

Introduction to Fitness

A Technical Book on Fitness

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Chapter 1

Introduction

I have no background in fitness or nutrition. In school I studied Computer Science and now I work as a Software Engineer. What made me get more into fitness was my weight: I was fat. Multiple times in my life. First, growing up as a kid I was fat and I managed to lose the weight in secondary school just by eating less. Second time I got fat was in university, just because I lacked any motivation to study for exams and would power my way through with food and energy drinks. After uni I found it much harder to lose weight than I previously knew. I would follow a lot of diets (keto ¹, food replacement like soylent ² or huel ³), sometimes going really low in calories intake, feeling like I have no energy and gaining the weight back on after ending the diet. I needed a better solution to this: I decided to start going to the gym.

I guess my goal was to build muscle and lose fat. I've always liked muscles as a kid, just never got the time to look into it and start working out. This was my chance. I had a lot of questions: how do I train? What do I eat? Are there other things I need to pay attention to? One solution would be to hire a personal trainer to help me achieve this goal. What stopped me from doing this is the way my brain works: I knew I would just be given a list of things to do without any explanation. I really like to understand how things work and I would end up being disappointed. This is also a big part of my life by now, I definitely wanted to understand well how everything works. I started looking into fitness the same way I look into everything: start searching on google, looking at professional bodybuilders, what they say, does it make sense etc. I feel that if you want to know a subject really well you should look for competitions related to that subject, and see what the people involved have to say about it. This is why I started following people that compete in bodybuilding shows, strongman competitions and so on. What bothered me was how poorly organised the fitness information I found was. I couldn't find a single place that could take me from 0 knowledge to getting started in a matter of few hours. I had to watch a lot of youtube videos, read a lot of articles and posts in fitness communities until things were clear in my head. Now that I know all this information I think it's possible to put it all in one place: this is the purpose of this book, to get you started with your fitness journey, especially if your goal is to build muscles and lose fat. And as I understand, this is the case for most people working out.

¹Ketogenic Diet on Wikipedia

²Soylent on Wikipedia

³Huel on Wikipedia

I just want to stress out: there is nothing wrong with being fat. If you get really fat it is unhealthy and you'll end up with health problems. However, the main reason I don't want to be fat is because I get anxiety from it. I feel like crap, especially if I take my shirt off in public. Saying I don't care about it is just lying to myself and I try my best to not do that, just for my mental health. This anxiety is something I can't control so for me the only solution would be to stay in shape. Besides, I already said I like muscles, so becoming muscular would make me feel proud of myself.

The book is structured in two parts: nutrition & workout. There is a lot of information in here, you don't necessarily need to understand all of it to get going. That's why at the end I just added an example of everything I did to get in my current shape without extra explanations. I will try my best to present information in an unbiased way, presenting what people think works and what not, what I tried on myself etc. If you think something is wrong or don't agree with some of the information presented here, this is an open source book so feel free to submit a PR! ⁴ At the end of the day I am a practical person, I only believe in results and what works in real life. I can say that the information I describe in this book worked really well on me, as you can see in the picture below.



Figure 1.1: From fat to muscular in 7 years: my lifelong struggle with being fat

⁴About Pull Requests on Github Docs

Chapter 2

Nutrition

2.1 Calories, BMR, TDEE

I feel like I need to explain how food works first before anything else. Your body is an energy convertor. It gets energy from food ¹ and converts it to heat, movement (kinetic energy) and electrical energy for thinking. The amount of energy needed without movement (so for heat, thinking and perhaps others things too) is referred to as basal metabolic rate or BMR ² and it doesn't change much from day to day. If you include the energy for movement too you get your total daily energy expenditure or TDEE. If you eat more than your TDEE in a day, the extra food will be stored on your body either as fat or muscle. If you eat less then your body will have to go to fat stores and muscles and break them down to get the extra food energy you need. Energy is measured in *kcal*, but most of the time you will only see the term calorie with the same meaning (basically *kcal* is the scientific term which was replaced by calorie when it started being used by food industries). To put energy values into perspective, the average human would need 2,000 calories for heat every day, or so I've seen in a physics course a long time ago. If I run on the treadmill for 1h I get a message that I burned roughly 600 calories. 1 Big Mac has almost 600 calories. It's important to understand that knowing exactly how many calories a meal has is next to impossible. There will always be small differences in every ingredient you use. For example not all loafs of bread are the same size, not all strawberries contain the same amount of sugar and so on. It's also impossible to know exactly how much energy you burn in a day. However, estimates work really well in practice. As long as you eat the same meals every week, you will either lose, gain or maintain weight.

People have tried to come up with formulas to compute BMR from different factors, such as height, age, sex or body fat percentage (this is just the proportion of fat you have in your body relative to your whole mass, so $100 \times \text{fat mass} / \text{body mass}$). At first only mass (m), height (h) and age (a) were taken into account in Harris-Benedict formula for BMR from 1919 ³

$$BMR = 13.7516m + 5.0033h - 6.755a + 66.4730 \quad (2.1)$$

¹Food Energy on Wikipedia

²Basal Metabolic Rate on Wikipedia

³Harris-Benedict on Wikipedia

This formula was later revised in 1984 with just a few minor changes. Later in 1990 Mifflin St Jeor ⁴ came with 2 formulas for BMR, one for men (2.2) and one for women (2.3).

$$BMR(\text{males}) = 10m + 6.25h - 5a + 5 \quad (2.2)$$

$$BMR(\text{females}) = 10m + 6.25h - 5a - 161 \quad (2.3)$$

Finally Katch-McArdle ⁵ included body fat percentage (f) into the equation, removing age and height

$$BMR = 370 + (21.6m(1 - \frac{f}{100})) \quad (2.4)$$

This is an interesting point because body fat percentage does affect how many calories you burn even at rest. The rule I know is that 10 pounds of muscle would burn 50 kcal in a day at rest, while 10 pounds of fat will only burn 20 kcal ⁶ (less than half), so if you're 80kg with 15% body fat you will burn more calories at rest than someone who is 80kg with 20% body fat. This also explains the Mifflin St Jeor above, since women have naturally more fat than men.

Let's take an example using the last formula: if you weight 70kg and your body fat percentage is 18% then your BMR should be $370 + (21.6 \times 70 \times (1 - 18/100)) = 1609.84$ calories. Add your movement energy to this and you get your TDEE. I haven't spent the time trying to derive how to compute this one (e.g. from kinetic energy) because all of these formulas are great but at the end of the day they are just for your orientation. The best way to compute your TDEE is to actually measure it: without changing your habits, eat 2,000 calories every day for 1-2 weeks. Weight yourself every day: does your weight change? If no then it's safe to assume your TDEE is 2,000 calories. Does your weight go up? It probably means your TDEE is lower. Keep adjusting your calories intake until you find your TDEE.

In theory you should be able to tell your TDEE without having to change your diet again just by looking at how much weight you gained / lost in the initial 1-2 weeks: you should lose 1lb (or 0.45kg) of mass at a total deficit of 3500 calories ⁷. Let's take an example again: you ate 2,000 calories for 2 weeks. During these 2 weeks you gained 2.2lbs (or 1kg) on the scale. According to the 3500 rule, you were at a total surplus of $3500 \times 2.2 = 7700$ calories. This surplus was achieved in 14 days, so the surplus each day was 550 calories. This means your actual TDEE is 2,550 calories. However I found this rule to not work on me, trying to adjust accordingly didn't put me at maintenance and I kept changing weight. As long as you always adjust to results you will be fine. I would personally start with an online TDEE calculator ⁸ (there are plenty out there) just to get a value to work with, then keep adjusting intake until I hit my maintenance.

2.2 Body Fat Percentage

Body fat percentage is discussed a lot in fitness because it affects how you look. Fat is something that is stored on your body between skin and muscles. The more fat you have

⁴A new predictive equation for resting energy expenditure in healthy individuals (1990)

⁵Essentials of Exercise Physiology Book by Katch & McArdle (2006)

⁶Burning Calories on WebMD

⁷What is the Required Energy Deficit per unit Weight Loss? (2008)

⁸Example of online TDEE calculator

on you the less visible your muscles will be. However, just taking the absolute value of fat mass is not a good indicator of how well your muscles are showing, since taller people will have more fat mass but more body surface to spread it across. So instead we can look at the proportion of fat in relation to muscles. The body fat percentage will normally dictate certain features you can see on your body, for example the average guy will have his abdominal muscles ("abs") showing around 10-14% body fat ⁹. To better understand what I'm talking about look at the image below that I found on builtlean.com ¹⁰. I cannot confirm the numbers to be correct but they give a good indication in my opinion to what body fat percentage looks like at different values (note that lower body fat percentage will not give you bigger muscles, it just happens to be the case in the pictures). Usually people say that an ideal body fat % (both in terms of health and looks) is around 12% for men and around 24% for women. Another thing to keep in mind is that your genetics will influence how low in body fat % you can get. For some men reaching 5% might be impossible without taking steroids for example. Also going under 10% is usually not considered healthy anymore, a lot of people complain about mood, sleep and even sex drive problems once you are that low in body fat % ¹¹.



Figure 2.1: Different body fat % for both men and women

⁹Healthline Article on Abs

¹⁰Body Fat Percentage Photos Of Men & Women

¹¹VitruvianPhysique on Optimal Body Fat % on Youtube

Computing body fat percentage is not easy. There is no 100% accurate way of doing it. You can take pictures of yourself in the mirror and then compare with the images above, a lot of people estimate this way and I find it good as well. If you want a more accurate way of doing it though, there are a few options out there. The most accurate way is an MRI scan¹². However this is not available to the public as far as I know. This leaves us with the second most accurate option I know, which is a DEXA scan¹³. This is a machine that does an x-ray scan of your body. It shows quite some details, for example the lean mass and fat mass in your arms, trunk (core) and legs. You can see an example of a DEXA scan result below.

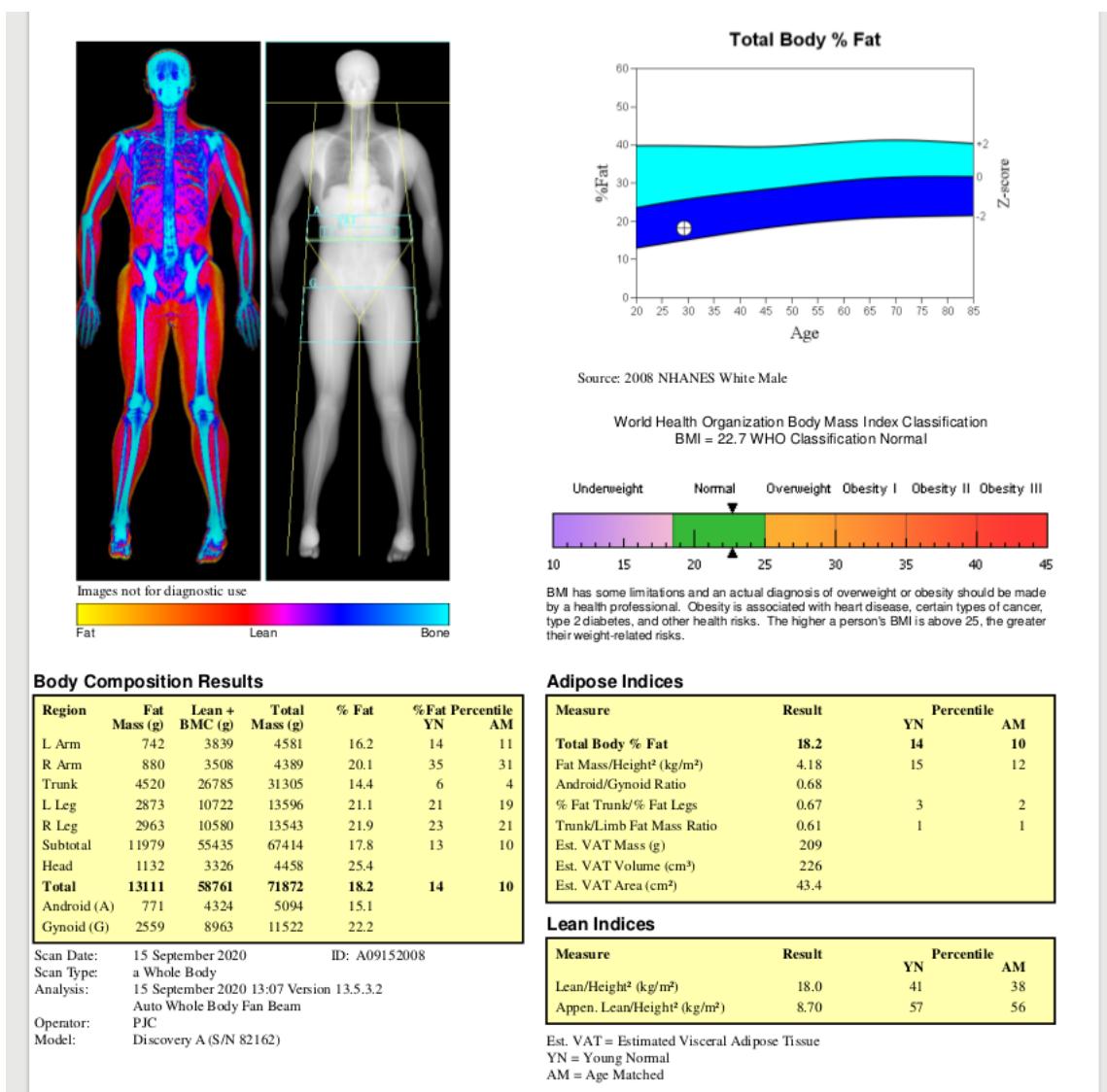


Figure 2.2: Result of a DEXA scan, showing body fat for different body parts

¹²Cadaver validation of skeletal muscle measurement by magnetic resonance imaging and computerized tomography

¹³DEXA on Wikipedia

However, DEXA scans can have errors too, and a lot of people talk against it¹⁴ ¹⁵. The scan is also expensive, I did it in London at bodyscan for roughly £100.

Before DEXA scans, hydrostatic weighing¹⁶ was considered the most accurate method available to the public. You had to step on a scale underwater and the value you get helps estimate your body density, which can be used to approximate your body fat percentage. Another way of estimating body fat percentage which is similar to hydrostatic weighing is whole-body air displacement plethysmography¹⁷ (for example Bod Pod¹⁸).

More common methods of estimating body fat are the skinfold methods¹⁹ (using a device called caliper) and using bioelectrical impedance analysis²⁰. The first method tries to determine the thickness of the fat layer under the skin. You use the caliper at various spots on the body and look up the measurement in a table which will tell you the estimated body fat. It's best if you use a personal trainer or someone with experience to perform the reading. For bioelectrical impedance analysis a small electric current is sent through the body and the resistance of the whole body is computed, which depends on body fat percentage. Some scales also state they can compute body fat percentage just from your weight, height, age and sex. However this is not really possible unless you don't train at all and the extra weight comes from fat alone. Just to recap all the methods described in this section, from most accurate to least one:

1. Magnetic Resonance Imaging (MRI) and Computerized Tomography (CT)
2. Dual-energy X-ray absorptiometry (DEXA / DXA)
3. Hydrostatic weighing
4. Whole-body air displacement plethysmography
5. Skinfold methods (calipers)
6. Bioelectrical impedance analysis

2.3 Macronutrients

The food you eat can be broken down into different components. The stuff that gives you energy (e.g. for movement) is called macronutrients — these are carbohydrates (carbs), fat & protein. The stuff that doesn't give you energy is called micronutrients (e.g. vitamins & minerals). You still need micronutrients to be a healthy individual. The reason people talk so much about macronutrients (or macros) is because your body process them differently: carbs can be broken down and used for energy faster than fats, proteins are the only macros

¹⁴Greg Doucette on DEXA Scans on Youtube

¹⁵Brain Shaw on DEXA Scans on Youtube

¹⁶Hydrostatic Weighing on Wikipedia

¹⁷Air Displacement Plethysmography on Wikipedia

¹⁸Bod Pod

¹⁹Skinfold Methods on Wikipedia

²⁰Bioelectrical Impedance Analysis on Wikipedia

that can be stored as muscle on your body and so on. It's hard for you to tell how many carbs, fats and proteins the food you're eating contains. You have to read the label or research in advance. To give some example of macros in different types of food: bread is mostly carbs, in 100g of bread you have 49g of carbs, 9g of protein and 3.2g of fat. This composition is also what tells us how many calories 100g of bread has. The rule is that 1g of carbs has 4 calories, 1g of fat has 9 calories and 1g of protein has 4 calories, just like carbs. If we add these values up for bread we get $49 \times 4 + 9 \times 4 + 3.2 \times 9 = 196 + 36 + 28.8 = 260.8$ calories. Your body can convert carbs and proteins into fat to store on your body as fuel for future days, but it cannot convert back fat to carbs or proteins. It's worth mentioning that fats and carbs cannot be converted to proteins either, so for building muscles you need proteins from food alone, since there's no way to store proteins on your body.

There are different theories that you should eat this many grams of carbs and this many grams of fat. One such example is the zone diet²¹. This says you should eat 40% carbs, 30% fat and 30% protein. For example, if you need to eat 2,000 calories a day and want to follow the zone diet, you should aim to eat 145.5g of carbs (582kcal), 109g of fat (981kcal) and 109g of protein (436kcal). However, from my experience it doesn't really matter how you split carbs and fat, it's just a matter of preference. At the end of the day it's calories in and calories out that matters²². You should pick a diet you feel comfortable with, so if you like carbs just eat more carbs, if you like fat just eat more fat. It does matter how much protein you have though, since it's the only thing your body can use for muscle growth. A common recommendation for building muscles is to eat 1g of protein per pound of body weight, or 2.2g per kg²³. For example, if you weight 70kg you should eat 154g of protein every day. If you really want to try and follow a certain macro split, you might want to compute how many grams of carbs, fat and protein to consume based on their percentage. I know I had to compute this when I was trying to follow certain percentages. To make your life easier you can plug in your values into the formulas below. The value c is the percentage of carbs, f is percentage of fat, p is percentage of protein and T is the total caloric intake:

$$Carbs(g) = c \times \frac{T}{4 \times c + 9 \times f + 4 \times p} \quad (2.5)$$

$$Fat(g) = f \times \frac{T}{4 \times c + 9 \times f + 4 \times p} \quad (2.6)$$

$$Protein(g) = p \times \frac{T}{4 \times c + 9 \times f + 4 \times p} \quad (2.7)$$

In our previous example, $T = 2000$, $c = 40\% = 0.4$, $f = 30\% = 0.3$ and $p = 30\% = 0.3$. If we plug these values in the formulas above we get

$$\frac{T}{4 \times c + 9 \times f + 4 \times p} = \frac{2000}{4 \times 0.4 + 9 \times 0.3 + 4 \times 0.3} = 363.63$$

$$Carbs = 363.63 \times 0.4 = 145.5g$$

²¹The Zone Diet on Healthline

²²Greg Doucette on Macros on Youtube

²³Protein Intake on Healthline

$$Fats = 363.63 \times 0.3 = 109g$$

$$Protein = 363.63 \times 0.3 = 109g$$

2.4 Fat Stores, Distribution and Carb Stores

If you eat more than you should in a day, so more than your TDEE, your body will store the excess food either as fat or muscle on your body. As I previously mentioned, only proteins can be stored as muscle and only if you train accordingly (more on this later). The way fat gets stored across your body (fat distribution) for example on arms, belly, hips etc, depends on genetics and you can't really influence it unless of course, you undergo surgery to remove fat cells from a specific area on your body. For example some people store a lot of fat on hips, other store it on legs and bums, others on face and so on. One clear factor that influences fat distribution is gender, usually women will store fat on legs, bums, arms and breasts while men will store most fat around their belly. I have a pretty unfortunate fat distribution, since I store fat the same way women do, I get a lot on arms, legs, bum and even around breasts. I used to think this is due to hormonal imbalances (maybe too much estrogen and too low testosterone) but it turns out this is not the case, since my testosterone levels are really high and estrogen really low. From what I've read, the fat distribution is influenced by fat cell receptors: alpha-2 and beta receptors. The beta receptors will release fat while the alpha-2 will stall it, so the ratio of alpha-2 to beta receptors will dictate how you lose or gain fat in different places on your body ²⁴ ²⁵. I don't know much more about it, but it seems to be purely genetic. The important thing to remember here is that you cannot control how your body stores or burns fat and from which areas. This is also what people mean when they say that losing fat is not site specific, you cannot burn fat from your belly just by doing crunches. Your body will decide where it takes the fat from based on the receptors I previously mentioned.

Your body also has a carbohydrate storage just like it has for fat. This is used as an emergency source of energy, since the body can process carbs faster than fat, for example if you come face to face with a lion and you have to run for your life, the carb storage will be used instead of the fat on your body. Usually high intensity activities, such as sprinting really fast or lifting heavy weights for a short amount of time (anaerobic exercise) will make use of the carb stores. Just because you use carbs instead of fat it doesn't mean you will not lose weight if you are dieting. These carb stores are not permanent like fat, they get replenished every day (I usually associate this with computer memory — carb stores are like volatile memory or RAM while fat stores are like disk memory). So if you burn 100kcal of carbs in a high intensity activity, your body will take 100kcal of carbs from your next meal to replenish these stores, so your meal will have 100kcal less that can be stored as fat. At the end of the day, it's calories in and calories out that matters. Most of the carb stores are located in muscles and it's called muscle glycogen. You also have them in liver as liver

²⁴VitruvianPhysique on Body Fat Distribution on Youtube

²⁵VitruvianPhysique on Body Fat Distribution Part 2 on Youtube

glycogen and a little bit in blood as plasma glucose. An average human adult will have around 503g of carbs (2012kcal) stored in body: around 400g in muscle glycogen, 100g in liver glycogen and 3g as plasma glucose.

Glycogen is important to understand random weight fluctuations, because it holds water. If you suddenly stop eating carbs (so the keto diet I previously mentioned), you will completely deplete your body of glycogen. This will result in a sudden loss of around 2kg of water from your body, which has nothing to do with you losing fat. If one day you have more carbs than the previous day then it's highly likely that your weight will go up the next day just because you have more glycogen and more water in your body, and not because you suddenly gained fat. It's a thing to keep in mind while you are dieting, and not get scared when you see sudden jumps in weight. Glycogen manipulation is something bodybuilders do before a contest too (peak week), to make themselves look more muscular, but more on this later.

2.5 Bulking & Cutting

Your TDEE is the total amount of energy your body needs every day to be able to function properly. If you eat less than that, your body has to go to fat stores or muscles to get that energy. If you eat more, the excess food will be stored on your body as fat or muscle. This is the reason people say that you need to be at a surplus to gain muscles, if you are at a caloric deficit then the proteins that should be stored on your muscles will be used for heat and movement instead. This phase in which you eat more than you should to build muscles is called bulking. Being at a caloric surplus will make it impossible for you to burn fat however, in fact you might end up gaining fat mass as well since the body is not optimal at storing pure muscles. To get rid of the excess fat you need to put yourself at a caloric deficit when you try to burn the fat stores while keeping the muscles you gained. This phase is called cutting. Bulking and cutting are normal cycles for bodybuilders, they will bulk, cut, bulk, cut and so on. There are instances when you can build muscles and cut down fat at the same time, I experienced this on myself when I started training again after a 3 months absence. I've read that it can also happen when you start training for the first time or if you take steroids, but more on steroids later. Building muscles and losing fat at the same time is also referred to as body recomposition ²⁶.

If you keep training (e.g. lifting weights) while cutting, your body will value your muscles more than the fat, so it will rather use fat to get the extra energy it needs. This is an oversimplified explanation of how everything works, in reality it's more complex than this. A different explanation would be this: the body has workers that take macronutrients (carbs, fat & proteins) from food to places where they need to be. In this case the workers that take proteins to muscle is the testosterone in your body. Testosterone will race other workers that take macronutrients to produce heat and convert them to movement — these workers prefer carbs and fat over protein. Based on how much testosterone you have and how easy it is for your body to rebuild the muscles you might be able to use all the proteins you get to gain muscles while the body will have to go to fat stores to get all the energy, so basically

²⁶Healthline Article on Body Recomposition

building muscles and losing fat at the same time. I've seen this analogy of testosterone with construction workers used a lot in fitness.

Knowing your TDEE, what is the caloric surplus you should aim for during a bulking phase? Most people seem to go 10-20% more for what's considered a "lean bulk" ^{27 28 29}. For example if your TDEE is 2,500 calories a day, you should eat 2,750 - 3,000 calories to lean bulk. If you go more than that it's considered a "dirty bulk" in which you gain more fat than you should. This happens because there is a limit to how much muscle you can gain. Eating more might make you feel stronger, however strength and muscle growth are not perfectly correlated, but more on this later. Doing a dirty bulk means you'll be spending more time to cut the fat afterwards. It can also make you feel like shit, eating this much and dieting for so long. Sure it might give you more energy in the gym and make you even stronger but it all depends on what you want to achieve. If you want to stay in shape all of the time then it's probably not for you, since the only time you'll be in shape is at the end of a cut for a short period of time. A lot of people speak against dirty bulks ^{30 31} and I don't approve of them myself since I tried it once — I felt like crap, out of shape and it made no sense to me since losing fat was one of the main reasons I got into this. You might also experience stretch marks on dirty bulks if you gain weight too fast ³². One mistake I notice people make when bulking is that they fall into thinking that overeating junk food is fine, since they are bulking anyway. I made this mistake myself as well. You should still "diet" and track your calories and weight accordingly, and have cheat days if you really feel like eating junk food.

How much should you eat when cutting down? The same holds true as for bulking, you should aim to eat 10-20% less than you need every day. For a TDEE of 2,500 calories you should eat 2,000 - 2,250 calories. If you lose weight too fast there is the risk of losing muscles too, and you don't want this to happen since you worked so hard to gain them in the first place. What many consider a good and safe pace to lose weight is 0.45-0.9kg per week (or 1-2 pounds) ³³. The idea is that if you eat too little, your body will go into shock and try to use anything it can to keep you alive, including muscle stores. Transitioning from a bulk to a cut (and the other way around) should always happen gradually, to give your body time to accommodate ³⁴. I noticed this on myself, I increased my caloric intake by more than 1,000 all of a sudden and I gained quite a bit of fat in a short amount of time. I would personally go back to maintenance and stay there for 1-2 weeks before starting to lean bulk.

Now that you know about bulking & cutting phase, how long do you do each and how do you plan them? For example, you could be bulking for 4 months and cutting for 1 month. However, there is no standard here, it depends on a lot of factors — what type of bulk you did, how easy you gain fat, what type of cut you are going to do. A common approach is to pick your ideal body fat % (from experience or if you can't, just estimate it looking at

²⁷VitruvianPhysique on Lean Bulking on Youtube

²⁸Lean Bulk on Myprotein website

²⁹Mike Thurston on Lean Bulking on Youtube

³⁰Greg Doucette on Bulking and Cutting on Youtube

³¹Greg Doucette on Bulking on Youtube

³²Article on Stretchmarks on Bodybuilding.com

³³Losing Weight too Fast on Healthline

³⁴Transitioning from Bulking to Cutting on ironbuiltfitness.com

pictures) and try to stay close to that value when you bulk & cut. For example my ideal body fat % is 12%. I want to end a bulk at +5% of that value, so 17%, and a cut at -5% so 7% body fat. Since single digit body fat is not that amazing I'm happy to end it around 10% body fat. If you never lifted before I would recommend starting with a bulk (to gain muscles, increase your metabolism and train your body to burn fat easier) for 3-4 months. After this bulking phase, I would cut for however long it takes me to get down to 10% (could be 1 month or even 5+). After my cutting phase is over I would switch again to bulking until I hit 17-20% then cut down again to 10% and so on. Another thing to keep in mind is that you might want to end a cutting phase in a certain time of the year, for example before summer and then maybe maintain it over summer. This is also possible, you're in charge of however you want to split your bulking, cutting and maintenance phases. I would normally bulk over winter, like most people do and start my cutting phase in time to get down to 10% for the summer. I usually start my cut beginning of March to reach my goal by June. A more detailed explanation: let's say I am at 80kg at an estimated 17% body fat — this means 66.4kg lean mass and 13.6kg of fat. To get down to 10% keeping my lean mass means I have to go down to 73.8kg (66.4kg lean mass and 7.4kg of fat), this means I need to lose 6.2kg of fat. I know I feel comfortable with a diet where I lose 0.7kg per week. Doing the math, this means I need to diet for 8.9 weeks. Knowing that it gets harder to lose fat as you drop body fat % and that my cheat days will set me back quite a bit, I think 12 weeks is a safe bet for me to reach my goal physique, this means I have to start my cutting phase start of March to get in shape by June! Even if I don't hit my goal of 10%, I will be in pretty damn good shape for the summer.

2.6 Metabolism and Adaptive Thermogenesis

When people say metabolism they usually mean BMR, which is the amount of energy you normally need in a day without extra physical activity. I talked about BMR before, and that it should depend on mass and body fat percentage. When people say they have a fast or slow metabolism I take it with a pinch of salt, because I know it should mostly depend on mass and body fat percentage. What I know however from experience is that I'm really bad at estimating how many calories I eat in a day. If everyone would track exactly how many calories they eat and how much they burn through exercise then the BMR values should be in accordance with the formulas described above. While this is true for most people, BMR can actually change for the same individual at the same mass and body fat percentage. Remember when I said that the energy your body needs to produce heat makes up most of BMR's value? It turns out your body can change how much heat it produces (this has nothing to do with your body's temperature, you just radiate more or less heat in the surrounding environment) which can affect BMR. This happens usually if you are at a caloric deficit or surplus for a longer period of time, your body will try to adapt to your new intake. This process is called adaptive thermogenesis ³⁵, or metabolic damage ^{36 37}.

If BMR adjusts to your diet then how can you ever lose weight? This is not as bad as

³⁵Adaptive Thermogenesis in Humans Article

³⁶VitruvianPhysique on Metabolic Damage on Youtube

³⁷Greg Doucette on Metabolic Damage on Youtube

Macronutrients	Energy it takes to break it down
Proteins	20-35% of calories ingested
Carbohydrates	5-15% of calories ingested
Fats	5-15% of calories ingested

Table 2.1: Thermic effect of food

it sounds and it won't keep you from losing weight. From my experience, this metabolic damage is not enough to keep you from losing weight. The BMR changes are really slow and there is always a limit to how low it can get. Notice that as you lose weight you'll also burn less calories for movement since you have less mass, so to keep a steady weight loss pace you need to continuously adapt either your diet or your cardio. Eating less also means less calories burned, since it takes a bit of energy for your body to process the food you eat. This is called the thermic effect of food ³⁸. You can see the energy required to break down carbs, proteins and fats in Table 2.1. This is usually one of the reason people recommend food high in protein for diets, since they have less calories than advertised. The fact that it takes a lot of energy to break them down should also make you feel satiated for longer period of time. I will discuss high protein diets later in the book. Going back to metabolic damage, the good news is that it's not permanent and it has been proven to recover after you increase your caloric intake again.

I've never had any issues with my weight getting stuck at a certain value. I would advice against going too low in caloric intake, whenever I did that I would feel like crap with no energy. A better approach is to just increase the cardio you are doing in a day, just run more to burn more calories. Even if you do more cardio, stay at a comfortable deficit overall, being in a big deficit will result in you losing muscles, which will decrease BMR by quite a bit. As a final note, I don't think you can get stuck while doing cardio and training to build muscle (e.g. by lifting weights), if you eat too much you'll end up gaining more muscle which will increase your caloric maintenance value (also called set point) which should result in being at a deficit eventually if you keep eating the same.

2.7 Intermittent Fasting

You might have heard of Intermittent Fasting ³⁹ before. This is a diet where you allow yourself to eat only in a specific time interval (for example from 1pm until 9pm — this means skipping breakfast). I've heard many people saying how good this diet is for losing weight. A diet like this could work because it's harder to overeat in the 8h you are allowed to. I tried it in the past too and found it good for me. In my case it worked because I find it easier to stay hungry in the morning — I usually drink 1-2 cups of coffee in the morning and this suppresses hunger. I also feel I can focus better when I don't eat in the morning so I felt great overall. Some would argue that it's also good to train in the morning on empty stomach, since your body is forced to go to fat stores to get the energy it needs (I would assume this to be the case if your glycogen stores are depleted, so maybe while doing a keto

³⁸Thermic effect of food on wikipedia

³⁹Intermittent Fasting on Healthline

diet). Personally I don't think it really matters when you exercise, as long as you are at an overall deficit, and it might be easier to exercise after you had something to eat. The thing that I realised however is that if you train to build muscle, intermittent fasting might not be the best option for you. When you lift weights you damage the muscle, so a repair process will start to take place, also known as muscle protein synthesis. This process is known to take up to 36h ⁴⁰, or even 48h ⁴¹. While your muscles are being repaired, you need to have proteins available in your stomach to go on the muscle. This is why it's recommended to eat something high in protein before going to bed (preferably casein protein, which is slow digesting) and also in the morning (whey protein, which is fast digesting). If you skip breakfast and you stay on empty stomach for too long then the muscle protein synthesis process will not be optimal. After I realized this I stopped doing intermittent fasting even when cutting down. Some bodybuilders also speak against it if you're trying to build muscle ⁴².

2.8 Tracking Calories, Meal Prep, Cooking

So now you know your TDEE, you know whether you want to bulk or cut, so you have a caloric intake goal. To hit this goal you have to start counting how much you eat every day (as I've said before, I would advice against estimating this, since big errors will make it impossible for you to hit your goal). You can track in multiple ways, for example you can read the label of everything you eat and just write it down somewhere. You can also use a phone app to help you with that (for example myfitnesspal ⁴³ has such a feature). For me this seemed like a big burden, to always remember to log every meal and make sure I hit my calories for the day. An alternative would be to make a meal plan: you plan your meals for the week, you cook in advance and then you don't need to track anymore. This option worked really well for me, and I felt like it saved me a lot of time and money. However, not everyone enjoys doing this, making a meal plan is not straightforward, takes time to perfect and unless you try really hard to diversify it, it could feel a bit boring to eat the same dishes every day. You can try having a hybrid between a meal plan and tracking new meals. Just add a few important dishes to your every day plan (most likely something high in protein) and have an amount of calories and protein you still need to hit by eating something different every day. I personally don't care that much about eating something completely new every single day and I think others have similar feelings, they would have the same meals every other day.

I will describe how I made my meal plan for myself, but keep in mind this: making a meal plan is not something you do once and that's it. You might make an initial plan but this will have to change and adapt until it actually works for you and you're extremely happy and can stick with it. I started by making a spreadsheet with all the food I normally like to eat, splitting them into different sections (high in carbs, fat, protein etc) and adding their nutritional values. I then made a table where I can adjust the amount of each type of food

⁴⁰The time course for elevated muscle protein synthesis following heavy resistance exercise

⁴¹Exercise, protein metabolism, and muscle growth

⁴²Greg Doucette on Fasting on Youtube

⁴³MyFitnessPal website

and it will automatically add the calories and macros for the day. Once I hit how many calories and proteins I need in a day, I'm done. I then proceed to test my meal plan in the following week: do I lose or gain the correct amount of weight? Am I happy with my meal plan? Do I enjoy the meals? Does it keep me full and not hungry all the time? If the answer is yes to all these questions, then I'm lucky and I just made the perfect meal plan. If not, then I keep adjusting it, swapping food until I can answer yes to all the questions. I made a copy of my meal plan calculator spreadsheet available for everyone online at ⁴⁴. You can copy that spreadsheet to a private one for yourself to edit. Just update the *Food* column with the food you like, add the macros, add your goals on the bottom right then keep adjusting the units in the calculator until you hit your goals! You can see a picture of the meal plan calculator below (Figure 2.3) and also an example of a day meal plan I made using it for cutting down (Figure 2.4).

Macros in 1 unit					
Unit	Kcal / Unit	Carbs	Fat	Protein	
Food high in carbs					
Basmati Rice (Laila Foods) - uncooked	1g	3.51	0.84	0.005	0.08
Basmati Rice (Laila Foods) - cooked	1g	1.6	-	-	-
Mashed Potatoes (Tesco)	1g	0.76	0.126	0.019	0.015
Coconut Curried Potatoes (Tesco)	1 pack	238	37.6	5.2	7.4
Bread (Tesco Toastie)	1 slice	120	22.8	1.1	4.1
Bread (Small Toastie)	1 slice	70	13.1	0.6	2.6
Uncle Ben Rice - Wholegrain Rice	1 pack	412	76.8	6.6	9.2
Uncle Ben Rice - Golden Vegetables	1 pack	382	73.8	5.6	8.2
Jordans Country Crisp - Chunky Nuts	1g	4.74	0.577	0.208	0.109
Jordans Crunchy Oat Granola - Raisin & Almond	1g	4.12	0.616	0.126	0.099
Ready Brek - Porridge Oats	1g	3.74	0.58	0.087	0.12
Food high in fat					
Caramelised Onion Houmous (Tesco)	1 container	417	21.8	30.6	9.6
Feta Cheese (Tesco)	1g	2.79	0.01	0.23	0.169

Calculator				
Units	Kcals	Carbs	Fat	Protein
100	351	84	0.5	8
	0	0	0	0
	0	0	0	0
1	238	37.6	5.2	7.4
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
40	111.6	0.4	9.2	6.76

Figure 2.3: The meal plan calculator I use to create new meal plans. The foods I eat are on the left, I just add the units on the right and it automatically adds everything at the bottom so I can compare it with my goal

It might be difficult to decide what amount to use for each type of food. I started from experience (e.g. a typical chicken breast meal I buy from the supermarket has around 125g of chicken breast and 125g of rice or something similar). I also had to take into account the preparation process for these meals and in what quantities I can buy the groceries. For example, I can find 1kg of chicken breast, so using 200g a day for 5 days is really easy to do — cook the 1kg and split into 5. If I ended up in my spreadsheet with a random odd number for the amount of chicken breast in a day (like 167g), then buying for the week would be impossible without throwing some away. So there is a bit of tweaking the numbers until you get everything right. If you want to have different meals on different days you repeat the process until you have something planned to eat for each day. In my case I don't mind eating the same thing Monday to Friday, so I cook 5 times the amount of food I would eat in a day every Sunday for the next week. On the weekends I allow myself to eat different things, but I try to stick to food high in protein and fiber so I don't end up overeating. After I have a meal plan, I move it to a different spreadsheet and label it accordingly.

Cooking the food is not as hard as you might think. If you're not pretentious with your food then it doesn't require any cooking skills at all. I will describe the way I do it, which

⁴⁴Meal Plan Calculator on Google Spreadsheets

	Grams	Kcal	Carbs (g)	Fat (g)	Protein (g)	
Protein Powder - Pure Whey Isolate Almond Unsweetened Milk	1 scoop	115	-	-	26.1	9:30am - morning protein shake
	300ml	39	-	-	1.2	154kcal, 27.3g of protein
Basmati Rice	76	266.76	-	-	6.08	
Chicken Breast	200	276	-	-	62	
Feta Cheese	40	111.6	-	-	6.76	
2 Eggs	-	121	-	-	11.3	11am meal
Broccoli	200	70	-	-	6.6	845.36kcal, 92.74g of protein
Salmon	100	225	-	-	23	
Mixed Vegetables	200	68	-	-	3.8	3pm meal
Bread	1 slice	93	-	-	3.5	386kcal, 30.3g of protein
Bread	1 slice	93	-	-	3.5	7pm - pre-workout carbs
PBfit Peanut Butter	2 Tbsp	70	-	-	5	163kcal, 8.5g of protein
Frozen Fruits	250	170	-	-	2.5	
Almond Unsweetened Milk	300ml	39	-	-	1.2	9pm - post-workout protein drink
Casein Protein Powder	1 scoop	116	-	-	23.8	325kcal, 27.5g of protein
Total		1873.36	-	-	186.34	

Figure 2.4: An example of a meal plan I made for cutting down. I used to track carbs & fat but not anymore

I think it is really fast and for me it tastes good too. In my cutting meal plan I have a few dishes that require cooking: the classic chicken, rice and broccoli dish, salmon with bread, vegetables and eggs. I usually buy frozen broccoli/vegetables so I just need to heat them up in the microwave before eating. This means I still have to cook the rice, chicken breast, salmon and eggs. For both the chicken breast and salmon I use a slow cooker. Slow cookers⁴⁵ are great devices if you don't have time to cook. They are also really cheap (£20-£30). I find them an alternative to microwave: instead of buying already cooked meals you can buy frozen food instead, throw it in the slow cooker in a similar way you do with the microwave, and later just take it out and it's ready to eat. It does take a rather long time to cook, 4h compared to 5min for microwave, so you need to plan in advance. Also usually frozen food doesn't come seasoned so you might want to add spices before you throw it in the slow cooker. Frozen food is also cheaper than pre-cooked meals, so in the long run you end up saving money. In my opinion slow cooked meals taste better than microwaved ones, but still fall behind something you'd cook in a pan.

Going back to my cooking process, I would normally buy 1kg of chicken breast, wash it, put it in the slow cooker with a bit of water and leave it on high for 4h. You could do 6h on low but at the end of the day it depends on how much you cook and what slow cooker you own. I realised that 6h on low is too long for my salmon, so I now put it for 5h (usually overnight) only. After the chicken breast is cooked I just split it into 5 portions (for Monday to Friday). I use a kitchen scale to split it as equal as possible, but sometimes I don't have time for this so I just eyeball it. I do the same with the salmon (500g in my case). I don't add any water to the salmon, it has a lot of grease so it will cook just fine. I don't use seasoning but you can use if you really want. I use Frank's Red Hot sauce⁴⁶ with my meals instead of seasoning. The sauce has almost no calories — it's like liquid salt with a bit of spice. If you don't like spicy, you can probably find low calories sauces out there for your

⁴⁵Crock-Pot slow cookers

⁴⁶Frank's Red Hot Website

taste. I cook the eggs and rice at the same time using a rice cooker. I know how many cups of rice I need to hit the amount I have in my spreadsheet. I did the measurements once and ended up being around 3 cups for 5 days. I rinse (a fancy word for washing) the rice, add it to the rice cooker and add water (in my case I use 2 cups of water per cup of rice, so 6 cups of water in total). My rice cooker came with a steam tray, so I place 10 eggs (I eat 2 each day) in this steam tray and turn on the rice cooker. I leave the eggs for about 18min for the perfect consistency (I like the yolk a bit runny). The rice cooker stops automatically after the rice is cooked. It normally takes around 40min. After this is done I split it again into 5 portions using the kitchen scale. I split the food I cook into tupperware⁴⁷ and put it in the fridge for the entire week. For some of you, eating a meal 5 days after it was cooked might be too much, but personally I had no issues. Yes, the food tastes much better early in the week (the rice is fluffier and the chicken breast more tender) and not so great on a Friday. However, I don't really have time to cook midweek. Even if it sounds like a lot of steps, I actively spend only 1-2h each Sunday to cook for the entire week and with enough Frank's Red Hot the food tastes amazing to me. It's more practical than proper cooking you could say.



Figure 2.5: Cooked rice, chicken breast and eggs for the entire week (top) and one meal of chicken, rice & broccoli (bottom)

⁴⁷You can buy meal prep containers online

From what I've seen a lot of people seem to struggle with diets because they get hungry. I personally don't have a big issue with this, but I've seen a lot of people in the fitness industry advocating meals high in protein and fiber. The idea is that both proteins and fiber take a long time to digest, so you will not feel hungry while this process is happening, even if you don't eat that many calories. I discussed this previously when I talked about the thermic effect of food. I tried cooking meals high in protein and I agree that some of them are super filling. For example egg whites are one of the most filling dishes I had and they are low in calories and high in protein. You can find egg whites liquid boxes ⁴⁸ that you can cook straight in the pan or make something like protein pancakes ⁴⁹. I find a lot of high protein recipes online, mostly on YouTube. Examples of youtubers with such recipes: Greg Doucette ⁵⁰ (he also has a cookbook full of such recipes ⁵¹; haven't tried it so I can't say if I recommend it or not), The Iron Musket ⁵² (a lot of high protein ice creams recipes, as you can see in Figure 2.6), Sam Does Fitness ⁵³, Remington James ⁵⁴, Will Tennyson ⁵⁵ and many more.



Figure 2.6: Example of a protein ice cream recipe from The Iron Musket YouTube channel. Notice it's much bigger than an actual ice cream tub and half the calories

Another struggle with diets are cravings. Not eating pizza in a long time would make

⁴⁸Two Chicks Egg Whites

⁴⁹Greg Doucette with Protein Pancakes on YouTube

⁵⁰Greg Doucette's Anabolic Kitchen on YouTube

⁵¹Greg Doucette's Cookbook

⁵²The Iron Musket on YouTube

⁵³Sam Does Fitness on YouTube

⁵⁴Remington James on YouTube

⁵⁵Will Tennyson on YouTube

me want a pizza slice so bad. The good news is that there are high protein alternatives to a lot of popular dishes you can cook, and they seem to kill cravings for me while on a diet, which is perfect! I can have protein pizza, protein ice cream, even low fat peanut butter⁵⁶ all while cutting. I can make a small pizza for less than 300 calories using Lo-Dough base⁵⁷ and EatLean cheese⁵⁸ that still tastes really good and looks amazing (Figure 2.7).



Figure 2.7: Protein pizza for less than 300 calories. It's small but it does the job when it comes to stopping cravings

2.9 Supplements

A good diet and workout plan should give you really good results. On top of this, some people advice that taking different pills or powders can help you get even better results. I take some of these supplements myself, however I never tested what actually works and what not since I'm getting results anyway and it's hard to tell what really makes a difference. I will just try to give a brief overview.

⁵⁶PBfit, low fat alternative to peanut butter

⁵⁷Lo-Dough Website

⁵⁸EatLean Website

Protein powders — these are powders made of different types of proteins. Most of the time you can get the same proteins from food, but if you struggle to hit your protein goals for the day or if you want a quick meal alternative then they might be for you! You can find different types of protein powders, such as whey protein (faster to break down) and casein (slower to break down). You mix these powders normally with water or milk (I prefer unsweetened almond milk for the consistency and low amount of calories) and drink them. I use whey protein powder in the morning (1 scoop or 26g of proteins) since I want a quick intake of proteins before I get to eat anything else. You can get whey protein naturally from milk which has both whey and casein in different proportions based on what type of milk it is. I also use casein protein powder (1 scoop) in the evening so that I have some protein in my stomach when I go to bed. I also add creatine to this casein protein shake, which I will discuss later. You can also get casein naturally from cheese, which is made from milk after removing the whey protein.

Branched-chain amino acids (BCAAs)⁵⁹ — proteins are made of amino acids. There's 20 different types of amino acids out there. From these 20, we need only need 9 in our diet to be healthy⁶⁰. We normally get all of them from food high in protein such as milk, eggs, meat and so on. From these 9 amino acids, 3 of them are called branched-chain amino acids: leucine, isoleucine and valine. People say these 3 amino acids are better at building muscles than the other ones. Most protein powders already have them, for example both whey and casein proteins contain all 3 (they actually contain all 9, which is why they are called complete proteins). BCAA powder only has the 3 amino acids I mentioned. Personally I've never tried powders with BCAAs only and I don't know if it's better than having complete proteins such as whey or casein. I've also seen people claiming that BCAAs don't have calories, which is hard to believe since they are amino acids just like the other ones which make up proteins, and proteins do have calories!

Glutamine⁶¹ — this is another amino acid, making up proteins just like BCAAs. However Glutamine is not part of the 9 essential amino acids, it is only needed under certain circumstances (for example injury or illness). Glutamine is found in whey & casein proteins too. You can also get it from certain types of food (eggs, milk). Glutamine has been shown to help with recovery. Again I never took glutamine by itself, just from foods and my whey and casein protein shakes.

Creatine⁶² — this is a supplement everyone believes to work. There have been studies showing it works, every bodybuilder^{63 64} I watch also approves of it. I take it as well, however I can't say how much it helped me. When I started taking it I was doing a bulk, relatively early in my lifting career so I was increasing the weight I can lift in the gym quite frequently anyway. Creatine is stored inside your muscle, and it's used with glycogen and fat to produce adenosine triphosphate (ATP) which makes your muscle contract. You normally get it from various types of meat (tuna, steak) but you can also take it as a supplement. Some people say that the amount you can get from food is not enough and supplements are needed for

⁵⁹BCAAs on Healthline

⁶⁰Protein-energy malnutrition on wikipedia

⁶¹Glutamine on Healthline

⁶²Creatine on Healthline

⁶³Greg Doucette on Supplements on YouTube

⁶⁴VitruvianPhysique on Supplements on YouTube

an optimal amount of creatine stores in your muscles⁶⁵. Taking it as a supplement should help with ATP production, which should give you more strength and endurance in the gym. You can buy creatine in powder form and mix it in your drink. I normally take it after gym in the evening when I mix it with casein protein powder and unsweetened almond milk as my post-workout drink. There's various theories on when it's best to take it (usually post workout)⁶⁶. The recommended intake is 3-5g per day, which should be 1 scoop with the scoop provided in the package. It normally takes time for the creatine stores in your muscle to increase from the supplement you take (around 2 weeks). This is why some bodybuilders do something called creatine loading⁶⁷ — taking 20g of creatine every day for 5-7 days to speed up the process, then going back to 3-5g a day.

One thing worth mentioning about creatine is that it has been linked to hair loss^{68 69}. Most guys will experience male pattern baldness⁷⁰ as they grow old. This happens because of testosterone (more specifically dihydrotestosterone or DHT) which gets attached to the hair follicle causing it to die out slowly. This normally happens with the hair on the top and not sides or back, since it's believed that the hair there is immune to DHT. In hair transplant operations, hair follicles from the back of the head are extracted and placed on the top, where they start growing again. There are also options to try and prevent the male pattern baldness from happening, which only works if you start using them before the hair follicle dies. If it died then the only solution is hair transplant. Some of these options include applying minoxidil solution⁷¹ on the top of your head, taking a pill called Finasteride⁷² and others⁷³. Before you take anything you should book a consultation with a doctor or hair loss specialist (there's other causes to hair loss than DHT, some of these meds have side effects etc). Back to the topic of creatine and hair loss, usually training in the gym will boost your testosterone. Any boost in testosterone can accelerate male pattern baldness. While creatine is linked to increase in testosterone, I assume that anything that helps you lift more weights should indirectly help increase testosterone so it's not really a surprise. Personally I haven't noticed hair loss after I started using it, but I do use minoxidil every day.

Multivitamins — a lot of people recommend taking multivitamins. Working out weakens your immune system right after exercise (T-cell production drops for up to 6h, after which it should return to normal)⁷⁴. This time interval in which your immune system is weakened is also called the *open window*⁷⁵ and you are more likely to get sick during this time. Multivitamins pills are known to help the immune system, which is one of the reasons they are recommended. If you manage to take your daily intake of vitamins and minerals from food I think you should be fine. However, I find it harder to track what vitamins and minerals I eat in a day, so I'm taking multivitamins pills daily.

⁶⁵Athlean-X on Supplements on YouTube

⁶⁶When to take creatine on Healthline

⁶⁷Creatine Loading on Healthline

⁶⁸Article on creatine effects on DHT

⁶⁹VitruvianPhysique on Creatine and Hair Loss on Youtube

⁷⁰Male pattern baldness on Healthline

⁷¹Minoxidil on Wikipedia

⁷²Finasteride on Wikipedia

⁷³DHT article on Healthline

⁷⁴Article on immune system response to exercise

⁷⁵Article on open window after intense exercise

Omega 3 — this usually comes from fish oil. It is believed that fish oil should help with recovery (e.g. joint recovery, inflammations). It's also recommended for a lot of different reasons⁷⁶. I personally eat fish almost every day, and when I don't, I take omega 3 supplements in form of pills.

Glucosamine Chondroitin⁷⁷ — this supplement is supposed to help with inflammations from exercise. I had a tendon inflammation in my right arm and tried this supplement in the form of pills and it did nothing to help me recover. There is information out there that it should help with the healing of tendons, however that was not the case for me. The only thing that helped me recover was a long absence from working out.

Pre-workout drinks — you must've seen pre-workout powders in shops. They are supposed to help you get energized before a workout. As such, they usually contain high amounts of caffeine (the equivalent of 2-3 cups of coffee for the weaker ones, and even more for the stronger ones). They also have other stuff in them, such as creatine, carbs, beta-alanine⁷⁸, citrulline⁷⁹ and so forth. I personally don't take pre-workout, running on the treadmill before doing my workout wakes me up and puts me in the mood to exercise. I also consume a large amount of coffee each day, so adding the caffeine from pre-workout will be bad for my health. If you struggle to get motivation to workout then maybe pre-workouts are for you. You can read more about pre-workout supplements at healthline⁸⁰.

Intra-workout drinks — not as famous as pre-workout, but some people use them too. Intra-workout means you have to drink it while you exercise. I get the idea of drinking something every 30min if your workout is too long. As previously discussed, if you perform high intense activity such as lifting weights, your body will use glycogen for energy, which will deplete the glycogen stores over time. There was a study where individuals were given drinks with low amount of carbs every 30min while they were working out, showing results that it actually helped them to a better workout. I believe intra-workout powders work in a similar way, they contain small amounts of carbs that should help you keep going. Consuming carbs every 30min or so is also called *carbing up*. I've seen many bodybuilders carbing up while doing a workout (e.g. eating a rice cake every now and then).

I just want to reiterate again with what supplements I use: whey protein powder in the morning, casein protein powder in the evening, creatine, multivitamins and if I don't eat any fish in a day I also take omega 3 capsules. Because I sweat a lot I end up losing a lot of sodium when exercising. I noticed that drinking water with a bit of salt (or stock cubes) makes me feel better than drinking plain water, although I don't consider this a supplement. There is also a website that claims to help with info on supplements — examine.com⁸¹. I'm listing all the supplements discussed in this section as a list, for easier referencing:

1. Protein powders (whey & casein)
2. Creatine

⁷⁶Fish oil on Healthline

⁷⁷Glucosamine on Healthline

⁷⁸Beta-alanine on Healthline

⁷⁹Citrulline on Healthline

⁸⁰Pre-workout supplements at Healthline

⁸¹Examine website

3. Omega 3
4. Multivitamins
5. BCAAs
6. Glutamine
7. Pre-workout (caffeine, creatine, beta-alanine, citrulline, carbs etc)
8. Intra-workout (carbs)
9. Glucosamine Chondroitin

2.10 Performance Enhancing Drugs

I've already discussed performance enhancing drugs (PEDs) in the previous section, since the definition is a bit broad: anything that gives you a mental or physical edge while exercising or competing. To that extent even caffeine or creatine are PEDs. However, when people in the fitness industry talk about PEDs they usually refer to either anabolic steroids or selective androgen receptor modulators (SARMs) which I will discuss in the next sections. Personally I've never tried any of these but I will describe what I've heard and read about them. Both steroids and SARMs have been used with great results: expect to gain muscles at least 5 times faster than training natural, all while cutting down fat ⁸². They are commonly used in bodybuilding competitions to make the competitors bigger and leaner at the same time. However, they can have serious side-effects, including death. In fact quite a lot of bodybuilders have died because of too much steroid use ⁸³. The reasons people usually decide to use PEDs are

1. Being able to get really low in body fat % (for example close to 5%). This is usually useful for bodybuilders that compete in shows, where being leaner gets you a higher place
2. Being able to keep growing in size even after training for a long time / reaching your genetic potential
3. Being able to gain muscles and cut fat at the same time, or get lean really fast
4. Being able to eat junk food and drink alcohol while staying in shape

However the side-effects can be

1. Impotence and testicular shrinkage (for men)
2. Brain & liver cancer

⁸²Example of anabolic steroid transformation in 20 weeks

⁸³21 Bodybuilders who Died of Heart Attacks

3. Heart & kidney disease
4. Development of breast tissue for men (Gynecomastia)
5. Deep voice or hair growth (facial or body) for women
6. Yellowing of eyes and skin
7. Depression
8. Severe acne
9. Bad breathe
10. Violent behavior
11. Death

Since both steroids and SARMs increase testosterone in the body, your body will start producing less testosterone naturally. As a result for guys, the testicles will start to shrink, which could lead to impotence. This is also why testosterone is used as a male contraceptive since it reduces sperm count⁸⁴. What people usually do to avoid this and other permanent damages is to have cycles of steroid use for around 8 weeks, followed by a post cycle therapy (PCT)⁸⁵ of 4 weeks. During PCT you make sure your body will go back to producing testosterone in normal levels. This usually means just taking a bunch of medication to help your body get back to normal, such as: Tamoxifen (Nolvadex, 20mg a day), testosterone boosters (e.g. Metatest from Metabolic Nutrition or InnovaPharm Stage 1), human chorionic gonadotropin (hCG), Clomifene (Clomid, 50mg every day), Letrozole (Femara). Most of these are available on doctor prescription only. Tamoxifen is used for light cycles, that are short in length and with low dosage, for example a PCT with Tamoxifen could mean taking 30mg a day for the first week, 20mg a day for the second, 10mg for the last one (first week is 1 week after end of cycle). hCG is used for stronger cycles, that take longer than 8 weeks and with higher dosage of substances. This is a solution you have to inject. An example of hCG PCT is doing 1,000 units on the first day, take a day off, another 1,000 units, another day off, 750 units, day off, 750, off, 500 and so on until the whole 5,000 vial is finished (you will need Tamoxifen as well afterwards). Since it takes some time for your testosterone levels to go back to normal, you might feel like crap during PCT — no strength, depression, no sex drive, you lose muscle mass etc. It's considered good if you manage to keep at least half the muscle mass you gained while on cycle.

Another common side effect is an increased level of estrogen in the body. This happens because some testosterone is converted to estrogen in a process called Aromatization⁸⁶ that keeps hormonal levels in balance. This will cause men to develop breast tissue just like women, and get *puffy* nipples, as seen in Figure 2.8. To avoid these problems people usually take aromatase inhibitors (AIs) like Aromasin (Exemestane) — 12.5mg once a day, or Arimidex (Anastrozole) — 0.5mg once a day, or even hCG.

⁸⁴Testosterone as a male contraceptive on WebMD

⁸⁵Website on PCT

⁸⁶Testosterone and Aromatization: How To Avoid Excess Estrogen Production

One last common side-effect is an enlarged heart (cardiomegaly). This can lead to heart failure and as I previously mentioned there's quite a few bodybuilders who died because of this^{87 88}.

Even with all these serious side-effects, a lot of people do end up using steroids or SARMs. In fact, most bodybuilders who compete use them⁸⁹ and a lot of fitness "influencers" you see on Instagram use them as well. Even actors who prepare to play certain muscular characters are using them. If you do decide to use them, it probably makes sense to talk to a doctor first and get your blood tested throughout the process. You might also want to take supplements to protect your liver, heart etc^{90 91}.

One last point to make about steroids and SARMs is that they are illegal in a lot of countries, so people might buy them from dealers in the gym or from edgy websites. This usually means that you might not be getting what you paid for. It also makes them rather expensive. There was a study done where they bought SARMs from various websites selling them and the result was that only 30% of the supplements contained what they actually say they contain.⁹² Most of them were underdosed, some even had nothing in them, or containing other chemicals.

2.10.1 Testosterone

Before talking more about anabolic steroids and SARMs, I just want to give a brief overview of testosterone. I mentioned before that testosterone plays an important role in building muscles. Testosterone is the male sex hormone, it's produced by testicles for men and ovaries for women (women have testosterone too, just in much lower quantities). The amount of testosterone in your body is measured in *ng/dL*, although sometimes you can find *nmol/L* which can be converted to *ng/dL* by multiplying the value with 28.85. The average male has between 300 and 1,000 *ng/dL* while for women it's only between 15 and 70 *ng/dL*. The amount of testosterone your body produces also declines with age, but not by much⁹³. If the testosterone production gets too low it's possible to do testosterone replacement therapy (TRT)⁹⁴, which is similar to taking anabolic steroids, but in much lower doses. TRT could also be prescribed if you have Osteoporosis (fragile bones) since testosterone increases bone density. If you want to know your testosterone level you need to get a blood test. For this you can talk to your doctor or check online (for example let's get checked⁹⁵ provides these type of services, however it's rather expensive and cheaper to do it with your doctor).

⁸⁷ Article on Rich Piana's death

⁸⁸ Zyzz dies from heart attack

⁸⁹ Brandon Harding - good example of what he's using to compete on YouTube

⁹⁰ Liver support supplements from HTLT Supps

⁹¹ Shield from Anabar

⁹² 20 SARM 'supplements' tested on ergo-log

⁹³ Article showing testosterone levels versus age for men

⁹⁴ TRT on Healthline

⁹⁵ Let's Get Checked website

2.10.2 Anabolic Steroids

Anabolic steroids are a type of artificial testosterone that you either inject in your body or take orally to increase your body's level of testosterone, usually in high doses. When doing anabolic steroids to build muscle, people would get over 3,500 ng/dL testosterone inside their bodies^{96 97} (compared to the 1,000 upper limit I previously mentioned).

The history of artificial testosterone is interesting: it was first synthesized (created in a lab) in 1935 and available to the medical community for experimentation and treatment purposes.^{98 99} At first you could only inject it but eventually tablets were made that you can take orally. Currently there's a lot of variations of anabolic steroids you can take, each with pros and cons.

The injectable ones come in the form of esters (oil characteristics) which can be either longer esters that have to be injected less times a week (usually twice a week) and shorter esters which have to be injected at least 3 times per week. This characteristic comes from how long the ester stays in your body, which is also referred to as the half-life¹⁰⁰.

When talking about steroids, people talk about anabolic and androgenic effects. Anabolic is about gaining muscle while androgenic is about male characteristics such as deep voice, facial hair etc. Different steroids have different anabolic and androgenic effects.

Anabolic steroids are usually classified based on the type of testosterone they are derived from: DHT, Testosterone or Nandrolone as seen in Figure 2.9. Usually DHT steroids don't get converted to estrogen, which means less estrogen problems (although you can still see estrogen levels increasing), but they will accelerate hair loss, mess up cholesterol levels, are bad on kidneys and other common steroid side effects. They are most commonly used for cutting down since you don't store as much fat on them. Testosterone derivatives will normally store more fat, since they convert to estrogen. Finally Nandrolone derivatives are really strong on both anabolic and androgenic scale, giving you a lot of mass gain but a lot of side effects as well. I will try to give a bit of information on a few steroids below

1. Testosterone^{101 102} — this is synthetically made testosterone that comes as an oil in a bottle from which you have to inject multiple times a week. There's 2 main versions of it: cypionate (depo-testosterone) which is a long ester, meaning you have to inject twice a week, and enanthate which is also a long ester. There is also a third type — propionate which is a short ester that you have to inject 3 times a week, but it's not as common. People would use around 500mg a week (maybe less, 250 if first cycle), so this means 250mg per injection twice a week. You get all the problems that come with steroids.
2. Anavar^{103 104} (Oxandrolone is the real name, Anavar is just the brand name) — oral

⁹⁶VitruvianPhysique on Testosterone on Youtube

⁹⁷VitruvianPhysique on Testosterone on Youtube, Part II

⁹⁸History of testosterone article

⁹⁹Nick's Strength and Power on The History of Steroids in Bodybuilding on Youtube

¹⁰⁰Biological half life on Wikipedia

¹⁰¹Greg Doucette on first testosterone cycle

¹⁰²Ryan Ankrom on Testosterone

¹⁰³Greg Doucette on Anavar

¹⁰⁴Ryan Ankrom on Anavar

steroid, one of the safer anabolic steroids out there, less strong than other steroids but really expensive (could be more than \$300 for only one cycle). Part of the DHT family so it speeds up hair loss. It's high on the anabolic scale and low on the androgenic scale (popular among women). One of the most popular steroids out there overall. In theory expect to get results 2 - 10 times faster than being natural. Highly likely to be fake when buying since it's so expensive. It's not aromatized into estrogen, so estrogen levels should stay normal. It has a short half-life so people take it twice a day. Men use around 50mg (25mg x 2) a day and women around 5mg a day.

3. Trenbolone ¹⁰⁵ (or commonly known as Tren) — injectable. Probably one of the strongest steroids out there, stronger than pure testosterone (in theory 5 times stronger). Part of the Nandrolone family. It's commonly used in cattle to improve strength. It has really bad side effects: it can screw up cholesterol, bad on kidneys, gives insomnia, hair loss, anger issues, impotence. You can find it in multiple variations such as acetate or enanthate but the most common one is acetate (Tren Ace). Men use around 30mg a day.
4. Winstrol ¹⁰⁶ (Stanozolol) — oral steroid, derived from DHT as well. Used for cutting down. It messes up cholesterol, increases liver toxicity. Does not convert into estrogen. Men use around 40mg a day (20mg x 2).
5. Halotestin ¹⁰⁷ (Halo) — available both orally or as injection. The oral version is more popular. It's a really strong steroid with strong side-effects. It's commonly known for a great increase in aggression, so people use it for strongmen competitions or before training or fighting. It also helps with strength. As side effects it increases hair loss a lot, it's really hard on the liver and every other side effect of steroids. Men use only 10mg a day.
6. Masteron (Drostanolone propionate) — injectable, from DHT, usually used for cutting down.
7. Deca-Durabolin (Nandrolone Decanoate, commonly known as Deca) — apparently best bulking steroid, it makes you gain a lot of mass, including water and fat at the same time.
8. Anadrol (Oxymetholone) — strongest oral steroid, supposedly stronger than testosterone. It comes with a lot of side effects. Even if it doesn't convert to estrogen, it still makes you gain water & fat.
9. Dianabol (Methandrostenolone, Dbol) — second strongest oral steroid, aromatizes into a stronger estrogen so it needs strong AIs.

There's a lot more other anabolic steroids that I won't cover: Equipoise (Boldenone Undecylenate), Proviron (Mesterolone), Turinabol (Tbol), Durabolin (Nandrolone Phenpropionate), Tetrahydrogestrinone (THG) etc. Bodybuilders tend to use multiple steroids at

¹⁰⁵Greg Doucette on Trenbolone

¹⁰⁶Ryan Ankrom on Winstrol

¹⁰⁷Ryan Ankrom on Halotestin

the same time while doing a cycle — this technique is called stacking. A stack is all the substances someone takes every day while on cycle. You might see videos with bodybuilders sharing the stack they used before a contest.



Figure 2.8: Example of gyno on bodybuilder - look at the nipple area. Picture taken from twitter

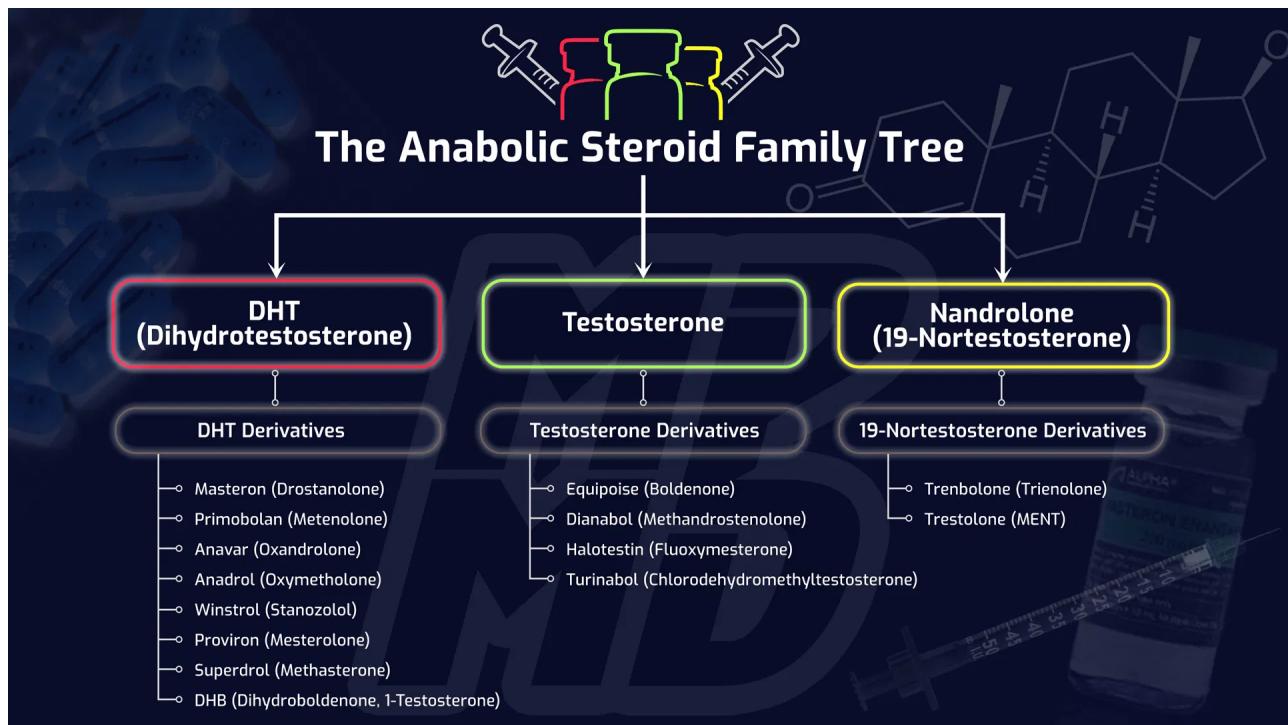


Figure 2.9: Classification of Anabolic Steroids. Picture taken from moreplatesmoredates.com

2.10.3 Selective Androgen Receptor Modulators (SARMs)

SARMs are chemical substances similar to anabolic steroids that will try to keep the anabolic effects of steroids while minimizing the androgenic effects. They are relatively new chemicals, invented in the late 1990s, and they are an attempt at making a substance that can get the muscle mass increase without any of the androgenic side effects (deep voice, hair loss, facial hair, conversion to estrogen etc). Androgen receptors are responsible for many of the male characteristics. Normally they get activated when an androgen such as testosterone binds to them. Anabolic steroids are also androgens that will bind to these receptors, that's why they give you androgenic features. SARMs are selective androgens that will only bind on receptors responsible for muscle growth, hence why they are called selective. In theory this sounds like a magic pill that helps you build muscle with no side effects. However, this is not the case. They are still androgens which will signal your brain to produce less testosterone, which leads to impotence. Also, they seem to increase blood & liver toxicity as well since they are taken by mouth. When doing SARMs people do cycles and PCTs afterwards, similar to steroids. Only 4 SARMs have been tested on humans: Ostarine (GTx-024, MK-2866), LGD-4033 (Ligandrol, VK5211) GSK2881078, PF-06260414 (with bad side effects, such as headaches, decreased appetite, dizziness, upper respiratory infection, fatigue, and anxiety). Since they are new they are legal to sell for research purposes only, that's why there's so many online shops out there selling them. I previously mentioned that a lot of these products don't contain what they say they do. I will give a bit of information on a few SARMs below

1. RAD-140 (Testolone)^{108 109} — oral administration. One of the safer SARMs out there but more expensive. It's really strong, close to testosterone in strength. Men normally use 20mg once a day (half-time of 20h). For PCT people use Tamoxifen or hCG if bigger dose was used.
2. Ostarine (MK-2866)¹¹⁰ — originally designed as Osteoporosis & muscle wasting treatment. It's less strong than RAD-140, usually good for cutting. It's supposed to help with joint & tendon problems. Some people mentioned it helps with cholesterol and blood glucose levels. Men use around 15mg once a day (half-life of 24h).
3. LGD-4033 (Ligandrol, VK5211)¹¹¹ — really strong SARM, stronger than RAD-140. It's good for bulking, but does not help with fat loss. It's also less safe (most suppressive SARM, which could lead to impotence) than RAD-140 or Ostarine, but cheaper. Long half-life of 24-36h, men usually take 10mg once a day.
4. S4 (Andarine)¹¹² — less strong than other SARMs, usually good for a dry look & vascularity. It has vision side effects, you can start seeing a yellow tint. Men usually take between 25 and 50mg a day.

Other SARMs I won't cover: S-23, ACP-105, LGD-3303, YK-11.

¹⁰⁸Ryan Ankrom on RAD-140

¹⁰⁹Greg Doucette on multiple SARMs

¹¹⁰Ryan Ankrom on Ostarine

¹¹¹Ryan Ankrom on LGD-4033

¹¹²Ryan Ankrom on S4

2.10.4 Other PEDs

Human growth hormone (HGH) — this is a hormone responsible for growth in children. You can buy synthetic HGH that has to be injected (prescription only). It's often stacked with steroids by bodybuilders when doing a cycle. This is a really expensive substance, you can pay up to \$5,000 a month for it, and the benefits are not that significant.¹¹³ One of the key benefits of growth hormone is faster recovery, as well as less joint problems. It also comes with bad side effects if used in higher doses, such as heart problems and acromegaly (a condition where bones grow too big, causing deformations). When sold, people advertise it as an “anti-aging” drug, which makes it popular, however none of these claims are actually proven and it's considered one of the most overrated PEDs out there¹¹⁴. Another PED that helps with HGH is MK-677 (Ibutamoren). This is a growth hormone secretagogue, which means it's not a GH itself, but rather it tells your body to produce more GH. It's usually mistaken for a SARM. People who used it¹¹⁵ reported increased hunger (which is not ideal for cutting) and skin improvements. Men use around 5mg a day of MK-677.

Turkesterone^{116 117} — this is an ecdysteroid, a substance found in insects and plants that is similar in structure to testosterone, with similar effects. There's been a few studies about this, some suggest it doesn't do anything and others suggest that it might help with muscle growth¹¹⁸. Turkesterone gained a lot of popularity recently since a few famous youtubers started promoting it. People who tried it reported that it does work but mostly just helping with strength, a bit similar to creatine but a little more powerful.¹¹⁹ Currently it's really expensive and it might not be worth it for the benefits it gives.

Fat burners — I'm first going to talk about over the counter fat burner pills¹²⁰. Contrary to what the name suggests, these don't actually burn fat but rather suppress appetite. They usually contain a combination of ephedrine, caffeine and aspirin (ECA stack¹²¹). I've never tried a fat burner before, but I did notice coffee suppresses hunger for me, which is why I find it easier to do something like intermittent fasting where I don't eat anything in the morning and just have coffee. There are also substances that actually help burning fat, but these ones are not approved for human consumption. The first example is GW-501516 (Cardarine)^{122 123} which is commonly mistaken for a SARM. It helps a lot with endurance by making cardio super easy. It does so by making your body better at burning fat rather than glycogen. It should also increase your BMR, making you burn extra calories in a day without doing anything. However there was a study about it where it was found to cause cancer in rats, but the doses administered were 50 times the normal dose and for 2 years at a time. People use around 20mg a day. Similar substances to GW-501516 are SR-9009 and

¹¹³Greg Doucette and Iain Valliere on HGH

¹¹⁴HGH on WebMD

¹¹⁵Ryan Ankrom on MK-677

¹¹⁶VitruvianPhysique on Turkesterone

¹¹⁷Greg Doucette on Turkesterone

¹¹⁸Ecdysteroids: A novel class of anabolic agents?

¹¹⁹VitruvianPhysique on Turkesterone

¹²⁰Example of fat burner pills on amazon

¹²¹ECA stack on Healthline

¹²²Ryan Ankrom on GW-501516

¹²³Greg Doucette on GW-501516

SR-9011, both with promising results for fat loss.

Clenbuterol ¹²⁴ — this is also a fat burner that works really well, with serious side-effects such as heart problems and even death. Some people claim it's more dangerous than steroids, at least in high doses. It works by increasing your body temperature and making thermogenesis burn more calories (so it increases your BMR). It also lowers appetite. People take anything between 10 and 120mcg a day. It's often used in combination with T3 (brand name Tiromel), which is another substance that increases metabolism in the body.

Fragment 176-191 ¹²⁵ ¹²⁶ — another fat burner, probably the strongest out there. The only downside is that you have to inject it (under the skin). It's part of the growth hormone responsible for burning fat. People would use between 300 and 1,000mcg a day, for up to 6 weeks (slowly increase the dose, since your body gets used to it), usually right before a contest to get down one extra body fat %. There's no known serious side-effects.

Diuretics ¹²⁷ — these are pills that will make you lose water via urine. They are mostly used for contests to get a leaner look right before the event, since water is stored between skin and muscles. Also people use them to make weight for a specific class since you can lose up to 1-2 kg of water with these pills (even outside bodybuilding, in martial arts for example). They come with side-effects such as dizziness, muscle cramps and even kidney failure.

Blood doping ¹²⁸ — this is a technique mostly used by cyclists to be able to perform better in competitions. You can increase oxygen carrying capacity to the muscle (VO_{2max} ¹²⁹) by increasing the amount of hemoglobin in the bloodstream, for example by injecting erythropoietin (EPO). This will improve endurance when exercising.

¹²⁴Clenbuterol on WebMD

¹²⁵Greg Doucette on Frag 176-191

¹²⁶Ryan Ankrom on Frag 176-191

¹²⁷Healthline Article on Diuretics

¹²⁸Blood doping on WebMD

¹²⁹ VO_{2max} on Wikipedia