Oisin O'Connell

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An Overview of Important Beginning Fitness Concepts from a Scientific Perspective

CALORIES AND NUTRITION

"If you consume more calories than your body expends, you will gain weight. If you consume fewer calories than your body expends, you will lose weight" (Dieter). Some of the most important ideas within building muscle and losing weight are calories, macronutrients, and the simple idea of caloric energy intake and energy output. However, micronutrients are important as well. The eating of more vegetables and fruits is important when considering nutritional value and can help with weight loss, creating an important consideration when constructing a diet. "[V]egetables as a group are so low in calories that it is very difficult to gain weight even if you overeat them" ("Why Do You Need to Eat Vegetables Every Day?"). This can help temper a diet because a large amount of vegetables can be eaten without creating a caloric level that is going to cause weight gain. Nutritionally, "diets high in fruits and vegetables are widely recommended for their health-promoting properties" (Slavin and Lloyd). In addition to this, recommended fiber is sourced from fruits and vegetables, seen in the quote "fruits and vegetables are recommended as a source of dietary fiber" (Slavin and Lloyd) and the Institute of Medicine "set an AI value for fiber of 14 g of fiber/1000 kcal" (Slavin and Lloyd), AI referring to "Adequate Intake" (Slavin and Lloyd).

This level of fiber is "derived from data on the relationship of fiber consumption and coronary heart disease" (Slavin and Lloyd) further increasing the level of importance of consuming fiber at a recommended rate, The Institute of Medicine's analysis also "considered

the totality of the evidence for fiber decreasing the risk of chronic disease and other health-related conditions" (Slavin and Lloyd) for their recommendation of fiber amounts, leading higher importance to this level of consumption for fruits and vegetables containing fiber. Slavin and Lloyd go so far as to state, during their concluding statements, that "public health messages to increase fiber consumption are warranted" (Slavin and Lloyd) presumably to aid with the medical effects listed above.

In addition to the medical benefits of fiber listed above, benefits of having a diet inclusive of fruits and vegetables include "lower[ing] the risk of heart disease" ("Vegetables and Fruits"), "protection against cancer" ("Vegetables and Fruits") in addition to the fact that this diet "can also keep your eyes healthy, and may help prevent two common aging-related eye diseases—cataracts and macular degeneration" ("Vegetables and Fruits"), many compelling reasons to include fruits and vegetables within a diet designed for fitness and health.

Online resources will give estimates of the amount of calories necessary based off of a multitude of factors, including height and weight and whether the goal of the individual is to gain or to lose weight ("Calorie Calculator"). However, it is important to bear in mind that if weight goals are not being reached or weight is not changing at all, there is a disparity between the necessary amount of calories and the recommended amount of calories, because, as seen at the beginning of this section, "[i]f you consume more calories than your body expends, you will gain weight. If you consume fewer calories than your body expends, you will lose weight" (Dieter). If weight is not being lost or gained according to an individual's goals, this signifies that the individual is not consuming an amount of calories necessary to reach a sufficient caloric deficit or is not consuming enough calories to reach a sufficient caloric surplus. This can be fixed by

consistently raising calories or lowering calories and changing macronutrient ratios accordingly until weight gain goals are reached.

STATE OF THE UNION

Unfortunately, "[t]he evolutionary process has favored biological traits associated with preferences for high energy density (sweet and/or fatty) energy-yielding foods" (Blundell et al.) In the United States, the "percent of adults age 20 years and over with obesity" ("National Center for Health Statistics") was "37.9%" ("National Center for Health Statistics") from "2013-2014" ("National Center for Health Statistics"). The health impact on those who compose this large level of the population that is obese is significant, in that "[o]besity-related conditions include heart disease, stroke, type 2 diabetes and certain types of cancer, some of the leading causes of preventable death" ("Overweight & Obesity"). Those who become obese are also leading to a large economic impact within the United States, in that the "medical burden of obesity has risen to almost 10 percent of all medical spending and could amount to $147 billion per year in 2008" (Finkelstein et al.). Additional economic and medical impacts of obesity include the fact that "obesity was responsible for 27 percent of the rise in inflation-adjusted health spending between 1987 and 2001" (Finkelstein et al.) a large indicator of the impact of obesity.

PROTEIN

When beginning a diet with the idea of fitness and weightlifting in mind, an important consideration is protein. However, there is confusion between sources on the exact amounts of protein necessary. One source states that "1.3-1.8 g [of protein]" per kilogram per day (Phillips et al.) is the recommended amount for active individuals (Phillips et al.), for "muscle protein synthesis" (Phillips et al.). This source additionally states that more protein is necessary while

attempting to lose fat, to prevent "lean mass losses" (Phillips et al.). In these "periods of energy restriction" (Phillips et al.) it is recommended that protein consumption "as high as 1.8-2.0 g [of protein]" per day per kilogram (Phillips et al.) is necessary.

A second source makes the argument that daily protein requirements are elevated for active individuals (Lemon). The study states that "[b]ased on laboratory measures, daily protein requirements are increased by perhaps as much as 100% vs. recommendations for sedentary individuals (1.6-1.8 vs. 0.8 g/kg)" (Lemon). This level of protein for active individuals is within the level of protein per kilogram recommended by the first source, however, the first source states that "1.3-1.8 g [of protein]" per kilogram per day (Phillips et al.) is the recommended amount for active individuals (Phillips et al.), for "muscle protein synthesis" (Phillips et al.). This range is wider and reaches lower per gram of protein per kilogram than the second source, leading credit to the idea that a level agreeing with both of those levels of protein intake would be reasonable. This can be changed as the individual learns more about their individual responses to differing levels of protein. While the recommendation for the amount of protein needed may vary, the importance of protein is clear, seen in the quote "[w]hen we eat protein – such as meat, fish or eggs – our digestive system breaks it down into amino acids, which our bodies can use for a range of functions, including muscle building" (Dacres-Mannings). Muscle building is one of the main goals of fitness and weightlifting, thus it is very important to consider and include protein when dieting.

CARBOHYDRATES

According to an initial source, "40-60%" of your diet should be made up of carbohydrates. ("How Many Carbs Should You Really Eat Per Day to Build Muscle"). This appears to be

confirmed to an extent upon further research, with another source recommending "45 to 65 percent" (Hermann 2) of calories daily should come from carbohydrates (Hermann 2). The scientific reasoning behind the amount of protein necessary per day, along with the amount of fats needed per day can lead the dieter to find the correct area within this range in order to have a healthy and balanced diet, depending on whether their goal is to gain or lose weight. Losing weight can be done by decreasing the amount of carbohydrates to reach the caloric goal, and gaining weight can be done by increasing the amount of carbohydrates within this range. Increasing protein as is likely necessary when attempting to lose weight but retain muscle (Phillips et al.). This can be seen in the quote "[e]levated protein consumption, as high as "1.8-2.0 g" per kilogram per day, can "be advantageous in preventing lean mass losses during periods of energy restriction to promote fat loss" (Phillips et al.). Carbohydrates are certainly a necessary part of a fitness and weightlifting oriented diet, as they are an important source of energy in the body, especially with muscle building, seen in the quote "[a]bout half of the energy used by muscles and other body tissues is provided from glucose and glycogen, a storage form of carbohydrate" (Hermann 1).

FATS

Continuing in the study of key dietary factors, sources continue to differ in their outline of the necessities for amounts of fats in a diet focused on fitness. A recommendation for bodybuilders, bodybuilding being a sport in which the maximum muscle gain and retention possible is wanted, was that "most but not all bodybuilders will respond best to [sic] 15-30% of calories from fat" (Helms et al.). An additional source stated, that for a balanced diet, "about 30%" ("Balancing Carbs, Protein, and Fat") of calories should come from fat ("Balancing Carbs, Protein, and Fat")

from an overall health standpoint. Another source stated that "20 to 35 percent of your calories should come from fats" ("How Much Fat Should I Eat?"). Fat should definitely not be overlooked, however, as it can "[h]elp protect and run your immune system" ("How Much Fat Should I Eat?") along with having the important functionality of helping with "good production of testosterone and estrogen" ("How Much Fat Should I Eat?"). This very important, as the production of testosterone is directly connected to muscle creation, seen in the quote "[b]y boosting protein synthesis in skeletal muscle, testosterone increases both the rate and extent to which muscles adapt to exercise" (Gallagher 1). This synthesis of information continually leads to the idea that, as a balanced athlete, a level of fat within the range of slightly differing information given should be acceptable if one is not attempting to be a bodybuilder but is still hoping to remain healthy with a reasonable production of necessary bodily compounds ("How Much Fat Should I Eat?"). This would likely be around the 30% of calories range based on this variety of information, with a consideration for a large amount of recommendations ("How Much Fat Should I Eat?"; "Balancing Carbs, Protein, and Fat"; Helms et al.). However, as one continues learning about themselves they may wish to change their macros slightly depending on their own bodily health, fitness results, and dietary preferences. This specific plan and set of research describes a relatively low ratio of fats, and while high fat, ketogenic diets are certainly popular, this essay discusses a high-carbohydrate diet and the research showing amounts of different macronutrients necessary in this type of diet. This choice is supported by the fact that studies show that increased amounts of carbohydrates cause less fat storage than increased amounts of fats, seen in the quote "[e]xcess dietary fat leads to greater fat accumulation than does excess dietary carbohydrate" (Horton) with carbohydrates demonstrating "75-85% of

excess energy being stored" (Horton) and fats demonstrating "storage of 90-95% of excess energy" (Horton).

SUGAR

Is removing sugar from your diet really necessary? When people talk about dieting, you might hear them speaking about possibly an ice cream addiction, a problem with chocolate, or other addictions to tasty goods. However, beginning a diet may not signify a necessity for a complete removal of sugar. In fact "there is little scientific justification for recommending restricting sugar consumption below the reasonable upper limit recommended by the Dietary Guidelines for Americans, 2010 of no more than 25% of calories" (Rippe and Angelopoulos). Consuming at levels higher than this, or possibly at this level of sugar consumption can lead to an important problem, however, seen in the quote "[c]onsuming a lot of foods high in added sugar is a concern because these foods may provide excess calories that contribute to weight gain or lower the intake of more nutritious foods" (Hermann 2). It is a necessity to ensure that one is staying healthy and avoiding fat gain, so it is suggested, based on quotes outlined above, that added sugar should definitely be avoided for the most part, but this can be adjusted as one learns about themselves and their own levels of fat gain in differing circumstances, similar to the macronutrients outlined above. Sources highly vary on opinions about sugar, some stating that "excess sugar consumption can spike your blood sugar out of the normal healthy range setting off a cascade of insulin ups and downs" ("How Sugar Makes You Gain Weight – Thrive Global"), others stating more blatantly that "[s]ugar makes you fat and fatfree food isn't really free of fat" ("How Sugar Makes You Fat") and still others continuing to state that "eating sugar,

especially when part of a proper diet, just isn't nearly as problematic as many people think" (Matthews).

Studies show an interesting mix of important factors, though. Quite the opposite to the quote "[s]ugar makes you fat" ("How Sugar Makes You Fat"), and in connection to the quote "eating sugar, especially when part of a proper diet, just isn't nearly as problematic as many people think" (Matthews) one study found that "higher intakes of sugar were related to leanness, not obesity" (Ruxton). In addition, a source regarding guidelines for sugar stated that:

> The American Heart Association recently released a statement advising consumers to limit sugars consumption. The macronutrient report for the dietary reference intakes addresses many of these same issues; the expert panel concluded that it was not appropriate to set a tolerable upper intake level for added sugars but suggested a maximal intake level of 25% of energy from added sugars because of concerns about reduced intakes of essential micronutrients" (Murphy and Johnson).

This source essentially shows a lack of reasoning for avoiding sugar based on a fat gain perspective (with the exception of being in an overly high caloric surplus because of sugar consumption), but from a health perspective, "micronutrients" (Murphy and Johnson) are important. Obviously, one wanting to eat a clean diet for better health would include large amounts of vegetables and fruits, seen in the quote "diets high in fruits and vegetables are widely recommended for their health-promoting properties" (Slavin and Lloyd). A key point here can be seen in the quote that was displayed at the beginning of this essay. "If you consume more calories than your body expends, you will gain weight. If you consume fewer calories than your body expends, you will lose weight" (Dieter). If someone is consuming a level of sugar that leads

to an excess of energy, this will definitely lead to fat gain. Small problems with a diet will not cause unwanted effects, so a diet can be definitely dynamic, within reason. Avoiding overall overconsumption while losing weight is more important than focusing on small dietary details, so if a incorrect diet is avoided, goals should be reached even if some of the small dietary details are not correct.

WATER

Because this is an essay about athletics and increasing athletic ability through weight loss or gain, it would be a poor judgement to overlook water in the diet from a health standpoint. The reason for this is that "[u]nder relatively mild levels of dehydration, individuals engaging in rigorous physical activity will experience decrements in performance related to reduced endurance, increased fatigue, altered thermoregulatory capability, reduced motivation, and increased perceived effort" (Popkin et al.). Rigorous physical activity will likely result from the addition of a workout plan to a dietary plan within losing or gaining weight, causing this dehydration and lowering of physical performance described. If one wishes to perform well in the gym, or in other areas, such as running, it is important to ensure that motivation and endurance are increased, along with fatigue being decreased. Increased fatigue, decreased motivation, and decreased endurance are all effects of dehydration described in the quote (Popkin et al.). In addition to the performance effects, dehydration can cause delirium in the elderly, gastrointestinal effects, kidney imbalances, headaches, and decreases in blood volume (Popkin et al.). To combat the effects of dehydration on performance and health, the recommendation for fluid consumption is 15.5 cups per day for men, and 11.5 cups per day for women (Mayo Clinic Staff). However, this recommendation includes fluids from food and other

sources, and most can stay hydrated by simply "drinking water and other fluids whenever they feel thirsty" (Mayo Clinic Staff).

METABOLISM

Through my own research, I have found metabolism to be a highly interesting concept with many components, worthy of understanding when one is attempting to gain or lose weight.

One of the factors of metabolism that can influence weight gain and loss is RMR or resting metabolic rate. This is "an estimate of how many calories you would burn if you were to do nothing but rest for 24 hours" (Merritt). Resting metabolic rate can have variation among different humans. However, the validity of resting metabolic rate being the sole factor in weight gain or loss is highly questionable, and this is seen in the quote, "[i]n humans, the coefficient of variation in the components of total daily energy expenditure is around 5-8% for resting metabolic rate" (Donahoo et al.). This level is not a large enough deviation to compensate for widespread obesity, and adds a higher level of reasoning that there is usually not a reasoning for weight gain or loss based solely on one's resting metabolic rate. Although resting metabolic rate, used in this study describing the difference in metabolic rate between all humans (Donahoo et al.), is taken in conditions that are not to the same level of control as basal metabolic rate, seen in the quote "[resting metabolic rate] measurements are typically taken under less restricted conditions than [basal metabolic rate]" (Merritt) these rates are still similar. This can be seen in the quote "[basal metabolic rate] is going to be a slightly more accurate reading" (Merritt) with focus on the idea of basal metabolic rate being a measurement with only slightly more accurate results. This leaves the conclusion that resting metabolic rate is not a major factor to be placed at

fault for weight gain or loss, due to the small variation in resting metabolic rate of "5-8%" (Donahoo et al.).

Resting metabolic rate is not the only factor in metabolism, however. Usually, metabolic rate is divided into postprandial thermogenesis, basal metabolic rate, and physical activity (Barr). Postprandial thermogenesis is the "increase in metabolic rate after ingestion of a meal" (Reed). Evidence shows that increased burning of calories through thermogenesis can be induced by a higher level of fat free mass, seen in the quote "[the thermic effect of food was] positively correlated with fat-free mass (FFM)" (Reed). However, the thermic effect of food is mainly influenced by factors such as meal composition, meal frequency, and body composition ("Thermic Effect of Food"). Genetic differences could cause a higher level of the the "5-8%" (Donahoo et al.) coefficient in humans for the difference in resting metabolic rate, which could lead to a higher fat content. This would lead to a higher thermic effect of food characterized by those with higher body fat ("Thermic Effect of Food"), but solely these factors without outside influence of increased calories or decreased exercise is unlikely to cause obesity or a significant difference in body composition. This can additionally be seen in the quote "[t]o be honest, it is really not worthwhile to make modifications to your eating habits with the sole intent of optimizing the thermic effect of food. If you managed to do it the effects would be minimal at best" ("Thermic Effect of Food").

HOW MUSCLE IS BUILT FROM A SCIENTIFIC STANDPOINT

When muscles are exercised, they undergo trauma and are thus injured. The effort to repair this injured muscle activates "satellite" cells which attempt to repair that muscle (Kwon and Kravitz). The increase in muscle size is caused by these repair efforts, seen in the quote "[i]n

essence, a biological effort to repair or replace damaged muscle fibers begins with the satellite cells fusing together and to the muscle fibers, often leading to increases in muscle fiber cross-sectional area or hypertrophy" (Kwon and Kravitz). Cross sectional area increases, and muscle growth, will become apparent as a result of creating trauma for muscles, but "[t]he adaptation of muscle to the overload stress of resistance exercise begins immediately after each exercise bout, but the effect often takes weeks or months to physically manifest itself" (Kwon and Kravitz) signifying that for muscle growth, there is a definite need for sustained and effective trauma to the muscles. Additionally, becoming older has an effect on muscle, seen in the quote "[a]ging also mediates cellular changes in muscle, decreasing the actual muscle mass" (Kwon and Kravitz). This is, however, clearly not reason to not work out as one grows older, because "the detrimental effects of aging on muscle have been shown to be restrained or even reversed with regular resistance exercise" (Kwon and Kravitz). This shows a definite reasoning for people of all ages to begin interacting with fitness and becoming healthier.

THE "ANABOLIC WINDOW"

When eating after working out muscle breakdown is more effective, leading to more muscle creation. This is seen in the quote "[i]ngestion of carbohydrate or carbohydrate and protein during recovery further increases muscle protein synthesis" (Houston). Muscle creation, therefore, is aided by eating during the recovery period after resistance training occurs (Houston). However, this does not signify that eating directly after completing resistance training is necessary, seen in the quote "the anabolic effect of a resistance training bout may last well beyond 48 hours" (Houston) anabolic referring to the process of anabolism in building "new compounds and tissues, including muscles" (Rogers).

HYPERTROPHY AND REPETITION RANGES

Sources vary in explanations of the best repetitional ranges for creating hypertrophy within weightlifting, with regards to synthesizing muscle within the body. In addition, scientific studies as a whole seem to be inconclusive as to the best rep range for hypertrophy. Examples include this study, which states that those who used "the heaviest loads (> or =90% 1RM [one repetition maximum])" (Human Performance Laboratories) for differing exercises leads to a "preferential hypertrophy" (Human Performance Laboratories). Heavier loads, especially loads at "> or =90% 1RM" (Human Performance Laboratories) lead to lower rep ranges, signifying the claim that better hypertrophy would be obtained with these lower rep ranges and these "heaviest loads" (Human Performance Laboratories) referred to in the study. The fact that the study specifically states that these loads are equal to or greater than "90%" (Human Performance Laboratories) of the one repetition maximum for the given exercise gives concrete evidence that these weights would lead to low rep ranges, because the one repetition maximum for that weight is the maximum amount of weight that can be lifted for one repetition for the given exercise.

Another example includes a study which compared training at "3 sets of 10 repetition maximum (RM)" (Schoenfeld et al.) to "7 sets of 3RM [repetition maximum]" (Schoenfeld et al.). The study found that both methods "promote similar increases in muscular size" (Schoenfeld et al.) however, "powerlifting-type training [with higher weight] is superior for enhancing maximal strength." (Schoenfeld et al.). With these "similar increases in muscular size" (Schoenfeld et al.) this study again provides an example of differing information about the ideal amount of repetitions for muscle building, conflicting with the study above which stated

that "the heaviest loads (> or =90% 1RM [one repetition maximum])" (Human Performance Laboratories) will lead to a "preferential hypertrophy" (Human Performance Laboratories). This specific study also suggests that the repetitional range (either 3 repetitions or 10 repetitions in this example) is not that important for stimulating muscle growth, that it will grow regardless of repetitional ranges (Schoenfeld et al.), because of these "similar increases in muscular size" (Schoenfeld et al.).

Given these studies, it appears clear that higher weights and lower repetitional ranges overall will provide the added benefit of increasing strength while either not making a difference with hypertrophy or increasing hypertrophy. However, as long as sufficient trauma occurs to the muscle, it will grow, so the beginner can change their program as wanted if sufficient trauma still occurs.

PROGRESSIVE OVERLOAD AND WORKOUT PROGRAMMING

After the beginner has developed their eating plan, they are going to want to seek out a fitness or weight lifting program, if their goal is to gain muscle. However, with a caloric deficit, one will lose weight regardless of lifting program, seen in the quote "[i]f you consume fewer calories than your body expends, you will lose weight" (Dieter). This quote also leads us to realize that muscle gain will be limited by a caloric deficit and aided by a caloric surplus, seen additionally in the quote "the amount of energy [calories] you consume affects how much muscle you can build" (Tzur). Of course, this effect is positive with a caloric surplus, seen in the quote "the more energy and protein you consume, the more [muscular] gains" (Tzur). An increase in muscle size is seen when your body is repairing damaged muscles after you work out, so if you are sufficiently damaging your muscles, you will see muscle growth, or hypertrophy, seen in the

quote “[i]n essence, a biological effort to repair or replace damaged muscle fibers begins with the satellite cells fusing together and to the muscle fibers, often leading to increases in muscle fiber cross-sectional area or hypertrophy” (Kwon and Kravitz). However, working out doesn’t essentially mean that you are always going to be damaging muscles enough to grow, seen in the quote “[s]keletal muscle grows bigger and stronger in response to the training stimulus, but for further gains, you need to continue making greater demands on it. If you don't progressively overload the muscles by forcing them to do more than they're accustomed to, they have no reason to make further adaptations” (Goulet). Additionally, “in order to get bigger and stronger, you must continually make your muscles work harder than they're used to” (Goulet). This emphasizes the necessity of progressive overload and progress within a program. If one cannot see progress and one is not gaining strength, it is definitely possible that it is necessary to find a program with sufficient progressive overload, or simply increase workout intensity and increase weight levels. Thus we see that doing specific exercises to maximize full-body growth is important, but more important is progressive overload within a program to ensure continued muscle gain, which will be facilitated by progressive overload (Goulet).

SUMMARY

Throughout this essay, the main important concept of calories and overall nutrition was analyzed, continuing forward to speak about the nationwide effect of fitness and dieting, or lack thereof. After this, the macronutrients of a diet were analyzed, including an analyzation of fat, protein, and carbohydrates. Continuing, metabolism and the extent of the difference in resting metabolism within humans was analyzed, reaching the conclusion that resting metabolic rate isn’t usually a large reason for weight loss or gain. To provide background information for how

muscle can be built, an analysis of how muscle is actually made from a scientific standpoint was created. Moving forward an analysis about the anabolic window was created, reaching the conclusion that due to the extent of time that the anabolic window can extend it is usually not necessary to place a large amount of importance on hitting this window after working out. After this, an analysis of muscle gain based on the merits of differing repetitional ranges was completed, building on the previous section of the science behind muscular growth. Finally, the importance of progress and progressive overload in muscle gain was shown, analyzing how sufficient muscle damage and progress is necessary for muscle gain.

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