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The Muscle Ladder: Get Jacked Using Science

Jeff Nippard

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> Common warning signs include Persistent joint aches Persistent loss of strength Feeling exhausted and run down Persistent extreme muscle soreness Loss of training motivation Difficulty sleeping If you experience several of these warning signs concurrently, you should consider reducing your training load for a week or two to see if the signals decrease or go away. These lighter weeks, formally called deloads, can help reduce fatigue and give your body time to repair muscle damage. Later in the book, I'll show you how to set up a deload week, but for now, you can simply think of it as a light week where you train with a little less weight and a little less volume.

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> The National Sleep Foundation recommends that adults get between seven and nine hours of sleep per night for overall health.[7] Weight training, however, imposes an additional recovery demand. This means you may actually need eight to nine hours per night to fully recover.[8] Sleep deprivation is profoundly negative for training performance. In a classic 1994 study, researchers restricted subjects who normally slept eight hours per night to only three hours per night for three days in a row.[9] Then they did 20 reps of biceps curls, bench presses, leg presses, and deadlifts while sleep deprived. As you'd expect, there was a significant and linear decline in the amount of weight they could lift for the three compound exercises—bench press, deadlift, leg press. It got progressively worse with additional sleep deprivation. The control group did not experience any decrease in performance. Maximum strength on the biceps curl decreased as well, but not enough to reach statistical significance. The researchers speculated that missed sleep has a bigger effect on larger, more complicated exercises. At the other extreme, several studies have shown that performance improves when athletes get more than the recommended amount of sleep. For example, a 2015 study by Schwartz and Simon found that with just one week of

extended sleep duration—nine hours instead of seven—collegiate tennis players significantly improved the accuracy of their serve.[10] A 2011 study from Mah and colleagues also showed impressive results by increasing sleep time in collegiate basketball players.[11] When the players were instructed to spend a minimum of 10 hours in bed per night, their sleep time increased from about 6.7 hours per night to about 8.5 hours. This resulted in significantly improved sprint speed, free throw shooting, three-point shooting, and reaction time. The sleep-loaded athletes also reported improved mood, less fatigue, and better well-being.

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A 1999 study from Westenhoefer and colleagues found that a more flexible approach to nutrition was associated with less disordered eating behavior when compared to a rigid approach.[5] Moreover, the flexible approach was associated with lower body mass index (a ratio of weight to height) and more successful long-term weight-loss maintenance.[6]

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The strongest lifters didn't get strong by compromising their technique. They did it by lifting progressively heavier weights with a consistent ROM.

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A 2023 review from Wolf and colleagues pooled data from 24 studies on how ROM affects hypertrophy.[3] They found that full and partial ranges of motion were similarly effective for muscle growth as long as the partial reps were done with the muscle in a more lengthened position. In fact, several studies showed lengthened partials outperformed the same exercises done with a full ROM, although the effects were small. So, what is a "lengthened" partial? Think of the part of an exercise where the muscle is stretched—for example, the quads are stretched in the bottom of a squat. Same with the pecs in the bottom of a bench press, when the bar is on your chest. In a pulling exercise, it's usually the opposite. For example, in a lat pulldown, your lats are stretched in the top half of the movement, when your arms are extended overhead.

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> To summarize this section: Pick a handful of exercises that fit your goals and stick to them for a while. Get better at those movements and watch your strength improve over time. There's no reason to change exercises if you're still making progress, especially if you're a new lifter. After a few months, when your progress slows or you feel like your workouts are getting stale, swap out a few of the stale exercises to keep your training novel and interesting. But don't swap out all of them. I'll show you a precise method for rotating exercises later in the book.

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> The most commonly noted difference is that free weights allow unrestricted movement, whereas many machines lock you into a specific trajectory. For example, you can do almost anything with a dumbbell: curl it, press it, pull it, squat while holding it, and more. But, a leg extension machine is meant to do one thing: leg extensions. Within some circles, there's no question that free weights are superior for developing strength and muscle mass. And if your goal is to be a competitive strength athlete, they're mostly right. There's no Olympic medal for the leg press or pec deck. But if your goal is to build your best physique, you won't find much evidence that one is better than the other. For example, two papers published in 2020 compared free weights to machines.[19] Both studies showed similar increases in muscle mass. That doesn't mean there are no differences between the two. Each has its pros and cons, which you need to keep in mind when creating a training program. Tables 5.5 and 5.6 highlight these differences.

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> Another key point: Technical failure can look different on machines versus free-weight exercises. Because your body is usually locked into position on a machine, it's easier to maintain consistent form all the way to muscular failure. Some researchers have investigated failure in terms of rep speed rather than small shifts in technique. It's an interesting idea because we've all experienced it. The more fatigue you feel, the slower the reps become. It's what we mean when we talk about "grinding" out those last few reps when it feels like some crazy physicist

has found a way to increase the force of gravity. One study found that rep speed slowed down by 30 percent halfway through sets of bench presses.[7] When the participants reached their last possible rep, the weight moved about 80 percent slower.

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Some coaches, especially in powerlifting circles, now use high-tech rep-speed trackers to measure changes throughout a set. That gives the coach an objective way to measure how close a lifter is to failure and use that data to decide how hard they should push for the rest of the workout. I highlight this research not because I think anyone reading The Muscle Ladder needs to time their reps. I just want you to be aware that your lifting velocity will decline as your muscles fatigue. If your reps aren't getting slower, you're most likely not close to failure, no matter how you define it.

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A 2017 study by Morán-Navarro and colleagues showed that pushing sets to failure causes more fatigue, which seems obvious if you've ever done it.[11] Less obvious are the consequences of training to that level of fatigue. In this study, the researchers looked at creatine kinase, an enzyme often used as a proxy for muscle damage. Creatine kinase levels were significantly above baseline in the failure group forty-eight hours post-exercise, which wasn't the case in the nonfailure group. A workout that causes so much fatigue and muscle damage will be much harder to recover from. That's true in any athletic endeavor, whether training or competing. Every body has a tolerance threshold, beyond which it begins to break down. Bodybuilding is no different. If your program is based on failure training, you have to give your muscles more time to recover between workouts, which means less total work. That might be the optimal approach for someone with limited time to train. Pushing every set to failure means shorter, more efficient workouts. You're getting the best possible results per unit of time. But is the most efficient training system also the most effective way to maximize muscle growth? I doubt it. We have piles of research showing a clear relationship between volume—the total number of sets you do for any given muscle group—and hypertrophy. I'll explain this in more detail in the next chapter. For now, I'll just note that, on average, more volume leads to more muscle growth, at least up to a point. The data in Figure

6.3 is taken from a meta-analysis led by James Krieger.[12] As you can see, eleven of the fifteen studies included in the study favored higher volumes, as does the average overall effect. I think this result is intuitive for most lifters. If you do more work, you'll build bigger muscles. (I'll discuss the point of diminishing returns in the next chapter.)

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First, most muscles don't need a full week to recover. They typically repair themselves and recover their strength in three to five days. As for muscle growth, research shows that post-workout muscle protein synthesis remains elevated for forty-eight to seventy-two hours in novice lifters.[1] For experienced trainees, it's more like twenty-four hours.

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So waiting seven days between training sessions for any given body part is not only unnecessary but it's probably counterproductive. The data implies you could get faster results by hitting individual muscles more often. However, I don't want to overstate this point. It's not clear that short-term post-workout protein synthesis is the best marker of long-term muscle growth. Some evidence shows that once-a-week training for a given muscle can be just as effective as more frequent workouts, especially for less experienced lifters.[2] The second and more damning limitation of the basic body-part split is that it's a less-than-ideal way to distribute volume throughout the week. The more experienced you are, the bigger a problem it becomes.

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The available research suggests that any rep range from 3 to 30 can stimulate muscle growth to a similar degree, as long as effort and volume are matched. But think about how hard it would be to match effort and volume across that spectrum. Just because it's possible to build the same amount of muscle with low reps as with high reps doesn't mean it's a good idea to do a lot of work at either extreme. High reps—15 to 30—make sense in some circumstances. Low reps—1 to 5—make sense in others. But in most circumstances, 6 to 15 reps is the most practical and productive range for hypertrophy.

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> Finally, high reps simply work better on some exercises, especially those that isolate smaller muscles. Take your glute medius or your rear delts: Isolating them requires specific movement patterns. You can't easily do those movements with even moderate weights, much less heavy loads. If you try, your form quickly breaks down as you recruit bigger muscles to move the weight. But with high-rep hip abductions or reverse pec deck flies, you can generate a high level of tension in those smaller muscles.

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> Generally, the low end of the practical range—6 to 10 reps—works best with compound exercises that activate a lot of muscle mass. You can focus on improving your technique while also getting stronger on the exercises where you typically care about strength—squat, bench press, deadlift, and overhead press.

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> The high end of the practical range—10 to 15 reps—is better for exercises that target smaller muscle groups. That includes isolation exercises (like curls, pressdowns, and lateral raises) and some compound movements where you normally want to establish a mind-muscle connection (like face pulls and pulldowns).

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> A 2007 study from Ratamess and colleagues found that both load and volume declined dramatically with rest periods of one minute or less.[2] A 2024 review looked at studies comparing short (less than one minute) and long (more than one minute) rest periods. While all nine studies only lasted between five to ten weeks (a relatively short duration for research designed to detect changes in hypertrophy), the results do still suggest a hypertrophic advantage with longer rest.[3] The reason is straightforward enough: Longer rest periods allow more complete recovery between sets, which means you'll be able to generate higher

tension deeper into your workout. That, in turn, means higher volume load and more muscle growth.

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Stretching is an interesting type of exercise. Studies have shown that sedentary people who do a flexibility program will actually get stronger.[4] There's also some research suggesting that stretching a muscle in between sets may enhance muscle growth.[5] This shouldn't be incredibly surprising if you've been paying close attention because I've already talked about value in challenging the muscle in the stretched aspect of the range of motion. The evidence on stretching a muscle when it isn't under load is still quite mixed, though. In a 2020 review, only two of the five studies that included resistance training showed a positive effect of stretching.[6] Both of those studies used interset stretching—stretching between sets—rather than before or after the session.

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This led the authors to speculate that stretching between sets could potentially be beneficial. Still, two studies is a far cry from a strong body of science, and a more recent 2021 study found no benefit of interset stretching on pec hypertrophy in trained subjects.[7] And another study from 2023 found no benefit of stretching the biceps in between sets.[8] The studies that do favor inter-set stretching have mainly found a positive effect for the quads and calves.[9] So while there is definitely reason to be skeptical of this approach, because there isn't any apparent downside (when incorporated properly) and there is a possible small upside (at least for some muscles), it could be worth trying out.

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Generally speaking, a periodized training plan will have three components: the macrocycle, the mesocycles, and some microcycles (see Figure 13.1). The macrocycle is the whole enchilada. If your goal is to get shredded for summer, your macrocycle might begin with a higher-volume training phase in January and conclude with a lower-volume phase from May to June when caloric intake is also lower. For a competitive bodybuilder or powerlifter, the macrocycle might begin

with your recovery from one major contest and end with achieving peak form for the next one. A team-sport athlete's macrocycle would cover twelve months—preseason, regular season, postseason, and offseason. An Olympic-level athlete might have a four-year macrocycle, one that begins with their first training session after the most recent Games and concludes forty-eight months later with their final prep for the next one. Within that macrocycle are at least two mesocycles. Each mesocycle focuses on a key goal and lasts one to three months. If you're doing Arnold's eight-week arm-blaster program (that may or may not be a real thing), that's your mesocycle. Within each mesocycle are several microcycles. A microcycle typically lasts a week and refers to how individual workouts are laid out throughout the week. For example, if you're running an upper/lower split with four workouts per week, your microcycle spans one week's worth of upper/lower workouts. In the asynchronous push/pull/legs split I discussed in Chapter 9, your microcycle repeats every eight days instead of seven.

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Post-workout carbs usually aren't a huge concern. No matter how hard you train, you probably leave the gym with plenty of glycogen left in your muscles, and then you still have twenty-four hours to replace what you burned before the next workout. A possible exception is if you exercise twice a day, and one of those sessions involves a lot of running (like soccer or basketball) or repetitive efforts (like a combat sport). In that case, you want to get some carbohydrates immediately after the first session so you have the energy you need for the next one. Fat is the least important macronutrient following a workout. Some people will tell you to limit fat in your post-workout meal because it slows down protein absorption. If you believe in a limited post-workout anabolic window, any delay in protein absorption is a potential risk to your gains. As you should guess by this point, I believe that concern is overblown. If you hit your daily protein target, your body will figure out the rest. How much fat you include in your post-workout meal is a matter of personal preference and convenience.

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L-citrulline is one of the few products to come along in recent years with performance-enhancing claims that seem to hold up under scientific scrutiny. To understand how it works, you first need to

understand L-arginine. L-arginine is an amino acid that helps increase nitric oxide. Nitric oxide (not to be confused with nitrous oxide, aka laughing gas) has a number of important roles in health and performance. One is vasodilation—relaxing blood vessels to allow higher blood flow. Another is neurotransmission—making it easier for neurons to communicate with each other. And that's just scratching the surface.[24] Both functions could conceivably improve performance. Interestingly, because of absorption issues with L-arginine, supplementing L-citrulline increases L-arginine more than supplementing L-arginine itself.[25] That's why L-citrulline appears to be a more effective nitric oxide booster. A 2019 meta-analysis by Trexler and others found small but significant strength improvements after taking an L-citrulline supplement.[26] It's still too early to call L-citrulline a proven performance booster, much less move it to tier 1 with protein and creatine, but it does look promising. The

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