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How Do Muscles Grow? The Science of Muscle Growth

© Updated 1 month ago

□ Muscle Building



If you're the typical guy in the gym working with weights, not only do you want to lose some fat, but also gain some muscle.

Lee Boyce **Reveals His Top Muscle** Building **Tips**

Lee Boyce is a

Toronto based strength coach and fitness writer who is fast rising...

How Fast Can You Build Muscle? 5 **Factors That** Affect Muscle Growth

I've discussed in depth How Much Muscle You Can Gain Naturally, or your maximum muscle...

How Much Muscle Can You Gain **Naturally?**





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want to be a ripped...

women won't gain large amounts of muscle when working with weights.

Although there are different types of muscles, such as cardiac muscle (your heart), for our concerns, we will talk exclusively about skeletal muscles.

Skeletal muscle is composed of thread-like myofibrils and sarcomeres that form a muscle fiber and are the basic units of contraction.

The 650 skeletal muscles in the human body contract when they receive signals from motor neurons, which are triggered from a part of the cell called the sarcoplasmic reticulum. Motor neurons tell your muscles to contract and the better you become at having those signals tell your muscles to contract, the stronger you can get.

When someone like a powerlifter is able to lift very heavy weight despite not looking very muscular, it's due to their ability to activate those motor neurons and contract their muscles better. This is why some powerlifters can be



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more weight. Motor Unit recruitment also helps to explain why, after practice, certain movements become easier to perform and most of the initial strength gains will be when you first start to lift weights. Muscle growth tends to occur more steadily after this initial period of strength gain because you are more easily able to activate the muscles.

The Physiology Of Muscle Growth

After you workout, your body repairs or replaces damaged muscle fibers through a cellular process where it fuses muscle fibers together to form new muscle protein strands or myofibrils. These repaired myofibrils increase in thickness and number to create muscle hypertrophy (growth). Muscle growth occurs whenever the rate of muscle protein synthesis is greater than the rate of muscle protein breakdown. This adaption, however,



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you rest.

So how do you actually add muscle to your muscle cells? This is where Satellite cells come in and act like stem cells for your muscles. When activated, they help to add more nuclei to the muscle cells and therefore contribute directly to the growth of myofibrils (muscle cells). Activating these satellite cells may be the difference between what allows certain "genetic freaks" to grow massive muscles and what makes other people "hardgainers.2"

In one of the most interesting studies in the past 5 years, researchers showed that those who were "extreme responders" to muscle growth, with an incredible 58% myofiber hypertrophy from an exercise, had 23% activation of their satellite cells. Modest responders, who had a 28% growth, had 19% activation of their satellite cells. What is interesting to note, though, is that some people known as "non-responders" in the study had 0%



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Therefore, it seems the more you can activate these satellite cells, the more you'll be able to grow. So then the question becomes, how do you activate these satellite cells to increase muscle growth?

3 Mechanisms That Make Muscles Grow

Underlying all progression of natural muscle growth is the ability to continually put more stress on the muscles. This stress is a major component involved in the growth of a muscle and disrupts homeostasis within your body. The stress and subsequent disruption in homeostasis causes three main mechanisms that spur on muscle growth.

1. Muscle Tension

In order to produce muscle growth, you have to apply a load of stress greater



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this? The main way is to **lift progressively heavier weights**. This additional tension on the muscle helps to cause changes in the chemistry of the muscle, allowing for growth factors that include mTOR activation and satellite cell activation.³

Muscular tension also most dramatically effects the connection of the motor units with the muscle cells. Two other factors help to explain why some people can be stronger, but not as big as other people.

2. Muscle Damage

If you've ever felt sore after a workout, you have experienced the localized muscle damage from working out. This local muscle damage causes a release of inflammatory molecules and immune system cells that activate satellite cells to jump into action. This doesn't mean that you have to feel sore in order for this to happen, but instead that the damage from the workout has



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time by other mechanisms.

3. Metabolic Stress

If you've ever felt the burn of an exercise or had the "pump" in the gym, then you've felt the effects of metabolic stress. Scientists used to question bodybuilders when they said the "pump" caused their muscles to become larger. After more investigation, it seems as though they were onto something.

Metabolic stress causes cell swelling around the muscle, which helps to contribute to muscle growth without necessarily increasing the size of the muscle cells. This is from the addition of muscle glycogen, which helps to swell the muscle along with connective tissue growth. This type of growth is known as sarcoplasmic hypertrophy and is one of the ways that people can get the appearance of larger muscles without increases in strength.



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question is: how do hormones affect muscle growth?

How Do Hormones Affect How Muscles Grow?

Hormones are another component largely responsible for muscle growth and repair because of their role in regulating satellite cell activity. Insulin Growth Factor (IGF)-1, in particular Mecho-Growth Factor (MGF) and testosterone are the two most vital mechanisms that promote muscle growth.⁴

Testosterone is the main hormone that most people think about when working out with weights, and there seems to be some validity to the thought that testosterone increases protein synthesis, inhibits protein breakdown, activates satellite cells, and stimulates other anabolic hormones. Although



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to 98%), strength training seems to help not only release more testosterone, but also make the receptors of your muscle cells more sensitive to your free testosterone. Testosterone can also stimulate growth hormone responses by increasing the presence of neurotransmitters at the damaged fiber site, which can help to activate tissue growth.

The IGF regulates the amount of muscle mass growth by enhancing protein synthesis, facilitating glucose uptake, repartitioning the uptake of amino acids (the building blocks of protein) into skeletal muscles and once again, activates satellite cells to increase muscle growth.

Why Muscles Need **Rest To Grow**

If you do not provide your body with adequate rest or nutrition, you can actually reverse the anabolic process



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muscle protein metabolism to a resistance exercise bout lasts for 24-48 hours; thus, the interaction between protein metabolism and any meals consumed in this period will determine the impact of the diet on muscle hypertrophy. Keep in mind there is a certain limit on how much your muscles can actually grow dependent on gender, age, and genetics. For instance, men have more testosterone than women, which allows them to build bigger and stronger muscles.

Why Rapid Muscle Growth Is Unlikely

Muscle hypertrophy takes time and is relatively slow for the majority of people. People will generally not see visible growth for several weeks or months as most initial changes are due to the ability of your nervous system to activate your muscles.



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from hormonal output, muscle fiber type and number, along with satellite cell activation, that can all limit muscle growth. To ensure you're doing your best to grow muscle, muscle protein synthesis must exceed muscle protein breakdown. This requires that you take in an adequate source of protein (especially essential amino acids) and carbohydrates to help facilitate the cellular process of rebuilding broken down muscle tissue. Visible muscle growth and evident physical changes in your body's muscle structure can be highly motivational which is why understanding the science behind how muscles actually grow is important.

How Muscles Grow: Conclusion

For muscle breakdown and growth to occur you must force your muscles to adapt by creating stress that is different than the previous threshold your body has already adapted to. This



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exercises so that you can damage more total muscle fibers and pushing your muscles to fatigue while getting a "pump." After the workout is completed, the most important part begins which is adequate rest and providing ample fuel to your muscles so they can regenerate and grow.

Have any questions about **how to get muscles to grow?** Leave a comment below.

Show 5 footnotes



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Rajesh

September 17, 2013 11:31 am

What an article. I am sure to not find a similar one in the whole internet.



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ensuring muscle growth. My question is – Still, only when we (at least for me) work out, the working muscles seems to be in its best shape and bigger., for eg. on doing push ups, one can immediately feel some expansion on the chest.

My biceps looks big and toned, only when I am working out for biceps, which is same for all my body parts. Why this, if the muscles are only breaking down at this point, while working out?

forgive me, I am not a native English speaker, if I havent put this question across, very well.

John Leyva

September 18, 2013 9:41 pm

@Rajesh – The reason the muscle looks bigger during the workout is because of the increased blood flow to the muscle while you're working out. This is the "pump" factor that I discussed in the article can definitely make the muscle look and feel noticeably larger



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Rajesh

September 19, 2013 4:19 am

Thank you. got it.

brad

January 9, 2017 2:56 am

myobrils are not muscle cells

Marc Perry, CSCS, CPT

January 16, 2017 6:57 pm

Hey Brad, I think John meant that it's a unit within a muscle cell

Ann Gales

September 17, 2013 12:50 pm

Excellent article which summarises it all well. Now just got to go and build that muscle...

Matt

September 18, 2013 1:36 pm



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what this is referring to.

Justin

September 19, 2013 4:35 pm

John, great article! Will combining weight lifting in the morning and cardio exercises in the afternoon prevent me from getting the necessary rest? In addition, will working out through slight soreness help alleviate and expidite my recovery or hinder it? Thanks.

John Leyva

September 20, 2013 12:01 pm

@uncandego – The first question that really needs to be addressed is if you're taking in enough protein in order to repair the muscle tissue that's being broken down through your workouts. In addition to that, the second question is how's your sleep and stress levels. Third is really are you taking in enough calories overall. If you're not taking in enough protein, your body will have a hard time recovering from the workouts, whereas if you're



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protein's benefits for your muscles. If you're not taking in enough calories, and more carbs will help here if you're not primarily working on losing weight, then again, your body may not be utilizing the protein effectively to help you recover. The epsom salt baths should help as it allows for an increase in magnesium which has been shown many people are deficient in.

Sometimes though a week off can help the body's response to exercise as it not only rests your muscles but nervous system. If all of those things are in line, then you might want to consider taking some BCAA's before and during your workout. (You can find more info here:

https://www.builtlean.com/bcaasupplement/) If that doesn't help, I would add a multi-vitamin with enough of B-complex as some people have a hard time utilizing BCAA's effectively if they are



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Marc Perry, CSCS, CPT

September 20, 2013 12:07 pm

Great answer, John.

John Leyva

September 20, 2013 12:14 pm

@Justin – Glad you liked the article. Breaking up the weight lifting in the morning and cardio in the afternoon should be sufficient time for you to rest and recover. This is really dependent though on how hard you're pushing the weights and how intense the cardio is. If both are intense multiple times per week, you may have a hard time recovering consistently and might need to take an "easier" week every once in a while.

As for working out through slight soreness, you should be able to workout at a moderate level and that will help to speed up the recovery process, but too intense and it might hinder it.



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factors that come into play that include the intensity of the workouts, your workout experience, your nutrition, genetics and overall goals. For example, if you've been working out hard for years and are taking in enough protein/calories, and have trained yourself to work the same body part multiple times per week, you might be able to recover faster and without soreness after a few weeks. An example would be someone working construction might be sore the first day or few weeks, but after a while their body can adjust to the work load. On the other hand, if you're not taking in enough calories/protein and are a relative novice, there might not be much benefit to the extra work. If you have any other questions, let me know. Thanks.

uncadonego

September 20, 2013 5:00 am



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actually get to the point where it's hard to fall asleep. Three or four sessions a week is fine most of the time, but I just finished taking seven straight days off of weight lifting and feel much better now, and I'm ready to start again.

Epsom salt baths help a lot.

Is this normal?

Marc Perry, CSCS, CPT

September 20, 2013 10:45 am

That's actually not normal. It could be from a number of things including dehydration to some type of vitamin/mineral deficiency. John should be able to hop in to the conversation and give you some more ideas.

Marc Perry, CSCS, CPT

September 20, 2013 12:21 pm

See John's response to your question above.

uncadonego

September 20, 2013 12:27 pm



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Zach

September 21, 2013 5:43 pm

Great article, never found before such detail and concise text. Thank you. I am curious to know how it happens when we stop the workouts. I recently had to stop them for 20 days due to a liver issue, which is now solved. I noticed that after three days of lighter workout than I was used to, I was again in shape to perform the same weight and workout routine as before. How this would work for longer periods, will the muscle gain by muscle damage revert completely if we stop excercising?

John Leyva

September 29, 2013 3:50 pm

@Zack – This question really varies from individual and is based on a number of factors that can influence how quickly you lose strength, including muscle fiber type and recruitment, your absolute strength levels, your overall experience, if you were over-training before the layoff, etc.



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but research has shown that you can stave off most decreases in strength by performing at least one workout per week, where you work up to at least 80% of your 1 RM for as many reps as possible. This helps to maintain strength levels (or 90%) for up to a month. If you're not going to be doing anything, then those other factors really come into play. If you're good at accessing the muscle fibers, then you will be better at maintaining your strength levels and that's usually associated with how long you've been working out. If you have average or slightly above average strength levels, then you should be able to maintain most of your strength for 2-3 weeks without too much of an issue after a couple of workouts. A longer time period than that and your strength levels will tend to drop more significantly.

Muscle loss though is based on different factors and is usually



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be harder to maintain it), your diet while not working out (the higher the protein and carbs, usually the less you'll lose), your baseline hormonal levels and overall stress on your body. I know people that have taken years off and bounce back within 2-3 months to where they were years ago, whereas other people take 2 months off and it takes them 6 months to get them back to where they were previously.

Zach

September 30, 2013 6:26 am

Then it depends on each person. Just to share an interesting fact: I almost never feel muscle pains. That is, I feel that normal ache during the sets with freeweights and when reaching failure I feel the muscles burn. I usually do all the sets until failure, but while a friend next day cannot move his worked out muscles, I feel absolutely nothing. It is as if I



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do with metabolism. John, thank you for the insight. This is among the best websites on the subject. Really good technical stuff.

Deepak

September 23, 2013 3:44 am

Excellent article John..Thanks for sharing your inputs...Great job Marc with BuiltLean, Keep up the good work!

Jean

August 3, 2016 6:31 pm

Can you by chance tell where your body will build muscle? I cross fit 4 times a week and was curious to know why my shoulders seem to be building more muscle than my legs. I'm a late 20's female. Before I did cross fit I used to just strength train at the gym and never saw any of the gains or strength I have now. Is the way your body builds muscle dictated by hormones almost like the way it stores fat?

Kristin



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You can influence where your body puts on *more* muscle by targeting specific muscle groups with more volume. That's how bodybuilders shape their physiques. If you want bigger shoulders, then target your shoulders. If you want more developed quads, then target your quads.

That being said, your genetics also influence your ability to build muscle, and can absolutely affect where you experience more muscle growth.

From what I know of crossfit, there is a pretty heavy influence on shoulder movements and strength – front squats, overhead squats, burpees, cleans, snatches, split jerks, overhead presses, handstand push ups, muscle ups, push ups, thrusters... all of these exercises involve the shoulders. I strongly believe that the way you move your body (the workouts and



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top performing females in Crossfit, they all have very developed shoulders.

If you want to see more leg development, I would recommend performing more leg-specific exercises, such as back squats, deadlifts, lunges, etc.

-Kristin, BuiltLean Coach & **Managing Editor**

Rahul

August 6, 2016 2:08 pm

Hello

I have good cutting in my lean body but that is not bulking up while following a good diet charts with proteins ,creatine's with carbo.so sir what I have to do .I have wasted so much money on these things but no output occurs

Marc Perry, CSCS, CPT

August 6, 2016 4:36 pm

Rahul – follow the basics (1) eat more calories, (2) use progressively



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for example, if you can bench 155 pounds for 10 reps, then 6 months later you can bench 185 pounds for 10 reps, you will be bigger. And of course get plenty of sleep!

Supplements are mostly a waste of money, they are responsible for maybe 5% of your results.

elaisa barinjque

August 8, 2016 2:59 am

t.y

Rao tahir

August 11, 2016 1:59 pm

Good job john
I have learn 2 thing
For the growth or to build muscle
exercise 3 or 4 times in week and
For the break down of muscle exercise
daily????

david rowland

October 15, 2016 12:20 pm

doctor may you give me a tables of foods that I need to eat while doing



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goes in hand with the foods

Kristin Rooke, CPT

October 15, 2016 6:12 pm

Hi David,

If you're interested in a workout and nutrition program to get lean & strong, then I highly recommend checking out our Transformation program.

The BuiltLean Transformation program is a 12-week fat loss plan that tells you exactly which exercises, and what foods to eat. The workouts are designed to be challenging, effective, and efficient. They require minimal equipment, so they can be performed at home or in a gym.

The nutrition program is comprised of simple recipes using mostly whole food ingredients. Each meal and snack contains protein, and a healthy mix of fats and carbs. The meals are delicious and satiating,



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Definitely check out the program, and if you have more questions, feel free to contact us at support@builtlean.com

-Kristin, BuiltLean Coach & Managing Editor

Dr. Jason Ong

October 21, 2016 3:05 am

Hi John, May i seek your permission to use the pictures for my book on medicated oil. Thank you.

Kristin

October 21, 2016 5:17 pm

Hi Dr. Jason,

We purchased the image on a stock photography website, and we don't have a link to the image. If you like that image, we recommend finding a similar one on a stock photography website and purchasing it for use in your book. Hope that helps!



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zach redick

November 2, 2016 2:33 pm

OK THAT GOOD

zach redick

November 2, 2016 2:33 pm

this is going to help you grow

Normand Boccanfuso

November 11, 2016 7:30 pm

I, and also my buddies, ended up analyzing the good helpful tips located on your site. Before long though, I developed a horrible feeling because I never thanked the blog owner for those secrets. Most of the boys have been so stimulated to read through all of your articles and have in effect without a doubt been making the most of these things. I appreciate you for being very helpful as well as for figuring out this sort of notable things that millions of individuals are really needing to be informed on. Our sincere apologies for not saying thanks earlier.



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Hey Normand,

Really glad to hear that you and your buddies have been able to apply the lessons, information, and workouts you've learned on BuiltLean! We're purposeful about providing you with the most relevant, scientifically-proven strategies to get lean & strong. Thanks for sharing, and we hope you and your buddies keep reading.

-Kristin, BuiltLean Coach & Managing Editor

Olufeeky

November 18, 2016 6:36 am

Anytime I wake up, I usually notice too much muscle on my legs and hands, do I have to reduce my exercise which I normally do then? Please, is there any side effect and if there is, what is the way out? Thanks

Kristin Rooke, CPT



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understand what you have going on. Do your legs and hands look bigger in the morning, and then smaller later in the day? If that's the case, it sounds like you might be experiencing edema. Edema is swelling caused by excess fluid trapped in your body's tissues, usually due to injury or inflammation. However, I'm not a medical professional, and as such, am not allowed to diagnose symptoms or suggest treatments. I would recommend seeing your primary care doctor to discuss what you're experiencing, and to determine the cause and any potential negative side effects. I hope that helps! If you have more questions, feel free to reach out to support@builtlean.com.

-Kristin, BuiltLean Coach & Managing Editor

Dhananjay

November 28, 2016 1:15 pm



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exercise?

Kristin Rooke, CPT

November 28, 2016 2:22 pm

That's a great question. Honestly, it varies from person-to-person, and depends on factors such as your genetics, your current fitness level, your workout program, and your nutrition. Because of genetics, some people put on muscle more easily than others. And if you're new to exercise, you can expect to see muscle growth and development within 4 weeks of starting a strength training program.

All that said, if you follow an effective muscle building workout program while eating slightly more calories than you burn every day, you should be able to build muscle. Under optimal conditions, you can gain up to around 1-2 lbs of muscle per month.



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Gayle Ellenbee

November 29, 2016 2:14 am

I love the efforts you have put in this, appreciate it for all the great blog posts.

luwy

December 8, 2016 7:15 pm

great post for guys aiming to build sweet muscles.

Kristin Rooke, CPT

December 9, 2016 11:31 am

Glad you found it helpful!
-Kristin, BuiltLean Coach &
Managing Editor

Rachel Shorland

January 4, 2017 2:41 pm

Hi

I want to build muscle and tone but because Iv had Fibromyalgia, (this is not a question about curing FM, I'm in that faze)I find if I try any resistance exercise, specifically strength training,



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Iv built up a running programme which I react well to (endorphins mainly) I think! The very 'stress' you have to put on a muscle to make it 'grow, triggers my body into FM! I can't find ANY info on what I CAN do or if it's actually possible to 'grow' them! I wonder if you have any experience in this or theories? Thank you

Kristin

January 4, 2017 4:09 pm

Hi Rachel – your story is amazing, and it's awesome that you're starting to find exercises that work for you. I would recommend chatting with your primary care doctor, or a physical therapist to determine the best way for you to start building strength. A physical therapist (especially one who has experience with FM) should be able to help you design a progressive workout program to build your body's tolerance of strength training.



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session causes a flare up, then do less. For example, do 1 set each of 10 push ups, 10 bodyweight squats, and 10 cross body crunches. If you don't experience a flare up, stick with that bare-bones program for about 4 weeks. Then add on, increasing it to 2 sets, etc.

Again, consult with your primary care doctor or a physical therapist before starting any new workout program. That's incredibly important. That said, good luck & keep us posted on your progress!

-Kristin, BuiltLean Coach & Managing Editor

Rachel Shorland

January 4, 2017 5:33 pm

THANKYOU for your reply! Iv been trying to find a strength trainer who's experienced with FM but no joy! Iv worked it all out myself so far (Iv got a good supportive Doc in the back ground) hence the running and I surf!! I think your right, I'm going to have to



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just want to know if it will actually do anything! I.e build muscle tone .. eventually! Or at all! Or if it's just not! FM advice is so vague there's such a huge gap I can't find anything concrete! Maybe it's because there isn't any! I'm a sports therapist so have a real anatomy interest in this! I'll keep searching! Thank you?

Patrick

January 30, 2017 1:11 pm

Will working out for longer work instead of heavier and heavier weights?

Marc Perry, CSCS, CPT

February 3, 2017 2:57 pm

Possibly, but to maximize your results, both exercise volume and progression (lifting heavier weights or using more challenging exercises) are important. You can choose harder exercises which add more stress to the muscle instead of using heavier weights.



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Are there any negative effects in body building?

Marc Perry, CSCS, CPT

August 22, 2022 12:13 pm

Hey Matthew – It depends how you define "body building". At BuiltLean, we've shifted to an approach that focuses on function over targeting muscle groups. See The Functional Fitness Approach to Getting Lean & Strong for more information.

Dan

March 13, 2024 10:14 pm

How unusual is it for a 50yo man that has never lifted to experience extreme muscle growth after one week at the gym? The change is enormous. I am 220 lb and look like I have been hitting the gym for years. I'm nervous as to why so quickly.

Marc Perry, CSCS, CPT

March 14, 2024 12:55 pm



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Noah F.

April 21, 2024 3:47 pm

This article and the responses given to all the really great questions are amazing!!!!!! I have only recently started my fitness journey in earnest over the past six months. I really started off wrong so to lack of education and over did my walking and only did that. While my endurance increased I didn't see the progress. I added on an app that helped start me off on physical therapy due to chronic pain and that improved my ability to do more and expand my exercises with another workout app focused on my goals of weight loss and muscle growth.

While it's been a slow process I've started to learn on how to exercise and more importantly when and how much. I walked several miles a day and didn't see much change. Then I talked to my doctor and others who knew more and found out I was over doing it and only focusing on one thing. I pulled back the



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physical rehab one I noticed improvement. The second app which was more intense showed me I wasn't doing crap with all that walking. First day after I was walking like a newborn giraffe which struck me cause I thought I was captain America with all the miles I could do. Iol. As I said lots of mistakes.

I now understand the importance of rest and diet as well as the importance of mixing up the types of workout. The article helped me understand what I am now doing via this app schedule with recovery time is one of the things contributing to the changes I've seen. In addition the workout plan is different each time so not only is it keeping me motivated and I'm not bored but it's doing what the article is saying to do in order to build muscle properly.

My eating a high protein diet has helped despite me not grasping in depth why it was helping. It truly helps a person like to know the mechanism behind the process that helps make progress. Many of the actions I've taken



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accompanied by a quick and painful crash. Starting off poorly gives poor results. I can't wait to read more from Leyva and this site. I'm still learning and felt motivated to comment. Time to get back to work and be patient for results on this lifelong journey.

Marc Perry, CSCS, CPT

April 22, 2024 2:40 pm

Hey Noah – Very glad to hear you found this article helpful! As you said, fitness is a journey. Good luck!

Comments are closed.

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At BuiltLean, we empower busy professional men to become leaner, stronger, and more

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22 Feb at 3:37 pm

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