the CrossFit JOURNAL ARTICLES

Physics, Physiology, and Food

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When people think about "diet," they almost always think of losing weight. Pritikin, Atkins, Weight Watchers, Jenny Craig, South Beach, SlimFast, Nutrisystem, Learn, Paleolithic, Zone—diets galore and hype galore. All touted to provide you the means to a "healthy" weight, what do all these diets have in common... besides costing you money if you buy the books, supplements, or the prepackaged special foods that go with them? They all do three basic things: (1) modify the composition of your diet (limit your food selection), (2) either directly or indirectly limit your caloric intake, and (3) expect you to exercise as part of your diet. So they all are all basically variations on the same theme but there is a tremendous amount of controversy about which diet is superior.

Currently, the biggest debate in the media and among health academics is low-fat versus low-carbohydrate. Who would have ever guessed that a simple manipulation of a couple of macronutrients would be such a point of contention with fitness professionals, physicians, the media, and the public in general? Who would have thought that the tremendous amount of federal and private funds expended on nutrition and obesity research would create such a wealth of wrong thinking? Wrong thinking? How could I even suggest that some of the best minds in obesity research aren't producing useful information? They are forgetting basic physics, and they are also forgetting to consider the basic reasons why we eat. We'll come back to this latter consideration in a bit as it is particularly relevant to eating for CrossFit.

But first let's consider the current debate about dietary composition in the light of some simple laws of physics. The various kinds of diets prescribed, marketed, and researched are distinguished by their composition—by the kinds of foods and/or by the ratios of macronutrients (protein, carbohydrate, and fat) that they stipulate. Variations in composition make these diets easy to differentiate and easy to describe, but does the composition of your diet really matter?

Whether anyone likes to admit it or not, for sheer weight loss, it probably doesn't. It is the total amount of energy consumed (calories) that matters. And this is not an arguable point. There is this pesky little physical law of the universe that forms the basis of all weight loss and weight gain. The first law of thermodynamics states that energy cannot be created or destroyed but is always conserved. In other words, energy that enters a system will necessarily equal the energy that remains in the system or leaves the system. Food, as far as the body is concerned, is merely a form of energy, and the amount of calories you take in (eat and drink) must equal the amount of calories stored in the body or expended through metabolism. Nowhere in this inalterable equation is the quality of the diet or composition of the diet a consideration, only the math of caloric deficit or surplus. It's old, but the phrase "calories count" is still as viable today as it was when the first diet hucksters tried to cash in on the vain American obsession with skinniness. So, according to the law of energy conservation, if you eat according to the food pyramid and keep the numbers of calories you eat to less than you expend, you can lose weight. If you go low-fat and low-calorie, you can eat and drink nothing but Choco Cap'n Crunch and Coke in appropriate quantities and you can lose weight. If you go low-carbohydrate, you can eat and drink nothing but bacon and diet Coke in appropriate quantities and you can lose weight. If you go

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low-protein, you probably can't think clearly enough to comprehend this, but, believe me, the same energetic relationships apply.

While we don't recommend any of these diets for CrossFitters, it is prudent for trainers and trainees to understand the diets that are receiving the lion's share of media and clinical attention. There is some very simple calorie-based logic underlying both the low-fat and low-carbohydrate diets. The low-fat diet presumes, quite correctly, that since fat is a very energy-dense macronutrient at 9 calories (kilocalories, to be precise, but we'll just call them calories, per popular use) per gram, reducing how much fat you eat will reduce your caloric intake significantly. The average American gets somewhere around 34 percent of total dietary calories from fats in food. Reducing this intake to 20 percent would be enough of a caloric reduction for someone to lose about a pound a week—if the calories were not replaced with carbohydrate or protein. (Though, even replacing them on a gram-for-gram basis would likely net a weight loss of about a pound every ten days or so, since both carbohydrate and protein contain 4 calories per gram.) If you can hang with the food choices of the low-fat diet, you can effectively lose weight.

But high-carbohydrate diets have an innate problem that makes compliance with them difficult over the long term. Carbohydrate consumption stimulates insulin secretion (and this happens whether it is a "good" carbohydrate or a "bad" carbohydrate). Insulin stimulates the transport of that newly digested carbohydrate, now in the form of blood sugar, to be moved out of the blood into the various tissues of the body. The inevitable result of insulin action, a reduction in blood sugar, stimulates hunger, which is a response to depressions in blood sugar. You get hungry more frequently on a low-fat diet. That tiny little problem usually dooms low-fat diets to failure and abandonment in a matter of weeks. For a chance at success with a low-fat diet, not only do you need to change the foods you eat, you also need to change how you eat. Instead of three squares a day, it is much more effective to eat four or five smaller meals with little snacks between. Spreading the food relatively uniformly across the waking day helps minimize the time between insulin concentration troughs, thereby helping limit between-meal hunger pangs. It is interesting to note that, in the last decade, the government-sponsored campaign against dietary fat has resulted in a decrease in the percent of fat in the American diet (it peaked out at over 42 percent a few years ago). But, over the same time, the average body weight and body fat of the average citizen has increased despite the decrease in dietary fat. Oops. Looks like there was a misfire with this magic bullet for health. A blanket promotion of a low-fat lifestyle as a means toward national health does no good if we fail to consider the basic physics of eating and the fact that, for weight loss, it is calories—not food selections—that really count. We may be eating less fat but we are negating that reduction by adding a caloric excess of low-fat foods in their stead.

The highly touted low-carbohydrate diet has some quite clever elements that are biologically effective and promotionally effective. "Eat as much protein and fat as you like" is one element that almost every one of its practitioners loves. "Wait, I'm on a diet and I can eat as much as I want? Sign me up!" Despite its outward appearance, though, a low-carbohydrate diet is not a high-calorie diet. Two interesting things will initially prevent over-consumption of calories. First, fat is a very satisfying macronutrient. A protein- and fat-rich meal will satisfy hunger more effectively than a high-carbohydrate meal. Second, severely limiting carbohydrate consumption limits insulin secretion, and the dieter will not experience the swings in blood glucose seen in the low-fat diet. With a more consistent level of blood sugar throughout the day, the low-carbohydrate dieter will experience fewer hunger pangs (and mood and energy swings). Less perceived hunger results in a self-selected reduction in calories consumed. So eating "as much as you want" actually turns out to be less than you normally would eat with a typical American pattern of eating lots of carbohydrates along with your fats and proteins. There is a misconception out there that low-carbohydrate diets drop your body fat faster and to a greater magnitude than low-fat diets. You do lose "weight" very quickly in the early stages of the low-carbohydrate diet. This is because the body mobilizes and uses its existing carbohydrate stores (i.e., glycogen and glucose) when you stop consuming them in your meals. That elimination of stored carbohydrate carries with it an elimination of water weight as well. Any time carbohydrate is stored in a cell, it is stored in conjunction with water. Get rid of the carbohydrate and you will also get rid of the water. The end result is a rapid loss of body weight that is composed mostly of stored sugars and water and minimally of fat. But that loss of carbohydrate and water is fast enough and large enough for most dieters to perceive a difference in the

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mirror and on the scales. Success makes you feel good and contributes to staying on the diet longer. Once the initial carbohydrate losses have petered out, the body will then begin to tap into stored fat and the rate of fat loss will increase and be similar in rate and magnitude to that seen in a successful long-term low-fat diet.

Despite all the hype and hyperbole, there is enough research produced to date to demonstrate that any of the aforementioned diets will result in about a pound of weight loss per month. Hey! That's not what the commercials say. Well, hit pause on your Tivo when the diet ads are on and read the disclaimers about the big weight losses shown; "Results not typical" is always in the small print that flashes across the bottom of the screen for a microsecond. If we really evaluate all the research out there on all the diets, it is apparent that small to moderate weight loss is all we can expect to happen with any diet. And we can expect it only if the dieter persists with the regimen over the long haul. This typically doesn't happen. The average "diet" lasts only a matter of weeks, and even the longer-term success stories generally relapse to gaining weight eventually. So dieting for weight loss seems to be at best a transient and very short-term fix for what is considered to be a national health epidemic.

This isn't new information. The medical and health professions have failed to get the nation to make progress toward "healthy" body weights with thirty years of beating the dead horse of dietary modification. Why do we continue in the futile effort to find just the right dietary intervention for the entirety of the American population? Job security for clinical researchers in obesity? Catering to the endless need for promotional fodder of the political machine in its quest to appear as though it is saving us from certain death? Stop spending my tax dollars on something you know is doomed to failure. Dietary intervention research siphons off valuable federal research funds that could be more effectively used elsewhere. (Uh oh, looks like I slipped onto my soapbox for a minute there.)

Dietary intervention is not the only way to fight obesity. Everyone seems to loudly promote the energy-consumed component of the first law of thermodynamics—the "eat less" part—and forgets about the other component, the effective and easily manipulated one, the energy-expended component—"exercise more." In actuality, the diet industry and at least one government regulatory agency have not forgotten exercise. They do pay a very small, lawsuit-minimizing, amount of attention to it. That small disclaimer on every diet ad that says "results not typical" also says "part of a comprehensive program of diet and exercise." So let's think about exercise for a moment. The medical community, the exercise industry, and even Hollywood have framed everything, eating and exercising, as a means to being skinny, beautiful, and therefore healthy. But skinny is not the primary concern we should have when we eat. How much we weigh is not the important issue here.

We need to consider function when we consider health. We need to consider our ability to survive and our ability to manage the challenges of our daily lives and recreational pursuits. With CrossFit we consume food to fuel our efforts at gaining fitness and a better quality of life. When we focus on physical fitness, everything else tends to fall in line over time, including body fat.

We should never blindly follow conventional wisdom, so to best understand what we need to eat, we need to understand how training affects both the number of calories we need to consume and how it dictates the composition of our dietary needs. So let's work backward from conventional dietary prescription methods that start with appearance and begin here with how training drives the body's metabolic and dietary needs.

CrossFit programming stresses glycolytic and phosphagenic metabolism. Aerobic adaptations piggyback on top of adaptations to those systems. Glycolytic adaptations require carbohydrate to be present, phosphagenic adaptations rely in part on high-phosphagen foods (meats), and aerobic adaptations involve the oxidation of carbohydrate and fat. So right off the bat, it appears that extremely low-fat and extremely low-carbohydrate diets won't meet the nutritional needs of CrossFitters. Let's be a little more specific and evaluate the metabolic needs of the three basic exercise modes used in CrossFit training: gymnastic exercises, metabolic conditioning exercises, and weighted exercises.

Gymnastic activities are usually done with body weight and although an individual move is completed in a matter of seconds (a pull-up, a muscle-up, etc.), they are typically done for many repetitions and for many many seconds. These exercises expend stored high-energy phosphates and tap into stored carbohydrate. Metabolic conditioning exercises are done for up to several minutes and are driven primarily by stored carbohydrate (with a little fat

if the intensity is low enough). Weight exercises in the low end of the repetition continuum are dependent on stored high-energy phosphates but as the repetitions get out into the double digits, anaerobic glycolysis is active and some carbohydrate gets used to power sets. Doing CrossFit, we are doing all these types of work, often blended indistinguishably. So it is easy to see that we can't eliminate any of the macronutrients from an athletic diet and that low-carbohydrate diets might not be a wise choice to support CrossFit training. In fact, it is well known that low-carbohydrate diets reduce the amount of stored carbohydrate and it is similarly well known that lowering carbohydrate stores in the muscle and liver predisposes trainees to early fatigue. "Diane" can tire your butt out all on her own; you don't need to have your diet helping her.

It is not as easy to see that low-fat diets are not so relevant to fitness, and then there's the hurdle of getting over the popular belief that they automatically help prevent heart disease. First off, let's consider fat as a good thing, in the diet and in the body. Just sitting there reading this article, you are deriving about 66 percent or more of the energy you are using from fat stored in your body. If we extend that ratio to the average non-exercising American who might be expending 2500 calories per day, 1650 calories are coming from fat metabolism. If we use the average daily protein requirement numbers proposed by the American Dietetic Association (0.8 grams per kilogram of body weight per day), a 165-pound trainee would need to consume 240 calories of dietary protein per day. Simple subtraction provides us the number of carbohydrate calories Joe Couch would then need to consume per day, 610 calories. These numbers hardly paint the picture of the need for a low-fat diet; rather, they suggest fat is an essential element of the diet (it has been since the emergence of mankind).

And as for the heart-disease-prevention angle used to promote low-fat diets, most recent comparative research has shown that cardiovascular disease risk decreases similarly with low-fat and low-carbohydrate diets neither is heart-healthier than the other. Now let's add exercise into the picture, since surely exercise increases the need for carbohydrate? Yes, in fact, it does, but how much? A broad assessment of all exercise modalities might indicate that if 400 calories worth of exercise are added to Joe Couch's daily habits, about 300, or 75 percent, of the calories used to power exercise would come from carbohydrate, with the other 25 percent coming from fat. If we add those 300 calories to the 610 calories derived from carbohydrate needed for sedentary existence, that brings us to about 31 percent of our total caloric need from carbohydrate. That's not "low-carb," but it's pretty low compared to the 55 percent or more carbohydrate content pushed by the clinical and aerobic fitness communities.

The final macronutrient for consideration is dietary protein, which provides the building blocks of all structural and metabolic enzyme proteins. When we recover from exercise we don't just replete the expended energy substrates (fat and carbohydrate); we also have to replace any broken down structural proteins and enzymes that resulted from the exercise bout. That means we have to match protein intake to protein broken down just to maintain the status quo of fitness. With regular aerobic exercise (of the long-slow-distance ilk) it has been shown that up to 1.8 grams of dietary protein per kilogram of body weight are required to maintain a positive nitrogen balance. With intense weight training, up to 2.5 grams of protein consumption per kilogram body weight are needed to maintain a positive nitrogen balance. A positive nitrogen balance means that you have enough protein building blocks to support fitness gain. With a compromise of 2.2 grams of dietary protein per kilogram of body weight per day intake (in between 1.8 and 2.5 g/kg/day), more than 24 percent of the diet would need to be protein to support the fitness gains possible with CrossFit.

So where does this leave us? If we want to choose a named diet that best fits CrossFit, we would not choose Pritikin (low-fat), and we would not choose Atkins (low-carbohydrate). We need to have a diet that delivers a moderate quantity of every macronutrient—fat, carbohydrate, and protein—according to the demands of the basic physics and physiology of exercise adaptation. We need less carbohydrate than conventionally thought but more than the truly low-carbohydrate diets. We need about the American Dietetic Association recommendation for fat content, 30 percent—not the exorbitantly low quantities suggested by lots of low-fat diets. And we need more protein than most clinicians generally prescribe. Of all the diets listed in the first paragraph, the Zone is the best fit. Although not an exact match, the metabolic and structural stress placed on the body by CrossFit training will be best accommodated by the 40 percent carbohydrate, 30 percent fat, and 30 percent protein recommendations of the Zone.

Understanding nutrition is not that hard when we get rid of the hype and misinterpretations promulgated by clinicians, supplement manufacturers, and so many exercise professionals. Exercise is about adaptation. Nutrition is about the support of that adaptation. When we think of it this way, there is a hierarchy of adaptive support that diet must provide. First, the gross caloric content of the diet must meet or mildly exceed caloric expenditure for adaptations to occur. Second, the balance of macronutrient consumption must reflect actual biological need in order for adaptations to occur optimally (in rate and magnitude). Third, micronutrient intake must be adequate to support macronutrient utilization. And finally, peripheral issues such as food quality, timing, ergogenic aids, and so on, can be considered as tweaks of the overall adaptive system.

Most articles and books on nutrition and exercise jump the gun on this hierarchy and consider the peripheral issues before taking care of the basics. Hopefully this article has established (1) a basic appreciation of the physics of eating, (2) the concept that "diet" and "dieting" are two distinct entities, and (3) that survival and training—not socially driven concepts of health and beauty—drive the realities and requirements of dietary composition. Every CrossFit trainer should be cognizant of these basic concepts and be able to explain them, as training success hinges on our ability to get trainees to buy in to better nutrition to support better training. It really is the bedrock for the hierarchy of athletic development.

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