Chapter II

Nutrient Timing

What matters is what is in your bloodstream

Your consciousness experiences what you eat, but your cells do not. They only know what is in your bloodstream. You lose nutrients to your waste systems, body fat, and oxidation:

- Food that is not digested well passes through your intestines into your stool, generating gas while processed by bacteria. This is common with dehydration, typically from low or high salt intake relative to perspiration losses, regardless of how much water you drink (see hydration chapter).
- Nitrogen in protein you eat that your cells cannot process quickly enough goes to your urine, meaning that most protein shakes enrich your urine more than they do your cells. The carbon in excess protein in the blood at any given time goes to fat.
- Blood sugar that lean tissue cells cannot absorb quickly enough generates a large insulin response that clears the sugar out into fat and liver cells, and reduces fat release by fat cells. Blood sugar can end up lower than before eating, lowering brain function, commonly called "food coma." When carbs in a meal make you sleepy, you have increased your body fat and disease risk while simultaneously reducing your recovery and energy (both mental and physical).
- Phytonutrients and unsaturated fats contain easily oxidized double bonds, so they break down quickly and need to be replenished. It is therefore better to eat them every day (a continuous supply for your cells), as opposed to extremely large amounts sometimes and very few at other times. Surplus cannot be used or stored without oxidation over time.

Poor blood chemistry results in a loss of lean tissue

The cells in your lean tissue, particularly skeletal muscle, break down to keep your body going when you have poor blood chemistry, mainly low blood sugar and/or blood protein levels. This is at its worst when you wake up in the morning (having not eaten in many hours) and right after exercise (having used up nutrients in your bloodstream faster). And yet these are the two times people are generally least likely to eat. The body does not have much capacity to store water, protein or sugar, which is why we get hungry and thirsty more than once per day. The body stores enough body fat to not eat fat as frequently as the other food groups, but fats generate a hormonal response that reduces hunger hormonally, so include dietary fat in all meals if you have incessant hunger issues. But to the initial point, hunger perception can be low when the body is starved.

A lack of hunger perception in the morning or after exercise is irrelevant to the experience of your cells, which are actively breaking down at the rate of 10-20 Cal per hour based on RDA estimates.

On the flip side of this, continued snacking after a large dinner because of continued hunger or cravings is irrelevant to any cellular benefits. If you could just eat based on your perception, there would be no need to ever ask the question of how to improve your nutrition because perception would automatically optimize your nutrition for you. The point of mentally engineering your nutrition is to systematically take care of your cells even when your perception is not providing you all of the information you need.

PROTEIN

Hours of cell growth depends on how many hours the protein is available in your blood

Low blood protein stimulates cortisol release, breaking down muscle tissue to provide protein. Studies with individual cells, animals, and humans indicate that we need amino acids continuously, 24 hours a day. Our bloodstream fluctuates between getting amino acids from the intestines after we eat, and from out muscle when the intestinal supply runs low. The slower the protein we eat digests, the longer it is available from the intestines for growth. For example, in a study with NYC police officers during 3 months of strength training, there was twice the muscle gain, twice the body fat loss, and significantly greater strength gain when using casein versus whey protein powder [Demling RH & DeSanti L, Ann Nutr Metab 44 **2000** 21]. This does not mean, however that we should use casein protein powder; it digests slower and is available longer because of hydrophobic side chains, making it more susceptible to oxidation. Since protein powder is processed and dried at high temperature it is oxidized, as are both the protein and fats in most commercially available milk since most is exposed to extended high temperatures for pasteurization or while reducing the fat content [Meyer B et al., J Agric Food Chem 60 **2012** 7306]. To lengthen the digestion and therefore cellular growth time of your cells, use food, which takes much longer for your digestive system to process than liquids.

Amino acid availability duration to your cells might be something like the following:

- Whey protein powder, shakes, or bars 2 hours
- Casein, or milk (which contains casein) 3 hours
- Yogurt 4 hours
- Cottage cheese 5 hours
- Cooked eggs, meats, fish, tofu 6 hours
- Together with dietary fats and vegetables 6+ hours

Eat the amount of protein that actually benefits you based on the protein process time

Once you have an estimate of how many hours your cells will benefit from the particular protein you are choosing to eat at any given time, you can then estimate how much of that protein you should eat. Since cells use protein at the rate of 10-20 Cal per hour (up to 30 Cal per hour for an NFL lineman weighing 340 lb during intensive training), multiply 10-20 Cal times the number of hours your protein will last. For example, if you are training hard, use the upper limit of 20 Cal per hour, and if you are eating:

- Whey protein in powder, liquid or bar form, anything more than 40 Cal (10 grams) of protein is unlikely to provide any additional benefit other than enriching your urine
- Yogurt as your protein, which likely processes within 4 hours, you would ideally consume 80 Cal (20 grams) of protein, the amount in 10 oz of Greek yogurt
- If you are eating meat, poultry or fish, you get 6 hours of growth and should eat 120 Cal or 30 grams of protein, so 4-5 ounces

CARBOHYDRATE

Hours of cell growth depends on how many hours of sufficient blood sugar supply

Low blood sugar stimulates cortisol release, breaking down muscle tissue to supply amino acids to the liver for conversion to glucose. The length of time that eating a carbohydrate boosts your blood glucose depends on the type of sugar and how quickly it digests.

Carbohydrate type

Glucose is directly burned as fuel by your cells, so as it digests and enters the blood from the intestine it is transported into your cells. If glucose enters your blood faster than your lean tissue can absorb it, blood glucose levels rise rapidly, elevating insulin enough to increase glucose going into body fat. Foods primarily glucose are tubers (yam and potato) and cereals (rice, corn, grains).

Sucrose is half glucose and half fructose. Fructose goes to the liver, where it is converted into glucose at the rate of 1-2 Cal per min. Fructose entering the liver faster than this activates a transcription factor that increases gene expression for the proteins that convert fructose into fats, elevating liver and therefore blood fat levels. This is why fruit juice and sugary foods, which are half fructose and process quickly, are not fundamentally healthy. Sucrose foods are legumes, fruits, vegetables, and foods with added sugar. Legumes digest so slowly that the chances of a large

insulin response from the glucose or fat production from the fructose are very low. This makes legumes the most effective time-release glucose supply (directly and then via liver production) that I am aware of. Berries and fruit consumed with the peel (coarseness slows digestion) would be a close second. Vegetables, which digest at a rate dependent on how much they are cooked, would be as slow as legumes but they are so low in calories that their main benefit comes from extremely high nutrient level and their impact on slowing the REST of the foods you consume WITH them. Dairy sugar is lactose, which is half glucose and half galactose. Galactose is also converted to glucose by the liver, but dairy sugar processes fairly slow and is not a significant fat production risk.

Using vegetables to slow starches (tubers and cereals)

Studies with diabetics compared to normal controls show that both groups have their starchy foods slowed by 1/3 if they eat vegetables 10 min before as opposed to 10 min after eating the starch [Imai S et al., Diabet Med 30 **2013** 370]. This means having a lot of vegetables won't help you slow digestion very much if you have already digested much of your meal before you eat them. It is shocking that 1/3 of the carbohydrate in meals is already digested and entering the bloodstream in just 10 minutes. This goes to show you how unhealthy carbohydrates have become in our toxic food environment in which everything is processed, and therefore digests faster than natural food. Fortunately, we have vegetables to save us from this mess. And the timing matters: If the vegetables are not in your stomach until later they cannot help you. Presumably eating vegetables together WITH the rest of your meal would be as helpful as eating them right before the meal, since either way the vegetables are in your stomach with the rest of the food, but this has not yet been tested. I personally choose to eat my vegetables together with the rest of my meals because it is easier to eat a lot of vegetables when you eat them with a tasty meal at the same time. Spinach tastes like pizza when you eat it with pizza. Kale tastes like a burger when you eat it with a burger.

How much carbohydrate to eat

Use legumes, fruits and (to a lesser extent) vegetables as your carbohydrate calories for baseline basic health and recovery. Use vegetables to slow the digestion of starches (tubers and cereals) when you choose to eat them, except when they are absorbed rapidly into your lean tissues i.e. when low in fuel reserves (right after you wake) or after intense muscle contraction (right after you exercise). Cell absorption rate is higher after intensive training than after waking, so combine your breakfast carb with protein and dietary fat to improve your body's hormonal and digestive response.

Right after exercise you depend less on your hormonal response to get calories to muscle because intense muscle contraction stimulates muscle to absorb calories faster independent of hormones. This effect disappears after exercise ends with a half time on the order of 20 minutes. A good carb target at breakfast without vegetables is 100-200 Cal, with an addition of vegetables to breakfasts with more carbs. A good carb target in the 10 min after training (liquid or solid calories in this case) is 100-300 Cal depending on the training intensity and how much carb was lost in the muscles overall in the workout. Many studies show that high-carb breakfasts lead to slower fat burning and eating more calories later because of the large insulin response. Clearly, you cannot just estimate how much carbohydrate you need and eat that amount, because if the carb i.e. sugars enter your bloodstream faster than they can be absorbed by the cells that need them, blood sugar rises too quickly and the large insulin response sabotages your benefits. Consume slow-digesting carbohydrates (legumes, fruits consumed with the peel, and vegetables) and use vegetables as a tool to slow starches except in the front end of the recovery window after hard exercise.

How much carbohydrate you need

The Institute of Medicine (IOM) in the Dietary Reference Intakes (DRIs) specifies that we need ~500 Cal of glucose per person per day for our brain and that the liver produces half of this. If we do not consume enough carb calories to provide the other half, it is produced by the liver from amino acids from muscle tissue broken down by cortisol until the brain shifts to ketone use. The trigger for the brain to shift to ketone use is a signal from the liver (through the vagus nerve) when the liver runs out of most of its glycogen after 1-2 days of low carbohydrate intake. In the first day of carbohydrate depletion before the brain transitions to ketone use, the IOM estimates that 1/4 pound of lean tissue is lost to glucose production, which is ten times more loss than intensive strength training could build in that amount of time. Therefore, if not doing exercise of any kind, low carbohydrate intake is fine. But exercise changes everything because muscle contraction activates blood glucose uptake into muscle, depriving the brain of the glucose the liver is trying to provide it. Since only half of brain fuel can be ketones, cortisol is again released to break down muscle for glucose production. In other words, a very low carbohydrate diet on the days you exercise hard stimulates both muscle building and muscle loss at the same time. Ironically, the harder the exercise the greater the blood sugar drop and the faster the muscle loss. This can lead to a lower fitness potential, feeling over-trained sooner, and reduced health. Health can drop because a consistently low blood sugar drops your hormone production (including fertility hormones),

immune system strength, injury recovery rate, bone density, mood, and the horrible irony of muscle loss eliminating your ability to reduce body fat, possibly to the point that the harder you work out the fatter you seem to get. These are precisely the opposite effects of what you would expect from exercise, all because your nutrition is not properly coordinated to your exercise. The bottom line is that hammering on your body hard from two different directions (more training and less nutrition) can be too much for it to overcome or adapt to, especially in the long term.

Studies show that training at lactate threshold or lower intensity uses mainly fat as fuel, making a relatively low-carb diet (a few hundred calories worth per day) sufficient. But workouts that are higher intensity require carbohydrates to be recovered into muscle in order to avoid the muscle loss cycle. It only matters how much carb is actually recovered into muscle, not how much carb you eat, which means your carb timing is critical. Not eating glucose right after exercise, and then over-eating carb later in the day just sends much of what your muscles need to body fat instead,you're your muscles continue to deplete your blood sugar. You reduce fat burning and increase body fat when you over-do the carb, and lose muscle tissue when carb levels are low, so this pattern oscillates back and forth between increasing body fat and losing muscle mass. You end up with the opposite body composition of what was expected from cutting calories and working out hard, which is an insanely frustrating situation to be in.

Layer your sports nutrition on top of your health nutrition

The solution is create your nutrition program based on health, and then layer on top of that your sports nutrition, meaning higher protein based on your training for the past week, and your glucose intake based on your training today. Since protein and dietary fats process relatively slow, eating them three times per day in your major meals is sufficient. When consuming a fast-digesting protein source, if your next meal is many hours away, have a snack that contains a protein between the meals e.g. yogurt. When consuming more than 200 Cal of starch in a meal use vegetables to slow its digestion rate. Determine how much carbohydrate you need, then use vegetables to slow it down so your bloodstream has both protein and carb available for the same duration of time. Both are needed at all times for recovery and growth. Determining how much carbohydrate you need and when is dependent on your training intensity and body fat goals using the concept of carbohydrate deficit (next chapter).

DIETARY FATS

Since dietary fats are accumulated into chylomicrons and sent through the lymph system to the bloodstream, they take more time to process than the other nutrients. This makes their timing in your day mainly up to you. You could put them into all your meals, or mainly just into one meal and not so much in the others, or in your snacks instead of meals. As long as you get at least a dozen calories of omega-3, at least 3 times that much of omega-6 and omega-9, roughly 1/3 of your meal calories as dietary fat, with no more than 1/3 of that from animals, you will stay healthy. The omega-3 would come from 1-2 Tbsp chia or flax seeds, or 3 oz of salmon or sardines. The omega-6 would come from at least 2-3 Tbsp of any nut or seed. The omega-9 would come from at least 1-2 Tbsp of olive oil, or 4 Tbsp or either olives or avocado. Again, twice these numbers per day during hard training. Fats should be 1/3 or more of your baseline health nutrition, 1/3 or a bit less during heavy training since recovery protein and re-fueling carbs increase disproportionately.

HYDRATION

Baseline hydration is ~1 L per ~1000 Cal that you eat spaced out through the day to facilitate digestion. At least half of this fluid needs to be water, not other fluids. Have at least as much water before any other type of fluid since other fluids do not hydrate as well. If salt intake is either high or low compared to exercise perspiration losses you will not be able to retain fluids and will be chronically dehydrated no matter how much water you drink; See hydration chapter.