



## WHEY PROTEINS AND BODY COMPOSITION

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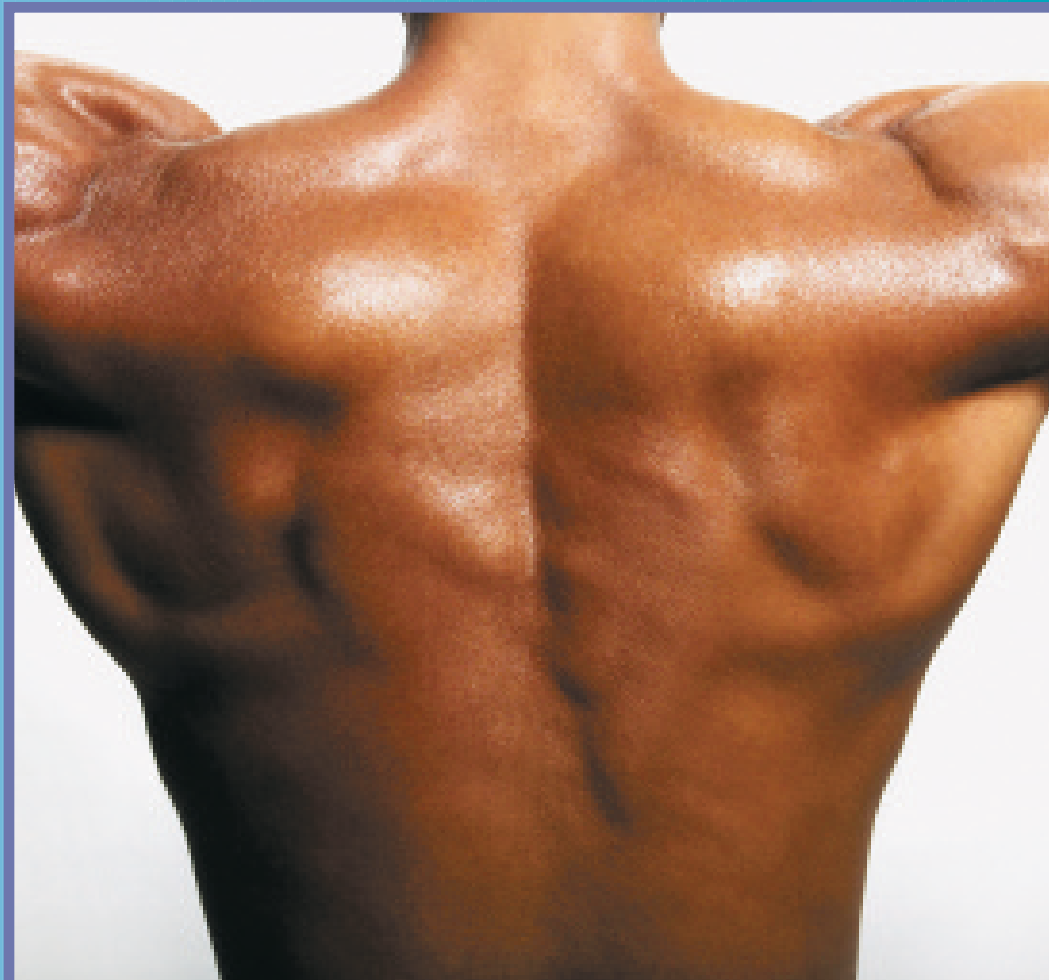
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*Recent studies show that consumption of whey protein, in combination with resistance training exercise, is a safe and effective strategy that will help adults build and maintain valuable muscle mass, and preserve their health throughout the aging process.*

### THE CRITICAL IMPORTANCE OF MUSCLE MASS MAINTENANCE

Body composition is the relative proportion of body fat and fat-free mass (organs, bone and muscle tissue) that makes up the human body. Unlike body weight, an individual's body

composition has a profound influence on health and longevity.<sup>4</sup> With advancing age, people increase adiposity (the rate of fat accumulation) and lose fat-free mass, mostly in the form of muscle.<sup>5</sup> Studies now confirm that these undesirable changes in body composition may have severe, long-term consequences to health.<sup>8</sup>



Muscles are a dynamic reservoir of bound and unbound proteins (amino acids) that are constantly broken down and regenerated to meet all the metabolic demands of the body.<sup>2</sup> Muscle is also the metabolic furnace that burns fat for fuel and drives the metabolism.<sup>6</sup> Metabolic rate is simply the rate at which the body burns calories; an individual's metabolism ultimately determines his or her body composition.<sup>7</sup> The controlled process of breakdown and synthesis of muscle proteins diminishes with aging.<sup>25</sup> Additionally, the body's ability to use fat for fuel also decreases. The result is a slower metabolic rate that predisposes the older adult to further muscle loss and unwanted fat gain.<sup>8</sup>

However, research now shows that the age-related decline in metabolic rate and increase in body fat accumulation is related specifically to a decrease in muscle mass and not aging per se.<sup>5,7</sup> For an individual in his 20s, muscle comprises up to 60% of the fat-free mass; when one reaches 70, this drops to less than 40%.<sup>1</sup> As fat-free mass diminishes, body fat levels steadily increase, and so does the risk of a shorter lifespan.<sup>8</sup> A high level of body fat (often linked to being overweight) is directly associated with a much higher risk of heart disease, stroke, adult-onset diabetes and other conditions that may reduce the lifespan.<sup>9</sup>

Simply by preserving or increasing fat-free (muscle) mass, older adults can protect themselves against undesirable changes in body composition as well as many ailments that are usually associated with aging.<sup>4,7,9</sup> In fact, some evidence suggests that the decline in resting metabolism and increase in body fat accumulation that occurs with age may be eliminated if muscle mass is maintained.<sup>7</sup> Striving to build and/or preserve muscle not only leads to a better body composition (less body fat and more fat-free mass), it also increases the chance of a longer, healthier life.<sup>8,9</sup>

## BODY COMPOSITION AND EXERCISE

Research that has examined body composition changes in older adults indicates that a person's body fat level throughout his or her lifespan is influenced more by the amount of muscle mass one possesses rather than one's level of physical fitness.<sup>5-8</sup> The past decade has seen an explosion in the awareness of exercise as part of a healthy lifestyle. Although regular aerobic exercise, such as walking, jogging or cycling, provides a great way to burn calories and increase fitness (cardiac efficiency), these activities do not provide adequate stimuli to maintain muscle mass.<sup>10</sup> Preventing the age-related decline in muscle mass appears to be the

most important determinant in avoiding excessive body fat accumulation throughout life.<sup>5-8</sup>

More than any other activity, resistance training exercise (using free-weight devices) stimulates muscle protein synthesis rates to promote increases in strength and muscle mass that ultimately lead to an improved body composition.<sup>11</sup> The effectiveness of resistance training for improving body composition (reducing body fat and increasing fat-free mass) has been demonstrated in a variety of populations.<sup>10,11</sup> Even frail adults in their 90s respond robustly to intense resistance training programs with significant increases in strength, muscle size and anabolic hormone concentrations.<sup>12</sup>

### Body Mass Index Chart

		Height																		
		58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
(in)	4'10"	4'11"	5'0"	5'1"	5'2"	5'3"	5'4"	5'5"	5'6"	5'7"	5'8"	5'9"	5'10"	5'11"	6'0"	6'1"	6'2"	6'3"	6'4"	
(ft/in)	4'10"	4'11"	5'0"	5'1"	5'2"	5'3"	5'4"	5'5"	5'6"	5'7"	5'8"	5'9"	5'10"	5'11"	6'0"	6'1"	6'2"	6'3"	6'4"	
(m)	1.47	1.49	1.52	1.54	1.57	1.60	1.62	1.65	1.67	1.70	1.72	1.75	1.77	1.80	1.82	1.85	1.87	1.90	1.93	
45/100	21	20	20	19	18	18	17	17	16	16	15	15	14	14	14	13	13	13	12	
48/105	22	21	21	20	19	19	18	18	17	16	16	16	15	15	14	14	14	13	13	
50/110	23	22	22	21	20	20	19	18	18	17	17	16	16	15	15	15	14	14	13	
52/115	24	23	23	22	21	20	20	19	19	18	18	17	17	16	16	15	15	14	14	
54/120	25	24	23	23	22	21	21	20	19	19	18	18	17	17	16	16	15	15	15	
57/125	26	25	24	24	23	22	22	21	20	20	19	18	18	17	17	17	16	16	15	
59/130	27	26	25	25	24	23	22	22	21	20	20	19	19	18	18	17	17	16	16	
61/135	28	27	26	26	25	24	23	23	22	21	21	20	19	19	18	18	17	17	16	
64/140	29	28	27	27	26	25	24	23	23	22	21	21	20	20	19	19	18	18	17	
66/145	30	29	28	27	27	26	25	24	23	23	22	21	21	20	20	19	19	18	18	
68/150	31	30	29	28	27	27	26	25	24	24	23	22	22	21	20	20	19	19	18	
70/155	32	31	30	29	28	28	27	26	25	24	24	23	22	22	21	20	20	19	19	
73/160	34	32	31	30	29	28	28	27	26	25	24	24	23	22	22	21	21	20	20	
75/165	35	33	32	31	30	29	28	28	27	26	25	24	24	23	22	22	21	21	20	
77/170	36	34	33	32	31	30	29	28	27	27	26	25	24	24	23	22	22	21	21	
79/175	37	35	34	33	32	31	30	29	28	27	27	26	25	24	24	23	23	22	21	
82/180	38	36	35	34	33	32	31	30	29	28	27	27	26	25	24	24	23	23	22	
84/185	39	37	36	35	34	33	32	31	30	29	28	27	27	26	25	24	24	23	23	
86/190	40	38	37	36	35	34	33	32	31	30	29	28	27	27	26	25	24	24	23	
88/195	41	39	38	37	36	35	34	33	32	31	30	29	28	27	27	26	25	24	24	
91/200	42	40	39	38	37	36	34	33	32	31	30	30	29	28	27	26	26	25	24	
93/205	43	41	40	39	38	36	35	34	33	32	31	30	29	29	28	27	26	26	25	
95/210	44	43	41	40	38	37	36	35	34	33	32	31	30	29	29	28	27	26	26	
98/215	45	44	42	41	39	38	37	36	35	34	33	32	31	30	29	28	28	27	26	
100/220	46	45	43	42	40	39	38	37	36	35	34	33	32	31	30	29	28	28	27	
102/225	47	46	44	43	41	40	39	38	36	35	34	33	32	31	31	30	29	28	27	
104/230	48	47	45	44	42	41	40	38	37	36	35	34	33	32	31	30	30	29	28	
107/235	49	48	46	44	43	42	40	39	38	37	36	35	34	33	32	31	30	29	29	
109/240	50	49	47	45	44	43	41	40	39	38	37	36	35	34	33	32	31	30	29	
111/245	51	50	48	46	45	43	42	41	40	38	37	36	35	34	33	32	32	31	30	
113/250	52	51	49	47	46	44	43	42	40	39	38	37	36	35	34	33	32	31	30	

Key: Underweight Healthy weight Overweight Obese

## WHEY—AN EMERGING PROTEIN FOR IMPROVING BODY COMPOSITION

Researchers have confirmed that protein supplementation enhances the results that are desired from resistance training.<sup>35</sup> However, a review of the scientific literature reveals that protein sources are not all the same in terms of the benefits they may contribute to health and body composition. An ever-increasing amount of scientific evidence indicates that whey proteins are tailored to promote a better body composition, particularly when combined with resistance exercise.

Studies using rodents have shown that incorporating whey into the diet results in less fat storage, more lean tissue and greater insulin sensitivity in muscles.<sup>16-20</sup>

In a variety of clinical settings such as cancer, HIV and hepatitis, the health benefits of whey supplementation are suggestive.<sup>21-23</sup> Although very few clinical studies have assessed whey's impact on body composition changes, whey's unique ability to boost glutathione concentrations within various cells in the body is clear.<sup>21-23,31</sup> Glutathione is a primary antioxidant defense system in the body that protects cells against free-radical damage, pollution, toxins, infection and UV exposure.<sup>21</sup> Glutathione levels decrease with age,<sup>26</sup> and this decline is associated with the onset of many age-related diseases such as Alzheimer's disease, cataracts, Parkinson's disease and arteriosclerosis.<sup>28</sup>

Low glutathione levels within various cells in the body forecast muscle loss, whereas adequate glutathione concentrations underline favorable changes in body



*Whey supplementation has been shown to provide a significant decrease in body fat.*

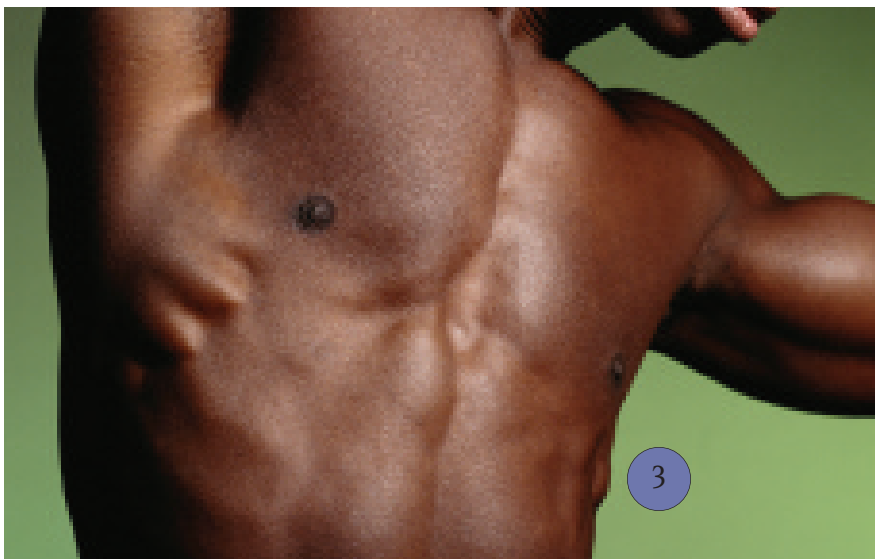
composition (such as increased muscle mass and reduced fat mass). This relationship has been demonstrated in a variety of unrelated medical conditions such as cancer and HIV as well as with healthy adults undertaking exercise training programs.<sup>26,30</sup> Some studies suggest that compared to other high-quality protein sources, whey has the unique capacity to increase glutathione production that leads to improvements in body composition.<sup>21,31</sup>

Whey supplementation (20 grams/day for 12 weeks) was shown to enhance glutathione status, improve athletic (anaerobic) performance and provide a significant decrease in body fat percentage in healthy, young adults.<sup>31</sup> These benefits were obtained without the stimulus of exercise training.<sup>31</sup> However, the combination of exercise and whey supplementation appears to provide even better improvements in body composition.

Compared to casein or carbohydrate supplementation before exercise, rodents given alpha-lactalbumin-enriched whey displayed lower body fat levels and more muscle tissue after a six-week training period. Metabolic analyses revealed that alpha-lactalbumin-enriched whey supplementation enabled more effective fat utilization (oxidation) and preservation of muscle. Alpha-lactalbumin-enriched whey supplementation in rats enhanced the efficiency of exercise to provide better improvements in body composition.<sup>20</sup>

Recently, there has been a surge in interest within the scientific community regarding the beneficial effects of combining dairy protein supplementation with resistance training.<sup>13-15,32,33</sup>

In an open trial, Demling and De Santi<sup>14</sup> reported that supplementation with whey (60 grams/day) was effective at decreasing fat mass and increasing fat-free mass in overweight men following a calorie-restricted diet during 12 weeks of resistance training.



One study reported that bovine colostrum supplementation (20 grams/day) during 12 weeks of resistance training resulted in greater body composition improvements (an increase in lean body mass of 1.49 kgs) than whey protein alone.<sup>15</sup> However, another study revealed that a whey and casein combination (75 grams/day) provided the same favorable strength, muscle fiber hypertrophy and body composition changes compared to two different colostrum supplements.<sup>13</sup> In both of these studies, the training programs were not supervised and/or controlled. Exercise selection, training intensity, frequency and volume (the amount of sets, repetitions performed) are all shown to affect the type and magnitude of results obtained from resistance training.<sup>11</sup> Therefore, it is difficult to draw firm conclusions on the effects of supplementation from these studies. However, preliminary results from more rigorously controlled studies involving direct comparisons of whey to other supplements suggest some remarkable effects on body composition.<sup>32,33</sup>

In a randomized, double-blind trial involving athletes (bodybuilders) undertaking an identical, supervised, 10-week resistance training program, the group provided with a pure whey isolate (1.5 grams/kg body

weight/day) experienced a gain in fat-free mass that was five times greater than a matched group receiving a casein supplement.

DEXA body composition assessments before and after the program also revealed that the whey-supplemented group experienced a significant (1 kilo) reduction in body fat. Combined, these results demonstrated that whey supplementation provided a highly significant improvement in body composition when compared to casein supplementation.<sup>32</sup> Additionally, the whey-supplemented bodybuilders also achieved significantly greater strength increases in every exercise that was assessed.<sup>32</sup> The researchers concluded that whey supplementation (particularly isolates) may provide much better body composition and strength improvements during resistance training compared to other high-quality proteins.

Another study was conducted by the same researchers on the effects of whey supplementation on body composition changes and muscle fiber adaptations.<sup>33</sup>



In this study, four groups of resistance-trained men (20 to 35 years old) were given either whey isolate, carbohydrate, creatine or a combination of creatine and whey supplement (1.5 grams of protein/kg body weight/day). Preliminary results indicate that the whey-supplemented groups experienced double the gain in fat-free mass after 11 weeks of resistance training compared to males given the carbohydrate supplement. The ability of whey to enhance muscle gains during resistance training was confirmed at the cellular level. Muscle biopsies taken from the men before and after training revealed that whey supplementation increased the size of some muscle fiber types by up to 543% compared to carbohydrate supplementation. Additionally, the greater muscle hypertrophy response from whey supplementation correlated strongly with the superior strength improvements seen in the whey supplemented groups.<sup>33</sup> As the researchers noted, all groups started the training program equal in strength, and they consumed an adequate protein intake aside from supplementation. These studies suggest that whey may be a catalyst that ensures better results from resistance training.



*Whey proteins are particularly effective at stimulating muscle protein synthesis and promote better results from training.*

## WHEY: BIOCHEMICALLY TAILORED TO PRESERVE MUSCLE

The biochemical rationale behind whey's effectiveness in preserving muscle mass and enhancing the results desired from resistance training is sound.

Stimulating protein synthesis and minimizing protein breakdown (proteolysis) are the two cellular processes that are essential to recovery and muscle hypertrophy.<sup>34</sup> Increased protein synthesis rates within muscle cells are vital to creating net gains in muscle protein and subsequent improvements in body composition.<sup>34</sup>

The ability of a protein to stimulate muscle protein synthesis resides in the dose and composition of amino acids.<sup>35</sup> Whey proteins are particularly effective at stimulating muscle protein synthesis rates for a number of reasons.

- Whey's amino acid profile is almost identical to that of skeletal muscle. Whey provides all the correct amino acids in approximate proportion to their ratios in skeletal muscle.
- Compared to other protein sources, whey proteins contain a higher dose (per 100 grams)<sup>36</sup> of the essential amino acids (those that cannot be synthesized by the body). The essential amino acids are shown to be the most effective at stimulating protein synthesis in adult muscle.<sup>37</sup>
- The high concentration of the branched-chain amino acid leucine found in whey is of particular interest to exercise scientists. Several researchers suggest that an abundant supply of leucine to muscle after exercise may promote more efficient recovery at the cellular level to speed the adaptation process of exercise training.<sup>40,41</sup>



However, creating and maintaining the optimal bio-environment that builds and preserves muscle actually centers around two other amino acids: glutamine and cysteine. Although glutamine and cysteine are referred to as nonessential, a series of studies confirms that the concentration of these two amino acids within the body virtually determines the amount of muscle tissue a person carries throughout life.

- Muscle protein synthesis rates and protein accretion are essentially controlled by the amount of glutamine held within the cell.<sup>41</sup> However, muscle glutamine is the essential fuel that drives many indispensable processes within the body, including immune function.<sup>39</sup> The body's demand for glutamine is ravenous. Without the constant *de novo* synthesis of glutamine by muscles, glutamine stores would be depleted within seven hours.<sup>38</sup>
- Muscle glutamine is manufactured exclusively by the branched-chain amino acids (leucine, isoleucine and valine). The branched-chain amino acids are unique in muscle metabolism; they must be present to stimulate protein synthesis within muscle as well as manufacture glutamine.<sup>43</sup> However, these amino acids are also metabolized extensively for energy within muscle rather than the liver. This is particularly evident during periods of metabolic stress such as illness, infection, calorie restriction and exercise training.<sup>38,39,42</sup>
- Cysteine is the rate-limiting amino acid in glutathione formation.<sup>26</sup> Additionally, a high concentration of cysteine in blood is required at all times to ensure correct protein metabolism that preserves muscle mass.<sup>26</sup> An abundant supply of cysteine (in the blood) down-regulates hepatic urea production and shifts nitrogen disposal in favor of muscle glutamine synthesis and the preservation of the muscle glutamine pool.<sup>26</sup> This essential metabolism of cysteine by the liver is vital to maintaining valuable muscle glutamine stores as well as the synthesis of glutathione.<sup>27</sup> However, this process is disrupted during periods of intense metabolic stress. Intriguingly, this tightly controlled process also diminishes with advancing age.<sup>26</sup> The result of this is a steady but aggressive decline in muscle tissue throughout the lifespan.<sup>26</sup>



Whey proteins contain a high concentration of all the amino acids that are essential to creating and maintaining the optimal bio-environment that preserves muscle mass.

- Supplementation with cysteine-rich compounds is shown to increase glutathione production, halt muscle protein breakdown, and improve muscle strength and body composition during exercise training.<sup>29,30,44</sup> Compared to other proteins, whey is a rare, rich source of cysteine that is easily assimilated by the body.<sup>42</sup> In fact, whey is viewed by scientists as an effective "cysteine-donor" that restores blood cysteine concentrations and boosts glutathione levels that may lead to improvements in body composition.<sup>21,31,42,45</sup>
- Whey is nature's richest source of branched-chain amino acids.<sup>42</sup> Characteristically, whey's amino acid composition is 26% branched-chain amino acids and 6% glutamate.<sup>36</sup> These are the amino acids used exclusively by muscle to manufacture glutamine.<sup>43</sup> That means more than one-third of whey's entire amino acid profile is devoted entirely to muscle glutamine synthesis.

Additional research demonstrates that whey's beneficial effects on muscle may not reside exclusively in its amino acid profile.

- Scientists have now confirmed that blood amino acid concentrations control muscle protein synthesis rates and the ability to gain muscle from resistance training.<sup>34</sup> A high level of amino acids in the blood is necessary to stimulate muscle protein synthesis rates and maximize the stimulus of resistance training.<sup>3</sup>



Unlike other high-quality protein sources, whey is rapidly absorbed and provides a significant increase in blood amino acid concentrations to stimulate muscle protein synthesis rates.<sup>47</sup> Additionally, when whey is consumed as part of a mixed macronutrient meal (with carbohydrate and fat), a strong and persistent inhibition of muscle breakdown (proteolysis) is witnessed along with increased muscle protein synthesis.<sup>47</sup> On an equal-serving basis, whey supplementation results in higher protein balance and greater muscle protein gain compared to other high-quality proteins such as casein.<sup>47</sup> For all these reasons, whey protein supplementation may prove to be helpful for building muscle and limiting muscle loss during aging.

#### *Dairy proteins and fat loss*

Whey protein's beneficial effects on body composition may not pertain exclusively to building muscle. Dairy products that are rich in calcium and dairy protein appear to play a key role in the regulation of energy metabolism and whether an individual gains or loses body fat.<sup>45</sup> Diets that are rich in calcium appear to prevent fat gain as well as increase fat metabolism, thereby markedly accelerating the process of losing body fat.<sup>46</sup> While the beneficial impact of a high calcium intake on body composition has been demonstrated, recent studies indicate that calcium provided from dairy foods exerts an even greater effect on body weight and fat loss.<sup>24,51</sup> Even without calorie restriction, increasing the intake of dairy products is shown to reduce body fat and increase fat-free mass.<sup>48</sup> Although the bioactive constituents responsible for dairy's beneficial effects on fat metabolism remain the subject of speculation, the researchers behind these studies suggest that dairy protein, including whey proteins, may be a major contributor.<sup>45,46,48</sup>



#### *Whey and satiety*

Of all the macronutrients, protein appears to have stronger appetite-suppressing effects. However, a recent study suggests that whey appears to have appetite-suppressing qualities.<sup>49</sup> In a series of trials, consumption of whey protein before a meal significantly reduced hunger and food intake and increased the feeling of satiety. When the participants drank a whey shake 40 minutes before a meal they felt more satisfied when consuming fewer calories.<sup>49</sup> The researchers discovered that whey stimulates much higher levels of two gastrointestinal hormones that control appetite: cholecystokinin and glucagon-like peptide-1. Consuming whey increased the levels of these hormones by 60% compared with drinking a casein supplement.<sup>49</sup>

Due to the multitude of benefits it provides, whey should be the first protein source considered when health-conscious people choose to increase their protein intake.



## APPLICATIONS: GUIDELINES TO IMPROVE BODY COMPOSITION

### *Using whey protein to build muscle mass*

An abundant supply of the essential amino acids to muscle during resistance training is shown to enhance the anabolic stimulus by up to 400%.<sup>50</sup> To achieve this effect:

- Take a serving of whey protein (20-40 grams) with a dose of carbohydrates (glucose) (20-40 grams) mixed in water within the hour before resistance training exercise.
- Additionally, take the exact same mix immediately after resistance training.

A single bout of resistance training exercise can stimulate muscle protein metabolism for up to 36 hours.<sup>34</sup> To minimize the muscle breakdown response and maximize the anabolic stimulus that resistance training provides, consume a serving of whey (20-40 grams) with a source of carbohydrates and some fat several times throughout the day. Simply mix or blend a serving of whey (concentrate or isolate) in 6-10 ounces of skim milk with some fruit and a tablespoon of canola or flaxseed oil.

Research shows that when whey is consumed as part of a mixed macronutrient meal (with carbohydrate and fat), a strong and persistent inhibition of muscle breakdown is witnessed along with stimulation of protein synthesis.<sup>47</sup>

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