58]. Manipulations are most commonly done on the spine, but other parts of the body may also be treated in this way [58].

Your spine, if out of alignment, can lead to muscular imbalances and pain, which can hinder your athletic performance and affect your training. Furthermore, if not using proper form, muscles can overwork and cause the vertebrae and other joints to become misaligned resulting in inflammation and decreased nervous system function [15]. The role of the chiropractor is to decrease the amount of physical stress placed on the body by performing adjustments that allow the muscle tissues to properly support the spine along with the vital neurological processes that occur within it. Chiropractic care can be a useful modality that can reduce recovery time. Having optimal alignment and function will allow you to train more efficiently. When starting a new treatment plan, it is common to have adjustments multiple times a week. As your body begins to heal, that number could drop to just once a week. And if you are pain-free and simply want to maintain your lifestyle, you might only need to get an adjustment once or twice a month. Make sure you do your research when looking for a chiropractor. Ideally, you want a practitioner who lifts weights and has experience treating athletes and weightlifters.

Sources

[1] *Active recovery: Reduce fatigue and enhance performance*. ISSA. (n.d.). https://www.issaonline.com/blog/post/active-recovery-reduce-fatigue-and-enhance-performance

[2] Ashmore, A. (2020). *Timing resistance training: Programming The muscle clock for optimal performance*. Human Kinetics.

[3] Avelar, A., Ribeiro, A. S., Nunes, J. P., Schoenfeld, B. J., Papst, R. R., Trindade, M. C., Bottaro, M., & Cyrino, E. S. (2019). Effects of order of resistance training exercises on muscle hypertrophy in young adult men. *Applied Physiology, Nutrition & Metabolism, 44(4)*, 420-424. Effects of order of resistance training exercises on muscle hypertrophy in ...: UMGC Library OneSearch

[4] Bell, L., Nolan, D., Immonen, V., Helms, E., Dallamore, J., Wolf, M., & Androulakis Korakakis, P. (2022). "you can't shoot another bullet until you've reloaded the gun": Coaches' perceptions, practices and experiences of deloading in strength and Physique Sports. *Frontiers in Sports and Active Living*, *4*. https://doi.org/10.3389/fspor.2022.1073223

[5] Bertucci, D. R., & Ferraresi, C. (2016). *Strength Training: Methods, Health Benefits and Doping.* Nova Science Publishers. https://eds-s-ebscohost-com.ezproxy.umgc.edu/eds/ebookviewer/ebook/bmxlYmtfXzExMzQ0NTZfX0FO0?sid=b5e6955f-8aa1-4fff-906c-5bba28f3d5d2@redis&vid=1&format=EB&rid=1

[6] Bryant, C. X., & Green, D. J. (2017). *Ace Essentials of Exercise Science for Fitness Professionals*. American Council on Exercise.

[7] Convertino, Victor & Armstrong, Lawrence & Coyle, Edward & Mack, Gary & Sawka, Michael & Senay, Leo & Sherman, W.. (1996). ACSM Position Stand: Exercise and Fluid Replacement. Medicine & Science in Sports & Exercise. 28. i-ix. 10.1097/00005768-199610000-00045.

[8] Dewar, M. (2023, August 31). *The ultimate guide to weightlifting belts (and how to use them properly)*. BarBend. https://barbend.com/how-to-wear-weightlifting-belt/

[9] Dewar, M. (2023, October 25). *Active recovery: What is it, benefits, & workout ideas*. BarBend. https://barbend.com/structure-active-recovery-days/

[10] Dolezal, B. A., Neufeld, E. V., Boland, D. M., Martin, J. L., & Cooper, C. B. (2017). Interrelationship between sleep and exercise: A systematic review. *Advances in Preventive Medicine*, *2017*, 1–14. https://doi.org/10.1155/2017/1364387

[11] Dshell. (2022, February 11). *Lifting chalk guide: Application, benefits, Liquid Chalk, & more*. Barbell Logic. https://barbell-logic.com/lifting-chalk-guide/#:~:text=Lifting%20chalk%20is%20magnesium%20carbonate,and%20effectively%20strengthening%20your%20grip.

[12] Dupuy, O., Douzi, W., Theurot, D., Bosquet, L., & Dugué, B. (2018). An evidence-based approach for choosing post-exercise recovery techniques to reduce markers of muscle damage, soreness, fatigue, and inflammation: A systematic review with meta-analysis. *Frontiers in Physiology*, *9*. https://doi.org/10.3389/fphys.2018.00403

[13] Eckelkamp, S. (2023). *Could a cold plunge speed up your workout recovery?*. Cold Plunges: Benefits, Risks, And the Science of Cold Water Immersion | The Output by Peloton. https://www.onepeloton.com/blog/cold-plunge-benefits/

[14] Efferding, S., & McCune, D. (2021). *The vertical diet*. Victory Belt Publishing.

[15] Elliott, K. (n.d.). *Weight training and chiropractic: More gains, less pain*. TheJoint.com. https://www.thejoint.com/arizona/tucson/rillito-crossing-marketplace-48034/189994-weight-training-chiropractic-more-gains-less-pain

[16] Evangelista, A. L., Braz, T. V., La Scala Teixeira, C. V., Rica, R. L., Alonso, A. C., Barbosa, W. A., Reis, V. M., Baker, J. S., Schoenfeld, B. J., Bocalini, D. S., & D'andrea Greve, J. M. (2021). Split or full-body workout routine: which is best to increase muscle strength and hypertrophy? *Einstein (São Paulo), 19*. http://ezproxy.umgc.edu/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=edsdoj&AN=edsdoj.0ebdad8a623c4bab819e9de364dc0051&site=eds-live&scope=site

[17] *Fiber*. Linus Pauling Institute. (2023, September 8). https://lpi.oregonstate.edu/mic/other-nutrients/fiber#classification-systems

[18] *Fiber*. The Nutrition Source. (2023, February 2). https://www.hsph.harvard.edu/nutritionsource/carbohydrates/fiber/

[19] *Fitness & Exercise Equipment for the Gym: Iron Bull Strength*. Iron Bull Strength - USA. (n.d.). https://ironbullstrength.com/
[20] Forbes Magazine. (2023, October 12). *How much water you should drink a day, according to experts*. Forbes. https://www.forbes.com/health/body/how-much-water-you-should-drink-per-day/
[21] Ghazzawi, H. A., Hussain, M. A., Raziq, K. M., Alsendi, K. K., Alaamer, R. O., Jaradat, M., Alobaidi, S., Al Aqili, R., Trabelsi, K., & Jahrami, H. (2023). Exploring the relationship between micronutrients and athletic performance: A comprehensive scientific systematic review of the literature in sports medicine. *Sports*, *11*(6), 109. https://doi.org/10.3390/sports11060109
[22] Green, A., Westcombe, A., (2012). *Sleep: Multi-Professional Perspectives*. Jessica Kingsley Publishers.
[23] Grgic, J., Schoenfeld, B. J., & Latella, C. (2019). Resistance training frequency and skeletal muscle hypertrophy: A review of available evidence. *Journal of Science & Medicine in Sport, 22*(3), 361-370. http://ezproxy.umgc.edu/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=ccm&AN=134213920&site=eds-live&scope=site
[24] He, F., Chen, C., Li, F., Qi, Y., Lin, X., Liang, P., Ren, M., & Yan, L. (2021a, March 22). *An optimal glycemic load range is better for reducing obesity and diabetes risk among middle-aged and elderly adults - nutrition & metabolism*. BioMed Central. https://nutritionandmetabolism.biomedcentral.com/articles/10.1186/s12986-020-00504-5
[25] *How much water do you need?*. Academy of Nutrition and Dietetics: eatright.org. (n.d.). https://www.eatright.org/health/essential-nutrients/water/how-much-water-do-you-need
[26] *How much water should I drink a day?*. Harvard Health. (2023, May 22). https://www.health.harvard.edu/staying-healthy/how-much-water-should-you-drink
[27] *How to calculate how much water you should drink*. How to calculate how much water you should drink | University of Missouri System. (n.d.). https://www.umsystem.edu/totalrewards/wellness/how-to-calculate-how-much-water-you-should-drink#:~:text=Your%20weight%20is%20one%20variable,amount%20in%20ounces%20of%20water.
[28] Huberman, A. (2023, October 8). *The Science & Use of Cold Exposure for Health & Performance*. Huberman Lab. https://www.hubermanlab.com/newsletter/the-science-and-use-of-cold-exposure-for-health-and-performance
[29] Institute of Medicine. 2006. *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements*. Washington, DC: The National Academies Press. https://doi.org/10.17226/11537.
[30] Kai, J. T. (2010). *Strength Training: Types and Principles, Benefits and Concerns.* Nova Science Publishers. https://eds-s-ebscohost-com.ezproxy.umgc.edu/eds/ebookviewer/ebook/bmxlYmtfXzM1Mjc1MV9fQU41?sid=b5e6955f-8aa1-4fff-906c-5bba28f3d5d2@redis&vid=3&format=EB&rid=2
[31] Krzysztofik, M., Wilk, M., Wojdala, G., & Golas, A. (2019). Maximizing Muscle Hypertrophy: A Systematic Review of Advanced Resistance Training Techniques and Methods. *International Journal of Environmental Research and Public Health, 16*(24). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6950543/
[32] *Learn about the glycemic index (GI)*. Glycemic Index Guide. (2023, June 16). https://glycemic-index.net/
[33] Leech, J. (2017, June 4). *Good fiber, bad fiber - how the different types affect you*. Healthline. https://www.healthline.com/nutrition/different-types-of-fiber
[34] Madarame, H., Neya, M., Ochi, E., Nakazato, K., Sato, Y., & Ishii, N. (2008). Cross-transfer effects of resistance training with blood flow restriction. *Medicine and Science in Sports and Exercise, 40*(2), 258-263. https://pubmed.ncbi.nlm.nih.gov/18202577/
[35] Mahaffey, K. (n.d.). *Active recovery workouts: What to do on your rest day*. NASM. https://blog.nasm.org/active-recovery
[36] Mayo Foundation for Medical Education and Research. (2022, October 12). *How much water do you need to stay healthy?*. Mayo Clinic. https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/water/art-20044256
[37] McCracken, J., (2021). The Importance of Sleep and How to Get It. *Tennessee Bar Journal*, *57*(6), 38 42. Retrieved from http://ezproxy.umgc.edu/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=asn&AN=153807861&site=eds-live&scope=site
[38] Muth, N. D., & Tanaka, M. S. (2013). *Ace Fitness Nutrition Manual*. American Council on Exercise.
[39] Muth, N. D., & Zive, M. M. (2020). *Sports nutrition for health professionals* (2nd ed.). F.A. Davis.
[40] *My food data - free nutrition tools to understand what you eat*. myfooddata. (n.d.). https://www.myfooddata.com/
[41] National Academies of Sciences, Engineering, and Medicine. 2005. Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate. Washington, DC: The National Academies Press. https://doi.org/10.17226/10925.

[42] National Academies of Sciences, Engineering, and Medicine. 2019. *Dietary Reference Intakes for Sodium and Potassium*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25353.
[43] National Academies of Sciences, Engineering, and Medicine. 2023. *Dietary Reference Intakes for Energy*. Washington, DC: The National Academies Press. https://doi.org/10.17226/26818.
[44] *No need to avoid healthy omega-6 fats*. Harvard Health. (2019, August 20). https://www.health.harvard.edu/newsletter_article/no-need-to-avoid-healthy-omega-6-fats
[45] *Omega-6 fatty acids*. Mount Sinai Health System. (n.d.). https://www.mountsinai.org/health-library/supplement/omega-6-fatty-acids
[46] Padilla, S. (2022, May 18). *Do you need squat shoes for squatting?*. SoCal Powerlifting. https://www.socalpowerlifting.net/post/do-you-need-squat-shoes-for-squatting#:~:text=A%20squat%20shoe%20refers%20to,and%20model%20of%20the%20shoe.
[47] Petrofsky, J. S., Khowailed, I. A., Lee, H., Berk, L., Bains, G. S., Akerkar, S., Shah, J., Al-Dabbak, F., & Laymon, M. S. (2015). Cold vs. heat after exercise—is there a clear winner for muscle soreness. *Journal of Strength and Conditioning Research*, *29*(11), 3245–3252. https://doi.org/10.1519/jsc.0000000000001127
[48] Pilon, R. (2023, August 11). *Do you need lifting straps? 5 benefits & 3 drawbacks explained*. GYMREAPERS. https://www.gymreapers.com/blogs/news/do-you-need-lifting-straps#:~:text=Lifting%20straps%20are%20mainly%20used,to%20failure%20to%20encourage%20hypertrophy.
[49] Rippetoe, M. (2011). *Starting strength: Basic barbell training*. The Aasgaard Company.
[50] Rippetoe, M., Baker, A., & Bradford, S. E. (2013). *Practical Programming for strength training* (3rd ed.). Aasgaard Company.
[51] Robbins, A., Diamandis, P., & Hariri, R. (2022). *Life force: How new breakthroughs in precision medicine can transform the quality of Your Life & Those You Love*. Simon & Schuster.
[52] Rønnestad, B. R., Nygaard, H., & Raastad, T. (2011). Physiological elevation of endogenous hormones results in superior strength training adaptation. *European Journal of Applied Physiology, 111*(9), 2249-2259. https://pubmed.ncbi.nlm.nih.gov/21327794/
[53] *Selectorized (pin loaded) strength equipment for sale*. www.fitnesssuperstore.com. (n.d.). https://www.fitnesssuperstore.com/Selectorized-Pin-Loaded-s/1832.htm
[54] Spritzler, F. (2023, January 26). *The 7 best types of protein powder*. Healthline. https://www.healthline.com/nutrition/best-protein-powder#3.-Egg-protein
[55] Stoppani, J., PhD. (2018, September 19). *3 key benefits of wearing a weightlifting belt*. Bodybuilding.com. https://www.bodybuilding.com/content/3-key-benefits-of-wearing-a-weightlfting-belt.html
[56] *There's more than one whey to build muscle*. MYPROTEIN. (2021, November 5). https://us.myprotein.com/thezone/supplements/9-best-whey-protein-alternatives/
[57] *Types of resistance training equipment*. Human Kinetics. (n.d.). https://us.humankinetics.com/blogs/excerpt/types-of-resistance-training-equipment#:~:text=Additionally%2C%20selectorized%20machines%20provide%20the,loaded%20machines%20and%20free%20weights.&text=As%20compared%20with%20selectorized%2C%20plate,via%20conventional%20free%2Dweight%20plates.
[58] U.S. Department of Health and Human Services. (n.d.). *Chiropractic: In depth*. National Center for Complementary and Integrative Health. https://www.nccih.nih.gov/health/chiropractic-in-depth
[59] *Water*. The Nutrition Source. (2021, July 6). https://www.hsph.harvard.edu/nutritionsource/water/#:~:text=General%20recommendations,exposed%20to%20very%20warm%20climates.
[60] *Web pages*. BRITA RO+UV Water Purifier. (n.d.). https://www.brita.in/experience-brita/personal-hydration-needs
[61] Westcott, W. L. (2020). *Strength Training Essentials.* Healthy Learning.
[62] Zainuddin Z, Newton M, Sacco P, Nosaka K. Effects of massage on delayed-onset muscle soreness, swelling, and recovery of muscle function. J Athl Train. 2005 Jul-Sep;40(3):174-80. PMID: 16284637; PMCID: PMC1250256.
[63] Zinczenko, D., & Spiker, T. (2010). *The new ABS diet: The six-week plan to flatten your belly and firm up your body for life*. Rodale Press.

Appendix A

A.1 Dietary Reference Intakes (DRIs).

Dietary reference intakes (DRIs) are a comprehensive set of scientifically developed reference values for nutrients. DRIs provide the scientific basis for nutrition professionals, governments, and non-governmental organizations to carry out activities such as:

- ✓ Developing nutrition labels
- ✓ Developing dietary guidelines and food guides
- ✓ Ensuring foods and supplements contain safe levels of nutrients
- ✓ Creating patient and consumer counseling and educational programs
- ✓ Assessing nutrient intakes and monitoring the nutritional health of the population

There is a set of different values for each nutrient, each with different uses, depending on the application. Most nutrients have several DRI values. Each type of DRI refers to the average daily nutrient intake for the general population over time. Definitions of the different DRIs provide further details about each of these values. Values related to meeting nutritional requirements, preventing excessive intakes, and reducing chronic disease risk are:

- ✓ Estimated energy requirement (EER)
- ✓ Recommended dietary allowance (RDA)
- ✓ Adequate intake (AI)
- ✓ Tolerable upper intake level (UL)
- ✓ Acceptable macronutrient distribution range (AMDR)

The EER and AMDR have already been covered in Chapter 1, Sections 1.1 and 1.3. The RDAs, AIs, and ULs of vitamins and minerals are presented in the following tables.

Recommended Dietary Allowance. The RDA is the daily dietary intake of a nutrient known to meet the nutritional needs of 97 percent of healthy persons in age- and gender-specific groups.

Adequate Intake. The AI is used when an RDA cannot be established. Adequate intake is a recommended nutrient intake level that appears to be sufficient for good health based on research.

Tolerable Upper Intake Level. This is the maximum intake that is unlikely to pose risk of adverse health effects to almost all individuals in an age- and gender-specific group.

Table A-1. Fat-Soluble Vitamin Facts [6, 29, 38, 39].

Vitamin	RDA/AI/UL			
	Men	Women		
A	(19-70 yrs.) RDA: 900 µg UL: 3,000 µg	(19-70 yrs.) RDA: 700 µg UL: 3,000 µg	Function	Formation/maintenance of skin, hair, and mucous membranes; helps people see in dim light; bone/tooth growth
			Food Sources	Yellow or orange fruits and vegetables, green leafy vegetables, fortified oatmeal, liver, dairy products
D	(19-70 yrs.) RDA: 15 µg UL: 100 µg	(19-70 yrs.) RDA: 15 µg UL: 100 µg	Function	Aids in bone and tooth formation; helps maintain heart action and nervous system function
			Food Sources	Fortified milk, sunlight, fish, eggs, butter, fortified margarine
E	(19-70 yrs.) RDA: 15 mg UL: 1,000 mg	(19-70 yrs.) RDA: 15 mg UL: 1,000 mg	Function	Protects blood cells, body tissue, and essential fatty acids from destruction in the body
			Food Sources	Fortified and multigrain cereals, nuts, wheat germ, vegetable oils, green leafy vegetables
K	(19-70 yrs.) AI: 120 µg UL: Unknown	(19-70 yrs.) AI: 90 µg UL: Unknown	Function	Essential for blood-clotting functions
			Food Sources	Green leafy vegetable, fruit, dairy, grain products

Note: RDA = Recommended Dietary Allowance; AI = Adequate Intake; UL = Tolerable Upper Intake Level; µg = micrograms; mg = milligrams

Table A-2. Water-Soluble Vitamin Facts [6, 29, 38, 39].

Vitamin	RDA/AI/UL			
	Men	Women		
B1 or Thiamin	(19-70 yrs.) RDA: 1.2 mg UL: Unknown	(19-70 yrs.) RDA: 1.1 mg UL: Unknown	Function	Helps the body release energy from carbs during metabolism; growth and muscle tone
			Food Sources	Fortified cereals and oatmeal, meats, rice and pasta, whole grains, liver
B2 or Riboflavin	(19-70 yrs.) RDA: 1.3 mg UL: Unknown	(19-70 yrs.) RDA: 1.1 mg UL: Unknown	Function	Helps the body release energy from protein, fat, and carbs during metabolism
			Food Sources	Whole grains, green leafy vegetables, organ meats, milk, eggs
B3 or Niacin	(19-70 yrs.) RDA: 16 mg UL: 35 mg	(19-70 yrs.) RDA: 14 mg UL: 35 mg	Function	Involved in carb, protein, and fat metabolism
			Food Sources	Meat, poultry, fish, enriched cereals, peanuts, potatoes, dairy products, eggs
B5 or Pantothenic Acid	(19-70 yrs.) AI: 5 mg UL: Unknown	(19-70 yrs.) AI: 5 mg UL: Unknown	Function	Helps release energy from fats and vegetables
			Food Sources	Lean meats, whole grains, legumes, vegetables, fruits
B6 or Pyridoxine	(19-50 yrs.) RDA: 1.3 mg UL: 100 mg (51-70 yrs.) RDA: 1.7 mg UL: 100 mg	(19-50 yrs.) RDA: 1.3 mg UL: 100 mg (51-70 yrs.) RDA: 1.5 mg UL: 100 mg	Function	Helps build body tissue and aids in metabolism of protein
			Food Sources	Fish, poultry, lean meats, bananas, prunes, dried beans, whole grains, avocados
B7 or Biotin	(19-70 yrs.) AI: 30 µg UL: Unknown	(19-70 yrs.) AI: 30 µg UL: Unknown	Function	Involved in metabolism of protein, fats, and carbs
			Food Sources	Cereal/grain products, yeast, legumes, liver
B9 or Folate	(19-70 yrs.) RDA: 400 µg UL: 1,000 µg	(19-70 yrs.) RDA: 400 µg UL: 1,000 µg	Function	Aids in genetic material development; involved in red blood cell production
			Food Sources	Green leafy vegetables, organ meats, dried peas, beans, lentils
B12 or Cobalamin	(19-70 yrs.) RDA: 2.4 µg UL: Unknown	(19-70 yrs.) RDA: 2.4 µg UL: Unknown	Function	Aids cell development, functioning of the nervous system, and the metabolism of protein and fat
			Food Sources	Meat, milk products, seafood
C	(19-70 yrs.) RDA: 90 mg UL: 2,000 mg	(19-70 yrs.) RDA: 75 mg UL: 2,000 mg	Function	Essential for structure of bones, cartilage, muscle, and blood vessels; helps maintain capillaries and gums and aids in absorption of iron; promotes resistance to infection
			Food Sources	Citrus fruits, berries, and vegetables (especially peppers)
Choline	(19-70 yrs.) AI: 550 mg UL: 3,500 mg	(19-70 yrs.) AI: 425 mg UL: 3,500 mg	Function	A precursor of acetylcholine; essential for liver function
			Food Sources	Milk, liver, eggs, peanuts

Note: RDA = Recommended Dietary Allowance; AI = Adequate Intake; UL = Tolerable Upper Intake Level; µg = micrograms; mg = milligrams

Table A-3. Mineral Facts [6, 29, 38, 39, 42].

Mineral	RDA/AI/UL			
	Men	Women		
Calcium	(19-50 yrs.) RDA: 1,000 mg UL: 2,500 mg (51-70 yrs.) RDA: 1,000 mg UL: 2,000 mg	(19-50 yrs.) RDA: 1,000 mg UL: 2,500 mg (51-70 yrs.) RDA: 1,200 mg UL: 2,000 mg	Function	Important for healthy bones, teeth, and muscle tissue; regulates heartbeat, muscle action, and nerve function; blood clotting, blood pressure
			Food Sources	Milk and milk products; canned fish with bones (salmon, sardines); greens (broccoli, mustard greens); legumes
Chloride	(19-50 yrs.) AI: 2,300 mg UL: 3,600 mg (51-70 yrs.) AI: 2,000 mg UL: 3,600 mg	(19-50 yrs.) AI: 2,300 mg UL: 3,600 mg (51-70 yrs.) AI: 2,200 mg UL: 3,600 mg	Function	Fluid balance; maintains proper pH levels, stimulates stomach acid; muscle and nerve function
			Food Sources	Table salt; occurs naturally in meat and seafood (shrimp, seaweed); additive in processed foods (deli meats, hot dogs, cheese, potato chips, soy sauce, ketchup)
Chromium	(19-50 yrs.) AI: 35 µg UL: Unknown (51-70 yrs.) AI: 30 µg UL: Unknown	(19-50 yrs.) AI: 25 µg UL: Unknown (51-70 yrs.) AI: 20 µg UL: Unknown	Function	Glucose metabolism (energy); increases effectiveness of insulin
			Food Sources	Corn oil, clams, liver, whole-grain cereals, brewer's yeast, nuts, cheese
Copper	(19-70 yrs.) RDA: 0.9 mg UL: 10 mg	(19-70 yrs.) RDA: 0.9 mg UL: 10 mg	Function	Formation of red blood cells; bone growth and health; works with vitamin C to form elastin
			Food Sources	Oysters, nuts, organ meats, legumes
Fluoride	(19-70 yrs.) AI: 4,000 µg UL: 10,000 µg	(19-70 yrs.) AI: 3,000 µg UL: 10,000 µg	Function	Stimulates bone formation; helps prevent tooth decay
			Food Sources	Fluorinated water, teas, marine fish
Iodine	(19-70 yrs.) RDA: 150 µg UL: 1,100 µg	(19-70 yrs.) RDA: 150 µg UL: 1,100 µg	Function	Found in thyroid hormone, which helps regulate growth, development, and metabolism
			Food Sources	Seafood, iodized salt
Iron	(19-50 yrs.) RDA: 8 mg UL: 45 mg (51-70 yrs.) RDA: 8 mg UL: 45 mg	(19-50 yrs.) RDA: 18 mg UL: 45 mg (51-70 yrs.) RDA: 8 mg UL: 45 mg	Function	Hemoglobin formation; improves blood quality; increases resistance to stress and disease
			Food Sources	Organ meats, red meats, fish, poultry, shellfish (clams), egg yolks, legumes, dried fruits, dark leafy greens, iron-enriched breads and cereals, and fortified cereals
Magnesium	(19-30 yrs.) RDA: 400 mg UL: 350 mg* (31-70 yrs.) RDA: 420 mg UL: 350 mg*	(19-30 yrs.) RDA: 310 mg UL: 350 mg* (31-70 yrs.) RDA: 320 mg UL: 350 mg*	Function	Acid/alkaline balance; important in carb, mineral and sugar metabolism; needed for making protein, muscle contraction, nerve transmission, immune system health
			Food Sources	Nuts and seeds, legumes, leafy green vegetables, whole grains, seafood, chocolate, artichokes
Manganese	(19-70 yrs.) AI: 2.3 mg UL: 11 mg	(19-70 yrs.) AI: 1.8 mg UL: 11 mg	Function	Enzyme activation; carb and fat production; sex hormone production; skeletal development
			Food Sources	Nuts, whole grains, vegetables, fruits

Note: RDA = Recommended Dietary Allowance; AI = Adequate Intake; UL = Tolerable Upper Intake Level;
µg = micrograms; mg = milligrams
*The UL for magnesium is 350 mg from supplements only. Extra magnesium from food is safe.

Table A-3 (continued).

Mineral	RDA/AI/UL			
	Men	Women		
Molybdenum	(19-70 yrs.) RDA: 45 µg UL: 2,000 µg	(19-70 yrs.) RDA: 45 µg UL: 2,000 µg	Function	Functions as a cofactor for a limited number of enzymes in humans
			Food Sources	Legumes, breads and grains, nuts, leafy greens and vegetables, milk, liver
Phosphorus	(19-70 yrs.) RDA: 700 mg UL: 4,000 mg	(19-70 yrs.) RDA: 700 mg UL: 4,000 mg	Function	Bone development; important in protein, fat, and carb utilization
			Food Sources	Fish, meat, poultry, eggs, grains, milk
Potassium	(19-70 yrs.) AI: 3,400 mg UL: Unknown	(19-70 yrs.) AI: 2,600 mg UL: Unknown	Function	Fluid balance; controls activity of heart muscle, nervous system, and kidneys
			Food Sources	Lean meat, vegetables, fruits
Selenium	(19-70 yrs.) RDA: 55 µg UL: 400 µg	(19-70 yrs.) RDA: 55 µg UL: 400 µg	Function	Protects body tissues against oxidative damage from radiation, pollution, and normal metabolic processing
			Food Sources	Seafood, organ meats, lean meats, grains
Sodium	(19-70 yrs.) AI: 1,500 mg UL: Unknown	(19-70 yrs.) AI: 1,500 mg UL: Unknown	Function	Fluid balance; controls blood pressure and blood volume; muscle and nerve function
			Food Sources	Table salt; occurs naturally in milk, beets, celery, water; added to processed meats, baked goods, and fast foods
Sulfur	RDA: Unknown AI: Unknown UL: Unknown	RDA: Unknown AI: Unknown UL: Unknown	Function	Important component of two amino acids (cystine and methionine); three vitamins (B1, B5, and B7); and heparin, an anticoagulant found in the liver and other tissues
			Food Sources	Meat, poultry, fish, eggs, dried beans, broccoli, cauliflower
Zinc	(19-70 yrs.) RDA: 11 mg UL: 40 mg	(19-70 yrs.) RDA: 8 mg UL: 40 mg	Function	Involved in digestion and metabolism; important in development of reproductive system; aids in wound healing; needed for making protein and genetic material; immune system health
			Food Sources	Lean meats, fish, poultry, liver, eggs, seafood, whole grains

Note: RDA = Recommended Dietary Allowance; AI = Adequate Intake; UL = Tolerable Upper Intake Level; µg = micrograms; mg = milligrams

Table A-4. Summary of Primary Micronutrients Researched in Sports Medicine [21, 39].

Micro-nutrient	Role in Exercise Performance	Deficiency Effect on Performance	Top Rich Food Sources
Vitamin A	Protects cells from free radicals' damage produced during exercise, lowering aches and fatigue.	Vitamin A has an oxidation potency which protects athletes against induced and intense exercise free radicals, contributes to the elimination of ROS, and prevents muscle damage and the onset of diseases, despite the higher demand for vitamin A in athletes. Its deficiency is not directly linked to performance impairment, unlike other micronutrients such as iron and others.	Beef liver, sweet potato, carrot
	Improves response time and muscle recovery, as it supports protein synthesis, which is a necessity for muscle growth and recovery.		
	Protects against injuries by increasing healing times and promoting the formation of healthy connective tissues.		
Vitamin D	It attenuates inflammation, myopathy, and pain while boosting muscle protein synthesis, ATP percentage, and jump height.	Deficient vitamin D concentration seems to have an unpleasant influence on muscle power, strength, and stamina and elevated musculoskeletal damage, including stress fracture and other injuries impacting inflammation and severe muscle injuries occurring post-intensive exercises.	Brown mushrooms oily fish (salmon, sardines, cod liver oil)
	Strength, speed, exercise capability, and physical endurance.		
	Musculoskeletal strain avoidance and recovery.		
Vitamin E	Protects body from oxidative stress.	Decreased performance, recovery, immunity, and blood flow.	Sunflower seeds, almonds, cereals ready to eat
	Increases the body's natural immunity and promotes recovery.		
	Improves blood flow and increases cardiovascular functions.		
Vitamin K	Vitamin K implies its anabolic influence on the bone turnover in several parts including, the regulation of specific gene transcription in osteoblasts, osteoblast differentiation initiation, and activating the bone-associated vitamin K-dependent proteins which play critical roles in the mineralization of the bone matrix and activating vitamin K-dependent proteins, which has an important role in extracellular bone matrix mineralization.	Insufficient consumption of vitamin K may be associated with a raised fracture risk.	Kale, spinach, parsley
B1 or Thiamin	Necessary for the metabolism of amino acids and carbohydrates for nucleic acid precursors development, myelin, and neurotransmitters	Increased oxidative stress	Fortified breakfast cereals, bacon, sunflower seed
B2 or Riboflavin	Helps the body release energy from protein, fat, and carbs during metabolism.	Does not have an effect on athletic performance.	Dairy products, meat, egg
B3 or Niacin	Lowers lipid levels by increasing homocysteine levels.	Muscle weakness, anorexia, indigestion, and skin abnormalities.	Whole grains, dairy products, milk, and meat
	Assists with redox processes and with amino acid, lipid, and carb metabolism.		
B5 or Pantothenic Acid	Improves aerobic performance.	No proven benefit, so deficiency does not cause any effect.	Lean meats, whole grains, legumes, vegetables, fruits
B6 or Pyridoxine	Increase muscular growth, strength, and aerobic capacity in the lactic acid and oxygen systems. Relaxing effect increased mental power.	No effect.	Fish, beef liver, and other organ meats
B9 or Folate	Crucial for proper brain functioning and works in combination with vitamin B12 in forming red blood cells and supporting iron in performing properly.	Megaloblastic anemia, impairing red blood cells, tingling in hands and feet, tiredness, fatigue, weakness, loss of coordination, and weight loss.	Dark green leafy vegetables, fruits, nuts, and beans

Micro-nutrient	Role in Exercise Performance	Deficiency Effect on Performance	Top Rich Food Sources
B12 or Cobalamin	Essential for the synthesis of DNA and serotonin, required for protein and red blood cell production, enhances muscular mass and blood oxygen carrying capacity, and lessens anxiety.	May cause higher odds of anxiety.	Fish, meat, poultry, eggs
Vitamin C	Antioxidant, wound healing and collagen production, boosts energy, and protects from illness and injury. Produces collagen, which strengthens joints and muscles.	May have a higher chance of getting sick and missing performances; increased wound repair time.	Citrus fruits, tomatoes, green peppers, kiwifruit
Calcium	Since calcium ion could move through and out of a cell's cytoplasm, it has an essential role in signaling for various process in the cell, including muscle contraction, exocytosis, proliferation of action potentials through cardiac muscle, and neurotransmitter release.	Calcium plays a crucial role in maintenance, growth regulating muscle contraction, normal blood clotting, and the conduction of nerve and bone tissue repair. The possibility of stress fracture and low bone-mineral density is elevated by low available levels of energy. In certain cases, such as female athletes, insufficient calcium intake combined with menstrual dysfunction increases the risk ratio.	Dairy products, sardines and salmon, kale, broccoli
Iron	Iron is a key component in a variety of physiological functions that impact athletes' physical performance. Due to the number of iron-dependent proteins and enzymes affecting energy production in mitochondria and the oxygen delivered to the muscles. Oxygen-carrying capacity and mitochondrial oxidative phosphorylation activity, which is determined by the hemoglobin mass, skeletal muscle, and maximal oxygen consumption.	Iron deficiency, whether combined with anemia or not, can lead to muscle impaired function and limited endurance capacity, which affect athletic performance and training adaptation negatively.	Lean meat and seafood, nuts, beans
Magnesium	Magnesium is an important mineral with an essential impact on the human body. It plays a crucial part in maintaining proper muscle functioning and energy metabolism; several studies assessed the relation between Mg status/supplementation and exercise performance and found a direct correlation between magnesium demand and raised levels of physical activity.	Athletes who are insufficient in magnesium levels are not protected from inflammatory reactions, which may increase the risk of hypertension, atherosclerosis, diabetes mellitus, osteoporosis, and cancer occurrence.	Whole grains and dark-green, leafy vegetables, dried beans, and legumes
Manganese	Manganese is an essential nutrient necessary for energy metabolism and in antioxidant enzymes that protect cells from damage due to free radicals.	The deficiency of manganese is indicated as an etiological agent in joint diseases and hip abnormalities development.	Whole grains, oysters, mussels, nuts.
Potassium	Potassium is a major source of energy for athletes. It helps to reduce the amount of lactic acid stored in the muscles, which can lead to fatigue as well as maintain a healthy metabolism. Potassium is also involved in the breakdown of carbohydrates, which helps to keep energy levels high during intense physical activity.	Whole body and muscle fatigue, resulting diminished athletic performance.	Dried fruits (raisins, apricots) beans, lentils, potatoes

Micro-nutrient	Role in Exercise Performance	Deficiency Effect on Performance	Top Rich Food Sources
Selenium	Selenium in glutathione peroxidase aids in allergies and inflammatory diseases elimination, defending the muscles and the cardiovascular system.	Insufficient selenium levels may raise exercise-induced oxidative stress over time.	Brazil nuts, seafoods, and organ meats
Zinc	Zinc has an advantageous effect on performance improvement by participating in muscle energy production, recruiting fast twitch muscle fibers and protein synthesis, which is necessary for physical performance.	Deficient zinc levels in athletes reduces endurance, leading to a significant reduction in body weight, and latened fatigue with impaired endurance and osteoporosis risk.	Meat, fish, seafood

A.2 Food Information.

The following tables highlight the kinds of foods that will ensure you are meeting your daily macro- and micronutrient requirements and should help you select the appropriate foods regardless of dietary restrictions. Food information was obtained from source [40] *My food data*.

Macronutrients

Table A-5. Top 10 Foods Highest in Omega 3 Fatty Acids
Table A-6. Top 10 Foods Highest in Protein
Table A-7. Top 10 Healthy High Fat Foods
Table A-8. Top 10 Healthy High Carb Foods
Table A-9. Top 10 Foods Highest in Fiber
Table A-10. Top 10 Complete Vegetarian Protein Foods with All the Essential Amino Acids[1]
Table A-11. Top 10 Beans and Legumes Highest in Protein[1]
Table A-12. Top 10 Seeds and Nuts Highest in Protein[1]
Table A-13. Top 10 Vegan Sources of Protein[2]

Micronutrients

Vitamins

Table A-14. Top 10 Foods Highest in Vitamin A
Table A-15. Top 10 Foods Highest in Vitamin D
Table A-16. Top 10 Foods Highest in Vitamin E
Table A-17. Top 10 Foods Highest in Vitamin K
Table A-18. Top 10 Foods Highest in Vitamin B1 (Thiamin)
Table A-19. Top 10 Foods Highest in Vitamin B2 (Riboflavin)
Table A-20. Top 10 Foods Highest in Vitamin B3 (Niacin)
Table A-21. Top 10 Foods Highest in Vitamin B5 (Pantothenic Acid)
Table A-22. Top 10 Foods Highest in Vitamin B6 (Pyridoxine)
Table A-23. Top 10 Foods Highest in Vitamin B7 (Biotin)
Table A-24. Top 10 Foods Highest in Vitamin B9 (Folate)
Table A-25. Top 10 Foods Highest in Vitamin B12 (Cobalamin)
Table A-26. Top 10 Foods Highest in Vitamin C
Table A-27. Top 10 Foods Highest in Choline

Minerals

Table A-28. Top 10 Foods Highest in Calcium
Table A-29. Top 10 Foods Highest in Chromium
Table A-30. Top 10 Foods Highest in Copper
Table A-31. Top 10 Foods Highest in Fluoride
Table A-32. Top 10 Foods Highest in Iodine
Table A-33. Top 10 Foods Highest in Iron
Table A-34. Top 10 Foods Highest in Magnesium
Table A-35. Top 10 Foods Highest in Manganese
Table A-36. Top 10 Foods Highest in Molybdenum
Table A-37. Top 10 Foods Highest in Phosphorus
Table A-38. Top 10 Foods Highest in Potassium
Table A-39. Top 10 Foods Highest in Selenium
Table A-40. Top 10 Foods Highest in Sodium[3]
Table A-41. Top 10 Foods Highest in Zinc

Footnotes

1) Vegetarian protein foods include tofu, beans, lentils, yogurt, milk, cheese, green peas, nuts, seeds, whole grains, peanut butter, eggs, and white button mushrooms.
2) Vegan protein foods are similar to vegetarian sources, but exclude yogurt, milk, cheese, and eggs, because vegans do not eat any foods that originate from animals.
3) Table salt is sodium chloride. Sodium and chloride together act as electrolytes to balance fluid levels in the body.

Macronutrients

Table A-5. Top 10 Foods Highest in Omega-3 Fatty Acids.

Food	% AI (Grams) per Serving	Calories (kcal)
1. Flax seeds	405% AI (6.48g) per oz.	152
2. Chia seeds	316% AI (5.06g) per oz. (2 tbsp.)	138
3. Fish (farmed Atlantic salmon)	246% AI (3.94g) per 6 oz.	350
4. Walnuts	161% AI (2.58g) per oz.	186
5. Firm tofu	92% AI (1.47g) per cup	363
6. Canola oil	80% AI (1.28g) per tbsp.	124
7. Shellfish (oysters)	75% AI (1.20g) per 3 oz.	139
8. Navy (haricot) beans	20% AI (0.32g) per cup	255
9. Brussels sprouts	17% AI (0.27g) per cup cooked	56
10. Avocados	16% AI (0.25g) per avocado	322

Note: 2g of Omega-3s = 100% of the Adequate Intake (% AI)

Table A-6. Top 10 Foods Highest in Protein.

Food	% DV (Grams) per Serving	Calories (kcal)
1. Lean chicken breast	109% DV (54.5g) per 6 oz.	267
2. Lean pork chops	105% DV (52.7g) per 6 oz.	332
3. Tuna	102% DV (50.8g) per 6 oz.	313
4. Beef (skirt steak)	97% DV (48.7g) per 6 oz.	456
5. Firm tofu	87% DV (43.5g) per cup	363
6. Lentils	36% DV (17.9g) per cup	230
7. Low-fat yogurt	28% DV (14.0g) per cup	137
8. Grated parmesan	20% DV (10.2g) per oz.	111
9. Squash and pumpkin seeds	17% DV (8.5g) per oz.	163
10. Eggs	13% DV (6.3g) per large egg	78

Note: 50g of Protein = 100% of the Daily Value (% DV)

Table A-7. Top 10 Healthy High Fat Foods.

Food	% DV (Grams) per Serving	Calories (kcal)
1. Avocados	38% DV (29g) per avocado	322
2. Tofu	28% DV (22g) per cup	363
3. Macadamia nuts	28% DV (22g) per oz.	204
4. Fish (farmed Atlantic salmon)	27% DV (21g) per 6 oz.	350
5. Peanut butter	21% DV (16g) per 2 tbsp.	191
6. Boiled soybeans (edamame)	20% DV (15g) per cup	296
7. Flaxseed oil	17% DV (14g) per tbsp.	120
8. Dark chocolate (85% cocoa)	16% DV (12g) per oz.	170
9. Cheddar cheese	12% DV (9g) per oz.	114
10. Eggs	7% DV (5g) per large egg	78

Note: 78g of Fat = 100% of the Daily Value (% DV)

Table A-8. Top 10 Healthy High Carbohydrate Foods.

Food	% DV (Grams) per Serving	Calories (kcal)
1. Sweet potatoes	20% DV (59.1g) per cup mashed	258
2. Brown rice	17% DV (51.7g) per cup	248
3. Navy beans	16% DV (47.4g) per cup	255
4. Lentils	13% DV (39.9g) per cup	230
5. Bananas	11% DV (34.3g) per cup	134
6. Oatmeal	9% DV (28.1g) per cup	166
7. Milk	8% DV (24.4g) per 16 oz. glass	205
8. Raisins	7% DV (20.6g) per oz.	78
9. Chestnuts	5% DV (15.0g) per oz.	70
10. Brown rice cakes	5% DV (14.7g) per 2 cakes	71

Note: 300g of Carbohydrate = 100% of the Daily Value (% DV)

Table A-9. Top 10 Foods Highest in Fiber.

Food	% DV (Grams) per Serving	Calories (kcal)
1. Navy (haricot) beans	68% DV (19g) per cup	255
2. Avocados	48% DV (13g) per avocado	322
3. Chia seeds	35% DV (10g) per oz. (2 tbsp)	138
4. Acorn squash	32% DV (9g) per cup cooked	115
5. Green peas	31% DV (9g) per cup cooked	134
6. Collard greens	27% DV (8g) per cup cooked	63
7. Broccoli	18% DV (5g) per cup cooked	55
8. Whole wheat pasta	16% DV (5g) per cup	174
9. Oranges	15% DV (4g) per cup	85
10. Sweet potatoes	14% DV (4g) per cup	114

Note: 28g of Fiber = 100% of the Daily Value (% DV)

Table A-10. Top 10 Complete Vegetarian Protein Foods with All the Essential Amino Acids.

Food	% DV (Grams) per Serving	Calories (kcal)
1. Firm tofu	87% DV (43.5g) per cup	363
2. Lentils	36% DV (17.9g) per cup	230
3. Low-fat yogurt	28% DV (14.0g) per cup	137
4. Cottage cheese	24% DV (11.8g) per 0.5 cup	92
5. Green peas	17% DV (8.6g) per cup cooked	134
6. Squash and pumpkin seeds	17% DV (8.5g) per oz.	163
7. Quinoa	16% DV (8.1g) per cup	222
8. Peanut butter	15% DV (7.7g) per 2 tbsp.	188
9. Eggs	13% DV (6.3g) per large egg	78
10. Mushrooms	8% DV (3.9g) per cup cooked	28

Note: 50g of Protein = 100% of the Daily Value (% DV)

Table A-11. Top 10 Beans and Legumes Highest in Protein.

Food	% DV (Grams) per Serving	Calories (kcal)
1. Boiled soybeans (edamame)	63% DV (31.3g) per cup	296
2. Lentils	36% DV (17.9g) per cup	230
3. Large white beans	35% DV (17.4g) per cup	249
4. Cranberry (borlotti) beans	33% DV (16.5g) per cup	241
5. Split peas	33% DV (16.3g) per cup	231
6. Pinto beans	31% DV (15.4g) per cup	245
7. Kidney beans	31% DV (15.3g) per cup	225
8. Black beans	30% DV (15.2g) per cup	227
9. Navy (haricot) beans	30% DV (15.0g) per cup	255
10. Lima (butter) beans	29% DV (14.7g) per cup	216

Note: 50g of Protein = 100% of the Daily Value (% DV)

Table A-12. Top 10 Seeds and Nuts Highest in Protein.

Food	% DV (Grams) per Serving	Calories (kcal)
1. Hemp seeds	18% DV (9.0g) per oz.	157
2. Squash and pumpkin seeds	17% DV (8.5g) per oz.	163
3. Peanuts (dry roasted)	14% DV (6.9g) per oz.	167
4. Almonds	12% DV (6.0g) per oz.	164
5. Pistachios (dry roasted)	12% DV (6.0g) per oz.	162
6. Sunflower seeds (dry roasted)	11% DV (5.5g) per oz.	155
7. Flax seeds	10% DV (5.2g) per oz.	152
8. Sesame seeds	10% DV (4.8g) per oz.	160
9. Chia seeds	9% DV (4.7g) per oz.	138
10. Cashews (dry roasted)	9% DV (4.3g) per oz.	163

Note: 50g of Protein = 100% of the Daily Value (% DV)

Table A-13. Top 10 Vegan Sources of Protein.

Food	% DV (Grams) per Serving	Calories (kcal)
1. Firm tofu	87% DV (43.5g) per cup	363
2. Dry roasted soybeans	81% DV (40.3g) per cup	418
3. Natto (fermented soybeans)	68% DV (34.0g) per cup	369
4. Tempeh	67% DV (33.7g) per cup	319
5. Lentils	36% DV (17.9g) per cup	230
6. Unsweetened soymilk	28% DV (14.0g) per 16 oz. glass	160
7. Soybean sprouts	18% DV (9.2g) per cup	85
8. Green peas	17% DV (8.6g) per cup cooked	134
9. Squash and pumpkin seeds	17% DV (8.5g) per oz.	163
10. Quinoa	16% DV (8.1g) per cup	222

Note: 50g of Protein = 100% of the Daily Value (% DV)

Micronutrients

Table A-14. Top 10 Foods Highest in Vitamin A.

Food	% DV (Micrograms) per Serving	Calories (kcal)
1. Carrots	148% DV (1,329µg) per cup cooked	55
2. Tuna (Bluefin)	143% DV (1,287µg) per 6 oz. fillet	313
3. Butternut Squash	127% DV (1,144µg) per cup cooked	82
4. Sweet Potatoes (baked)	122% DV (1,096µg) per medium potato	103
5. Spinach	105% DV (943µg) per cup cooked	41
6. Cantaloupe	33% DV (299µg) per cup	60
7. Romaine Lettuce	23% DV (205µg) per cup	8
8. Red Bell Peppers	22% DV (199µg) per cup cooked	38
9. Pink Grapefruit	15% DV (133µg) per cup	97
10. Broccoli	13% DV (120µg) per cup cooked	55

Note: 900µg of Vitamin A = 100% of the Daily Value (% DV)

Table A-15. Top 10 Foods Highest in Vitamin D.

Food	% DV (Micrograms) per Serving	Calories (kcal)
1. Fish (Sockeye salmon)	142% DV (28.4µg) per 6 oz.	265
2. Crimini Mushrooms	139% DV (27.8µg) per cup	19
3. Fortified Milk	32% DV (6.3µg) per 16 oz. glass	298
4. Fortified Milk Substitutes (soy milk)	29% DV (5.8µg) per 16 oz. glass	160
5. Fortified Tofu	28% DV (5.7µg) per cup	208
6. Fortified Yogurt	16% DV (3.2µg) per cup	250
7. Fortified Breakfast Cereal	12% DV (2.5µg) per ¾ cup	96
8. Fortified Orange Juice	12% DV (2.5µg) per cup	117
9. Pork Chops	10% DV (2.1µg) per pork chop	525
10. Eggs	6% DV (1.1µg) per large egg	78

Note: 20µg of Vitamin D = 100% of the Daily Value (% DV)

Table A-16. Top 10 Foods Highest in Vitamin E.

Food	% DV (Milligrams) per Serving	Calories (kcal)
1. Sunflower Seeds (dry roasted)	49% DV (7.4mg) per 1 oz.	165
2. Almonds	49% DV (7.3mg) per 1 oz.	164
3. Avocados	28% DV (4.2mg) per avocado	322
4. Spinach	25% DV (3.7mg) per cup cooked	41
5. Butternut Squash	18% DV (2.6mg) per cup cooked	82
6. Kiwifruit	18% DV (2.6mg) per cup	110
7. Broccoli	15% DV (2.3mg) per cup cooked	55
8. Trout (rainbow)	13% DV (2.0mg) per fillet (71g)	119
9. Olive Oil	13% DV (1.9mg) per tbsp.	119
10. Shrimp (Prawns)	12% DV (1.9mg) per 3 oz.	101

Note: 15mg of Vitamin E = 100% of the Daily Value (% DV)

Table A-17. Top 10 Foods Highest in Vitamin K.

Food	% DV (Micrograms) per Serving	Calories (kcal)
1. Kale	453% DV (544µg) per cup cooked	47
2. Broccoli	183% DV (220µg) per cup cooked	55
3. Brussel Sprouts	182% DV (219µg) per cup cooked	56
4. Cabbage	136% DV (163µg) per cup cooked	35
5. Pickled Cucumber	109% DV (130µg) per cup	207
6. Asparagus	76% DV (91µg) per cup cooked	40
7. Kiwifruit	60% DV (73µg) per cup	110
8. Okra	53% DV (64µg) per cup cooked	35
9. Green (snap) Beans	50% DV (60µg) per cup cooked	44
10. Romaine Lettuce	40% DV (48µg) per cup	8

Note: 120µg of Vitamin K = 100% of the Daily Value (% DV)

Table A-18. Top 10 Foods Highest in Vitamin B1 (Thiamin).

Food	% DV (Milligrams) per Serving	Calories (kcal)
1. Lean Pork Chops	92% DV (1.1mg) per 6 oz.	332
2. Fish (farmed Atlantic salmon)	50% DV (0.6mg) per 6 oz.	350
3. Flax Seeds	42% DV (0.5mg) per oz.	152
4. Navy Beans	33% DV (0.4mg) per cup	255
5. Green Peas	33% DV (0.4mg) per cup cooked	134
6. Firm Tofu	33% DV (0.4mg) per cup	363
7. Acorn Squash	25% DV (0.3mg) per cup cooked	115
8. Asparagus	25% DV (0.3mg) per cup cooked	40
9. Mussels	25% DV (0.3mg) per 3 oz.	146
10. Brown Rice	17% DV (0.2mg) per cup cooked	218

Note: 1.2mg of Vitamin B1 = 100% of the Daily Value (% DV)

Table A-19. Top 10 Foods Highest in Vitamin B2 (Riboflavin).

Food	% DV (Milligrams) per Serving	Calories (kcal)
1. Beef (Skirt Steak)	115% DV (1.5mg) per 6 oz.	456
2. Fortified Tofu	77% DV (1.0mg) per 6 oz.	208
3. Low-Fat Milk	69% DV (0.9mg) per 16 oz. glass	244
4. Fish (wild Atlantic salmon)	62% DV (0.8mg) per 6 oz.	309
5. Mushrooms	39% DV (0.5mg) per cup cooked	28
6. Lean Pork Chops	39% DV (0.5mg) per 6 oz.	332
7. Spinach	31% DV (0.4mg) per cup cooked	41
8. Almonds	23% DV (0.3mg) per oz.	164
9. Avocados	23% DV (0.3mg) per avocado	322
10. Eggs	23% DV (0.3mg) per large egg	78

Note: 1.3mg of Vitamin B2 = 100% of the Daily Value (% DV)

Table A-20. Top 10 Foods Highest in Vitamin B3 (Niacin).

Food	% DV (Milligrams) per Serving	Calories (kcal)
1. Tuna (Yellowfin)	234% DV (37.5mg) per 6 oz.	221
2. Lean Chicken Breast	101% DV (16.1mg) per 6 oz.	267
3. Lean Pork Chops	85% DV (13.6mg) per 6 oz.	332
4. Beef (skirt steak)	59% DV (9.5mg) per 6 oz.	456
5. Portobello Mushrooms	48% DV (7.6mg) per cup	35
6. Brown Rice	33% DV (5.2mg) per cup	248
7. Peanuts (dry roasted)	26% DV (4.1mg) per oz.	167
8. Avocados	22% DV (3.5mg) per avocado	322
9. Green Peas	20% DV (3.2mg) per cup cooked	134
10. Sweet Potatoes	15% DV (2.4mg) per cup mashed	258

Note: 16mg of Vitamin B3 = 100% of the Daily Value (% DV)

Table A-21. Top 10 Foods Highest in Vitamin B5 (Pantothenic Acid).

Food	% DV (Milligrams) per Serving	Calories (kcal)
1. Shiitake Mushrooms	104% DV (5.2mg) per cup cooked	81
2. Fish (wild Atlantic salmon)	66% DV (3.3mg) per 6 oz.	309
3. Avocados	56% DV (2.8mg) per avocado	322
4. Lean Chicken Breast	54% DV (2.7mg) per 6 oz.	267
5. Beef (skirt steak)	46% DV (2.3mg) per 6 oz.	456
6. Sunflower Seeds (dry roasted)	40% DV (2.0mg) per oz.	165
7. Whole Milk	36% DV (1.8mg) per 16 oz. glass	298
8. Lean Pork Chops	34% DV (1.7mg) per 6 oz.	332
9. Sweet Potatoes (mashed)	26% DV (1.3mg) per cup	258
10. Lentils	26% DV (1.3mg) per cup	230

Note: 5mg of Vitamin B5 = 100% of the Daily Value (% DV)

Table A-22. Top 10 Foods Highest in Vitamin B6 (Pyridoxine).

Food	% DV (Milligrams) per Serving	Calories (kcal)
1. Fish (wild Atlantic salmon)	94% DV (1.6mg) per 6 oz.	309
2. Lean Chicken Breast	94% DV (1.6mg) per 6 oz.	267
3. Fortified Tofu	65% DV (1.1mg) per cup	208
4. Lean Pork Chops	53% DV (0.9mg) per 6 oz.	332
5. Beef (skirt steak)	47% DV (0.8mg) per 6 oz.	456
6. Sweet Potatoes (mashed)	35% DV (0.6mg) per cup	258
7. Bananas	35% DV (0.6mg) per cup	134
8. Potatoes (with skin)	29% DV (0.5mg) per medium potato	161
9. Avocados	29% DV (0.5mg) per avocado	322
10. Pistachio Nuts	29% DV (0.5mg) per 1 oz.	159

Note: 1.7mg of Vitamin B6 = 100% of the Daily Value (% DV)

Table A-23. Top 10 Foods Highest in Vitamin B7 (Biotin).

Food	% AI (Micrograms) per Serving	Calories (kcal)
1. Beef Liver	103% AI (31.0µg) per 3 oz.	150
2. Eggs	33% AI (10.0µg) per large egg	78
3. Lean Pork Chops	26% AI (7.8µg) per 6 oz.	332
4. Pink Salmon (canned in water)	17% AI (5.1µg) per 3 oz.	116
5. Sweet Potatoes (mashed)	16% AI (4.8µg) per cup	258
6. Hamburger Patty	13% AI (3.9µg) per 3 oz.	255
7. Sunflower Seeds (dry roasted)	5% AI (1.5µg) per oz.	155
8. Spinach	4% AI (1.2µg) per cup cooked	41
9. Almonds	3% AI (0.9µg) per oz.	164
10. Tuna (canned in water)	2% AI (0.6µg) per 3 oz.	109

Note: 30µg of Vitamin B7 = 100% of the Adequate Intake (% AI)

Table A-24. Top 10 Foods Highest in Vitamin B9 (Folate).

Food	% DV (Micrograms) per Serving	Calories (kcal)
1. Edamame (green soybeans)	121% DV (482µg) per cup	188
2. Lentils	90% DV (358µg) per cup	230
3. Asparagus	67% DV (268µg) per cup cooked	40
4. Spinach	66% DV (263µg) per cup cooked	41
5. Broccoli	42% DV (168µg) per cup cooked	55
6. Avocados	41% DV (163µg) per avocado	322
7. Mangos	18% DV (71µg) per cup	99
8. Romaine Lettuce	16% DV (64µg) per cup	8
9. Sweet Corn	15% DV (61µg) per cup cooked	125
10. Oranges	14% DV (54µg) per cup	85

Note: 400µg of Vitamin B9 = 100% of the Daily Value (% DV)

Table A-25. Top 10 Foods Highest in Vitamin B12 (Cobalamin).

Food	% DV (Micrograms) per Serving	Calories (kcal)
1. Clams	3,504% DV (84.1µg) per 3 oz.	126
2. Tuna	771% DV (18.5µg) per 6 oz.	313
3. King Crab	642% DV (15.4µg) per 1 crab leg	130
4. Beef (skirt steak)	533% DV (12.8µg) per 6 oz.	456
5. Fortified Cereals	254% DV (6.1µg) per ¾ cup	95
6. Fortified Soy Milk	250% DV (6.0µg) per 16 oz. glass	244
7. Fortified Tofu	138% DV (3.3µg) per cup	208
8. Low-Fat Milk 2%	108% DV (2.6µg) per 16 oz. glass	244
9. Swiss Cheese	38% DV (0.9µg) per oz.	112
10. Eggs	25% DV (0.6µg) per large egg	78

Note: 2.4µg of Vitamin B12 = 100% of the Daily Value (% DV)

Table A-26. Top 10 Foods Highest in Vitamin C.

Food	% DV (Milligrams) per Serving	Calories (kcal)
1. Guavas	419% DV (377mg) per cup	112
2. Kiwifruit	186% DV (167mg) per cup	110
3. Sweet Red Bell Pepper	169% DV (152mg) per cup	31
4. Strawberries	109% DV (98mg) per cup	53
5. Oranges	107% DV (96mg) per cup	85
6. Papaya	98% DV (88mg) per cup	62
7. Broccoli (raw)	90% DV (81mg) per cup	31
8. Tomato	61% DV (55mg) per cup cooked	43
9. Snow Peas	42% DV (38mg) per cup	26
10. Kale	26% DV (23mg) per cup cooked	47

Note: 90mg of Vitamin C = 100% of the Daily Value (% DV)

Table A-27. Top 10 Foods Highest in Choline.

Food	% DV (Milligrams) per Serving	Calories (kcal)
1. Lean Chicken Breast	36% DV (198.9mg) per 6 oz.	267
2. Fish (Sockeye salmon)	35% DV (191.4mg) per 6 oz.	265
3. Lean Pork Chops	28% DV (152.8mg) per 6 oz.	332
4. Eggs	27% DV (146.9mg) per large egg	78
5. Beef (skirt steak)	24% DV (132.3mg) per 6 oz.	456
6. Shrimp	21% DV (115.1mg) per 3 oz.	101
7. Navy Beans	15% DV (81.4mg) per cup	255
8. Low-Fat Milk 2%	15% DV (80.0mg) per 16 oz. glass	244
9. Broccoli	11% DV (62.6mg) per cup cooked	55
10. Green Peas	9% DV (47.5mg) per cup cooked	134

Note: 550mg of Choline = 100% of the Daily Value (% DV)

Table A-28. Top 10 Foods Highest in Calcium.

Food	% DV (Milligrams) per Serving	Calories (kcal)
1. Firm Tofu	143% DV (1,721mg) per cup	363
2. Skim Milk	50% DV (598mg) per 16 oz. glass	167
3. Non-Fat Yogurt	41% DV (488mg) per cup	137
4. Grated Parmesan	28% DV (336mg) per oz.	111
5. Spinach	20% DV (245mg) per cup cooked	41
6. Black-Eyed Peas	18% DV (211mg) per cup	160
7. Okra	10% DV (123mg) per cup cooked	35
8. Trout	10% DV (123mg) per fillet (143g)	215
9. Acorn Squash	8% DV (90mg) per cup cooked	115
10. Clams	7% DV (78mg) per 3 oz.	126

Note: 1,200mg of Calcium = 100% of the Daily Value (% DV)

Table A-29. Top 10 Foods Highest in Chromium.

Food	% AI (Micrograms) per Serving	Calories (kcal)
1. Broccoli	62% AI (21.7µg) per cup cooked	55
2. Grape Juice	21% AI (7.4µg) per cup	152
3. Brewer's Yeast	9% AI (3.2µg) per tbsp.	30
4. Orange Juice	6% AI (2.1µg) per cup	112
5. Beef (skirt steak)	6% AI (2.1µg) per 3 oz.	228
6. Turkey Breast	5% AI (1.8µg) per 3 oz.	125
7. Apples	4% AI (1.4µg) per medium apple	95
8. Tomato Juice	4% AI (1.4µg) per cup	50
9. Green Beans	3% AI (1.1µg) per ½ cup cooked	22
10. Whole Wheat Bread	3% AI (1.1µg) per slice	81

Note: 35µg of Chromium = 100% of the Adequate Intake (% AI)

Table A-30. Top 10 Foods Highest in Copper.

Food	% DV (Milligrams) per Serving	Calories (kcal)
1. Oysters	422% DV (3.8mg) per 3 oz.	67
2. Shiitake Mushrooms	144% DV (1.3mg) per cup cooked	81
3. Firm Tofu	111% DV (1.0mg) per cup	363
4. Sweet Potatoes (mashed)	78% DV (0.7mg) per cup	258
5. Sesame Seeds	78% DV (0.7mg) per oz.	160
6. Cashews (dry roasted)	67% DV (0.6mg) per oz.	163
7. Chickpeas	67% DV (0.6mg) per cup cooked	269
8. Fish (wild Atlantic salmon)	56% DV (0.5mg) per 6 oz.	309
9. Dark Chocolate (70-85% Cocoa)	56% DV (0.5mg) per 1 oz. square	170
10. Avocados	44% DV (0.4mg) per avocado	322

Note: 0.9mg of Copper = 100% of the Daily Value (% DV)

Table A-31. Top 10 Foods Highest in Fluoride.

Food	% AI (Micrograms) per Serving	Calories (kcal)
1. Black Tea (brewed with tap water)	22% AI (884µg) per cup	2
2. Fruit Juice (grape)	9% AI (349µg) per cup	152
3. Sodas (orange soda)	8% AI (300µg) per 12 oz. can	179
4. Blue Crab (canned)	7% AI (283µg) per cup	112
5. Shrimp (canned)	6% AI (257µg) per cup	128
6. Fruit Flavored Water with Sweeteners	6% AI (248µg) per cup	2
7. Table Wine	6% AI (227µg) per 5 oz. glass	123
8. Coffee	5% AI (215µg) per cup	2
9. Average Municipal (City) Tap Water	4% AI (169µg) per cup	0
10. Oatmeal (cooked)	4% AI (168µg) per cup	166

Note: 4,000µg of Fluoride = 100% of the Adequate Intake (% AI)

Table A-32. Top 10 Foods Highest in Iodine.

Food	% DV (Micrograms) per Serving	Calories (kcal)
1. Cod	97% DV (146µg) per 3 oz.	71
2. Yogurt, Non-Fat	83% DV (124µg) per cup	137
3. Oysters	81% DV (121µg) per 3 oz.	87
4. Milk, Low Fat 2%	58% DV (87µg) per cup	122
5. Clams	37% DV (56µg) per 3 oz.	126
6. Swiss Cheese	27% DV (41µg) per oz.	112
7. Alaskan King Crab	21% DV (32µg) per 3 oz.	82
8. Eggs	21% DV (31µg) per large egg	78
9. Tuna	10% DV (15µg) per 3 oz.	110
10. Feta Cheese	10% DV (15µg) per oz.	75

Note: 150µg of Iodine = 100% of the Daily Value (% DV)

Table A-33. Top 10 Foods Highest in Iron.

Food	% DV (Milligrams) per Serving	Calories (kcal)
1. Fortified Cereals	109% DV (19.6mg) per ¾ cup	113
2. Beef (skirt steak)	52% DV (9.3mg) per 6 oz.	456
3. Shellfish (oysters)	43% DV (7.8mg) per 3 oz.	139
4. Dried Fruit	42% DV (7.5mg) per cup	381
5. Large White Beans	37% DV (6.6mg) per cup	249
6. Spinach	36% DV (6.4mg) per cup cooked	41
7. Baking Chocolate (unsweetened)	28% DV (5.0mg) per oz. square	186
8. Quinoa	16% DV (2.8mg) per cup	222
9. White Button Mushrooms	15% DV (2.7mg) per cup cooked	44
10. Squash and Pumpkin Seeds (dried)	14% DV (2.5mg) per oz.	159

Note: 18mg of Iron = 100% of the Daily Value (% DV)

Table A-34. Top 10 Foods Highest in Magnesium.

Food	% DV (Milligrams) per Serving	Calories (kcal)
1. Spinach	37% DV (157mg) per cup cooked	41
2. Squash and Pumpkin Seeds (roasted)	37% DV (156mg) per oz.	163
3. Lima Beans	30% DV (126mg) per cup cooked	209
4. Tuna (Bluefin)	26% DV (109mg) per 6 oz.	313
5. Brown Rice	20% DV (86mg) per cup cooked	218
6. Almonds	18% DV (77mg) per oz.	164
7. Dark Chocolate (85% Cocoa)	15% DV (65mg) per oz. square	170
8. Avocados	14% DV (58mg) per avocado	322
9. Non-Fat Yogurt	11% DV (47mg) per cup	137
10. Bananas	10% DV (41mg) per cup	134

Note: 420mg of Magnesium = 100% of the Daily Value (% DV)

Table A-35. Top 10 Foods Highest in Manganese.

Food	% AI (Milligrams) per Serving	Calories (kcal)
1. Mussels	252% AI (5.8mg) per 3 oz.	146
2. Toasted Wheat Germ	248% AI (5.7mg) per oz.	108
3. Firm Tofu	130% AI (3.0mg) per cup	363
4. Sweet Potatoes	109% AI (2.5mg) per cup mashed	258
5. Pine Nuts	109% AI (2.5mg) per oz.	191
6. Brown Rice	91% AI (2.1mg) per cup cooked	218
7. Lima Beans	91% AI (2.1mg) per cup cooked	209
8. Chickpeas	74% AI (1.7mg) per cup	269
9. Spinach	74% AI (1.7mg) per cup cooked	41
10. Pineapple	65% AI (1.5mg) per cup	83

Note: 2.3mg of Manganese = 100% of the Adequate Intake (% AI)

Table A-36. Top 10 Foods Highest in Molybdenum.

Food	% DV (Micrograms) per Serving	Calories (kcal)
1. Black-Eyed Peas	640% DV (288µg) per ½ cup cooked	80
2. Lima Beans	231% DV (104µg) per ½ cup cooked	105
3. Beef Liver	231% DV (104µg) per 3 oz.	150
4. Shredded Wheat Cereal	67% DV (30µg) per cup	200
5. Non-Fat Yogurt	58% DV (26µg) per cup	154
6. Low-Fat Milk 2%	49% DV (22µg) per cup	244
7. Baked Potatoes with Skin	36% DV (16µg) per medium potato	161
8. Banana	33% DV (15µg) per medium banana	105
9. Whole Wheat Bread	27% DV (12µg) per slice	81
10. Peanuts (dry roasted)	24% DV (11µg) per oz.	167

Note: 45µg of Molybdenum = 100% of the Daily Value (% DV)

Table A-37. Top 10 Foods Highest in Phosphorus.

Food	% DV (Milligrams) per Serving	Calories (kcal)
1. Tuna (Yellowfin)	81% DV (566mg) per 6 oz.	221
2. Lean Pork Chops	74% DV (515mg) per 6 oz.	332
3. Firm Tofu	68% DV (479mg) per cup	363
4. Low-Fat Milk	64% DV (449mg) per 16 oz. glass	244
5. Lean Chicken Breast	59% DV (410mg) per 6 oz.	267
6. Scallops	52% DV (362mg) per 3 oz.	94
7. Lentils	51% DV (356mg) per cup	230
8. Squash and Pumpkin Seeds (dried)	50% DV (350mg) per oz.	159
9. Beef (skirt steak)	48% DV (335mg) per 6 oz.	456
10. Quinoa	40% DV (281mg) per cup	222

Note: 700mg of Phosphorus = 100% of the Daily Value (% DV)

Table A-38. Top 10 Foods Highest in Potassium.

Food	% AI (Milligrams) per Serving	Calories (kcal)
1. Beet Greens	39% AI (1,309mg) per cup cooked	39
2. Fish (wild Atlantic salmon)	31% AI (1,068mg) per 6 oz.	309
3. Large White Beans	30% AI (1,004mg) per cup	249
4. Avocados	29% AI (975mg) per avocado	322
5. Baked Potatoes (with skin)	27% AI (926mg) per medium potato	161
6. Acorn Squash	26% AI (896mg) per cup cooked	115
7. Milk (low-fat 1%)	22% AI (732mg) per 16 oz. glass	205
8. White Button Mushrooms	16% AI (555mg) per cup cooked	44
9. Bananas	16% AI (537mg) per cup	134
10. Tomato	15% AI (523mg) per cup cooked	43

Note: 3,400mg of Potassium = 100% of the Adequate Intake (% AI)

Table A-39. Top 10 Foods Highest in Selenium.

Food	% DV (Micrograms) per Serving	Calories (kcal)
1. Brazil Nuts	989% DV (544µg) per oz.	187
2. Tuna (Yellowfin)	335% DV (184µg) per 6 oz.	221
3. Shellfish (oysters)	238% DV (131µg) per 3 oz.	139
4. Lean Pork Chops	147% DV (81µg) per 6 oz.	332
5. Beef (skirt steak)	111% DV (61µg) per 6 oz.	456
6. Lean Chicken Breast	98% DV (54µg) per 6 oz.	267
7. Firm Tofu	80% DV (44µg) per cup	363
8. Whole Wheat Pasta	78% DV (43µg) per cup	174
9. Shrimp	76% DV (42µg) per 3 oz.	101
10. Shiitake Mushrooms	65% DV (36µg) per cup cooked	81

Note: 55µg of Selenium = 100% of the Daily Value (% DV)

Table A-40. Top 10 Foods Highest in Sodium.

Food	% AI (Milligrams) per Serving	Calories (kcal)
1. Table Salt	155% AI (2,325mg) per tsp.	0
2. Cured Ham	140% AI (2,100mg) per cup	249
3. Ham and Egg Biscuit	133% AI (1,989mg) per item	424
4. Pickled Cucumber	125% AI (1,872mg) per cup	17
5. Sunflower Seeds (dry roasted)	114% AI (1,706mg) per oz.	155
6. Clams	68% AI (1,022mg) per 3 oz.	126
7. Canned Beans (with added salt)	59% AI (880mg) per cup	296
8. French Bread	56% AI (837mg) per slice	378
9. Teriyaki Sauce	43% AI (640mg) per tbsp.	32
10. Grated Parmesan	34% AI (512mg) per oz.	119

Note: 1,500mg of Sodium = 100% of the Adequate Intake (% AI)

Table A-41. Top 10 Foods Highest in Zinc.

Food	% DV (Milligrams) per Serving	Calories (kcal)
1. Oysters	473% DV (52.0mg) per 6 oysters	67
2. Beef (chuck steak)	140% DV (15.4mg) per 5 oz.	268
3. Chicken Leg	49% DV (5.4mg) per roasted leg	475
4. Firm Tofu	36% DV (4.0mg) per cup	363
5. Lean Pork Chops	32% DV (3.5mg) per 6 oz.	332
6. Squash and Pumpkin Seeds (roasted)	27% DV (3.0mg) per oz.	127
7. Lentils	23% DV (2.5mg) per cup	230
8. Low-Fat Yogurt	22% DV (2.4mg) per cup	137
9. Oatmeal	21% DV (2.3mg) per cup cooked	166
10. Shiitake Mushrooms	18% DV (2.0mg) per cup cooked	81

Note: 11mg of Zinc = 100% of the Daily Value (% DV)

Appendix B

B.1 Hypertrophy Programming.

Table B-1. Summary of Training Guidelines for Hypertrophy.

Training Goal	Experience Level	Sets	Repetitions	Rest Interval	Intensity	Frequency
Hypertrophy	Beginner	1-3	6-12	30-90 sec.	70-85% 1-RM	2-3 days/week
	Intermediate	1-3	6-12	30-90 sec.	70-85% 1-RM	4 days/week
	Advanced	3-6	1-12	30 sec. - 3 min.	70-100% 1-RM	4-6 days/week

Note: Beginner = not currently training or just beginning with minimal skill (<6 months of lifting experience)
Intermediate = basic skill (6 months to 2 years of lifting experience)
Advanced = advanced skill (>2 years of lifting experience)
1-RM = One-repetition maximum

Note: To support the hypertrophic stimulus induced by your resistance training program, you must be in a caloric surplus so that muscle protein synthesis exceeds muscle protein breakdown. Otherwise, your body will feed on its own muscles due to insufficient protein and calories, resulting in little to no increases in muscle size.

The following examples show you how to go about creating your training program for muscular hypertrophy using the guidelines from the sources listed below:

1. 3.2 Learn hypertrophy training the proper way: a basic overview.
2. 3.3 Maximize muscle hypertrophy with advanced training techniques.
3. 3.4 Understand muscle clocks and timing.
4. 6.1 Learn how to recover.
5. Exercise library of resistance exercises (anlianfitness.com).

Beginner Example

Table B-2. Example Outline of Hypertrophy Training Guidelines for a Beginner Level Weightlifter.

- Training goal: Hypertrophy
- Experience level: Beginner
- Sets: 2
- Repetitions: 10
- Rest interval: 30-90 sec.
- Intensity: 70-85% 1-RM
- Frequency: 2 days/week
- Exercise type: Free weights and machines.
- Exercise order: Multiple-joint exercises followed by single-joint exercises; utilize the biomechanical similarity principle.
- Training method: Multiple sets.
- Training time: 4 p.m.
- Recovery window: 48-96 hours between same muscle groups; not to exceed 96 hours.

Table B-3. Example 2-Day/Week Total Body Hypertrophy Routine.

Exercises	Sets	Reps
1. Leg press	2	10
2. Lunge	2	10
3. Leg extension	2	10
4. Leg curl	2	10
5. Lat pulldown	2	10
6. Seated cable row	2	10
7. Dumbbell bench press	2	10
8. Dumbbell chest fly	2	10
9. Lateral raise machine	2	10
10. Traditional ab crunch	2	10

Note: Perform the exercise routine 2 days per week spacing 48-96 hours apart. For example, you can follow either a Monday/Thursday or Monday/Friday schedule.

Intermediate Example

Table B-4. Example Outline of Hypertrophy Training Guidelines for an Intermediate Level Weightlifter.

- Training goal: Hypertrophy
- Experience level: Intermediate
- Sets: 3
- Repetitions: 8-12
- Rest interval: 30-90 sec.
- Intensity: 70-85% 1-RM
- Frequency: 4 days/week
- Exercise type: Free weights and machines.
- Exercise order: Multiple-joint exercises followed by single-joint exercises; utilize the biomechanical similarity principle.
- Training method: Multiple sets.
- Training time: 4 p.m.
- Rest days: Follow an intermittent rest schedule.
- Recovery window: 48-96 hours between same muscle groups; not to exceed 96 hours.
- Deload schedule: intentional undertraining every 5 weeks.

Table B-5. Example Lower/Upper Body Split Hypertrophy Program Routine.

Workout A	Workout B
Lower Body A	**Lower Body B**
1. Barbell back squat	1. Plate loaded leg press
2. Plate loaded leg press	2. Romanian deadlift (RDL)
3. Seated leg extension	3. Bulgarian split squat
4. Seated leg curl	4. Lying leg curl
5. Seated calf raise	5. Standing calf raise
6. Standing calf raise	6. Seated calf raise
Upper Body A	**Upper Body B**
1. Lat pulldown	1. Barbell bent over row
2. Seated cable row	2. DB shrugs
3. Barbell flat bench press	3. DB single arm row
4. DB flat chest fly	4. DB incline chest press
5. Lateral raise machine	5. Cable crossover
6. EZ bar skull crushers	6. Triceps cable pushdown
7. EZ bar curl	7. DB incline curl

Table B-6. Example Intermediate Lower/Upper Body Split Hypertrophy Program Schedule.

Weeks 1-5						
Mon	Tue	Wed	Thu	Fri	Sat	Sun
Lower Body A	Rest	Upper Body A	Rest	Lower Body B	Rest	Upper Body B
Week 6, Deload						
Mon	Tue	Wed	Thu	Fri	Sat	Sun
Lower Body A	Rest	Upper Body A	Rest	Lower Body B	Rest	Upper Body B
Weeks 7-11						
Mon	Tue	Wed	Thu	Fri	Sat	Sun
Lower Body A	Rest	Upper Body A	Rest	Lower Body B	Rest	Upper Body B
Week 12, Deload						
Mon	Tue	Wed	Thu	Fri	Sat	Sun
Lower Body A	Rest	Upper Body A	Rest	Lower Body B	Rest	Upper Body B

Advanced Example

Table B-7. Example Outline of Hypertrophy Training Guidelines for an Advanced Level Weightlifter.

- Training goal: Hypertrophy
- Experience level: Advanced
- Sets: 3-7
- Repetitions: 8-20
- Rest interval: 30 sec. - 3 min.
- Intensity: 50-85% 1-RM
- Frequency: 5 days/week
- Exercise type: Free weights and machines.
- Exercise order: Multiple-joint exercises followed by single-joint exercises; utilize the biomechanical similarity principle.
- Training method: FST-7.
- Training time: 6 a.m.
- Rest days: Follow an intermittent rest schedule.
- Recovery window: 72-96 hours between same muscle groups; not to exceed 96 hours.

Table B-8. Example 5-Day Split Hypertrophy FST-7 Routine for an Advanced Level Weightlifter.

Biceps, Triceps, and Calves	Sets	Reps	Back, Traps, and Calves	Sets	Reps
1. Alternate dumbbell curl	3-4	8-12	1. Neutral grip chin-up	3	Failure
2. Machine preacher curl	3	8-12	2. Wide grip pulldown	3	8-12
3. EZ bar curl	7	8-12	3. Barbell row	3	8-12
4. Close grip bench press	3-4	8-12	4. Hammer strength row	3	8-12
5. Weighted or machine dip	3	8-12	5. Machine or cable pullover	7	8-15
6. Skull crusher	7	8-12	6. Standing calf raise	4	10-12
7. Standing calf raise	4	10-12	7. Seated calf raise	4	15-20
8. Seated calf raise	4	15-20	8. Leg press calf raise	7	10-12
9. Leg press calf raise	7	10-12	9. Dumbbell shrug	3-4	8-12
Legs	**Sets**	**Reps**	10. Machine shrug	7	8-12
1. Leg extension	3-4	8-15	**Shoulders, Rear Delts, and Biceps**	**Sets**	**Reps**
2. Barbell back squat	4	8-12	1. Seated dumbbell press	4	8-12
3. Hack squat or leg press	3	8-15	2. Barbell or dumbbell front raise	3	8-12
4. Leg extension or leg press	7	8-15	3. Dumbbell lateral raise	3	8-12
5. Lying leg curl	3-4	10-15	4. Lateral raise machine	7	8-12
6. Stiff-leg deadlift	3-4	10-12	5. Dumbbell rear lateral raise	3-4	12-15
7. Single leg curl	3-4	10-15	6. Reverse pec fly or cable	7	12-15
8. Seated leg curl	7	10-15	7. Alternate dumbbell curl	3-4	8-12
Chest and Triceps	**Sets**	**Reps**	8. Machine preacher curl	3	8-12
1. Incline dumbbell press	3-4	8-12	9. EZ bar curl	7	8-12
2. Incline dumbbell fly	3	8-12			
3. Flat dumbbell press	3	8-12			
4. Pec deck or cable crossover	7	8-12			
5. Close grip bench press	3-4	8-12			
6. Weighted or machine dip	3	8-12			
7. Overhead cable extension	7	8-12			

Table B-9. Example Advanced 5-Day Split Hypertrophy FST-7 Program Schedule.

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Biceps, Triceps, and Calves	Legs	Rest	Chest and Triceps	Back, Traps, and Calves	Shoulders, Rear Delts, and Biceps	Rest

About the Author

David S. Anlian

David's passion for health and fitness fuels his dedication to living a fit and healthy lifestyle, shaping his daily habits and inspiring others to do the same. His journey into resistance training began during college, sparking a lifelong enthusiasm that continues to drive him today.

In addition to his fitness pursuits, David is a licensed professional engineer, holds a master's degree in business administration, and is a certified personal trainer. This unique blend of technical expertise, business acumen, and fitness knowledge positions him as a trusted voice in the health and wellness space.

As the creator of AnlianFitness.com, David combines his years of experience with a deep commitment to education. His platform is a go-to resource for anyone—from beginners to seasoned lifters—seeking practical guidance and expert insights into resistance training.

Stay connected with David and explore more of his content on Instagram, Facebook, and YouTube (@AnlianFitness).