THE SCIENCE BEHIND

BIG WHEY

Big Whey: a good quality protein

Key Points:

- Protein intake stimulates MPS and attenuates MPB
- Protein + resistance training enhances lean mass, strength, and power
- Approximately 0.25g per kg body weight of protein is needed at any 'meal' to promote MPS
- Whey protein is high in EAAs and BCAAs (and hence leucine), and so is ideal to stimulate MPS and overall net protein balance
- It is advantageous to take whey protein before and after resistance training in order to attain good net protein muscle balance
- NutritionX **Big Whey** is an ideal source of quality whey protein which has proven to aid athletes

Introduction

Whey proteins are (generally) high quality proteins, which together with casein, form the major proteins in milk. Whey protein is digested quickly, resulting in a more rapid increase in plasma amino acids, and rapidly stimulates muscle protein synthesis. Whey also augments adaptations to resistance training as shown by increases in muscle strength and enhanced lean body mass. These effects are most likely due to the quantity of branched-chain amino acids present (particularly leucine). Whey protein contains more leucine than other protein sources. In fact, whey proteins form the basis of many athletes nutrition plan in order to adequately recover from training and competition.

This article explains the science behind the use and benefits of taking whey protein (such as **Big Whey**) for athletes. For more background information on milk proteins and on the differences between whey and casein (the two key milk proteins), please read the two articles corresponding to those titles in our Science series i.e**. "Milk Proteins: whey and casein"**, and **"Whey vs Casein: which is best?"**.

Protein stimulation of muscle synthesis

Any athlete who engages in training (notably resistance types of exercise) does so in the knowledge that they wish to increase strength, power, speed, and even increase muscle mass. At the very least they do not undertake training if muscle mass and muscle integrity were to diminish – this would clearly defeat the objective of training. Examination of Figure 1 illustrates that muscle protein synthesis (MPS) is promoted by training for at least 48-h (Burd et al., 2009), and furthermore highlights the fact that when fed protein the increase in MPS is greater than training in a fasted state.

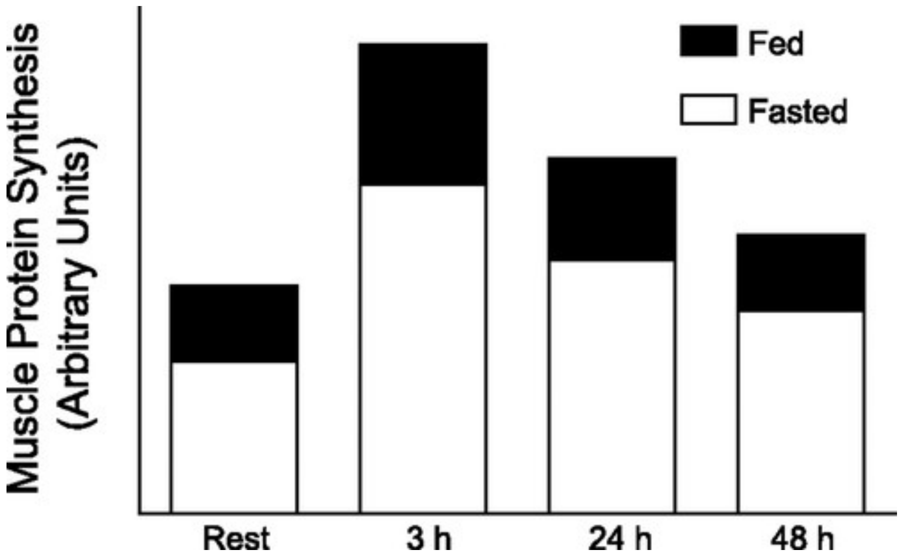

Figure1. Resistance training effects on muscle protein synthesis (after Burd et al., 2009).

It is important to recognise that exercise stimulates MPS in the recovery phase and Muscle Protein Breakdown (MPB) during the exercise bout. If an athlete undertakes an exercise bout in a fasted state (i.e. without some form of protein feeding) there is a greater amount of MPB than MPS in the hours after exercise. In effect, there is a net negative protein muscle balance i.e. the muscle is losing mass. Clearly this is not desirable and so feeding protein after exercise is recommended. Indeed, there is good evidence that ingesting protein after exercise not only promotes a greater amount of MPS but also reduces the amount of MPB – hence a more positive net protein muscle balance. Figure 2 captures the relationship between MPS and MPB. Repeated bouts of resistance exercise and protein feeding leads to muscle hypertrophy (Cermack et al., 2012). Of course, if the exercise is more endurance based then greater muscle recovery ensues rather than hypertrophy of the muscle.

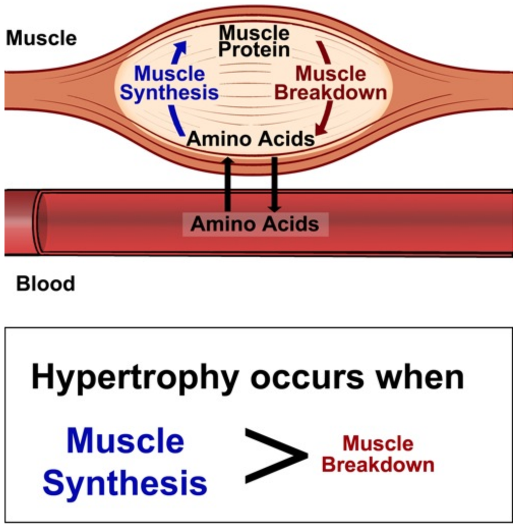

Figure 2. Schematic of relationship between MPS and MPB.

Exercise increases MPB and decreases MPS during the exercise bout. However, in recovery after exercise MPB continues to be high whereas MPS becomes stimulated. In a fasted state the cross-over between increased MPB and MPS in recovery can be some hours – that is before MPS is greater than MPB. This is a reason why most athletes do not train the same muscle group twice or more during the same day – indeed they rest that muscle group for 48-h to get full recovery i.e. MPS has overtaken MPB significantly. In the 'real world', athletes would consume some protein and this stimulates MPS and slows down MPB – just what is required for muscle recovery, growth, and repair. Figure 3 illustrates that feeding alone enhances MPS. Note that MPB is diminished somewhat whereas MPS is stimulated after a meal containing protein, and this process continues for ~3-h. After this time MPB increases and MPS decreases.

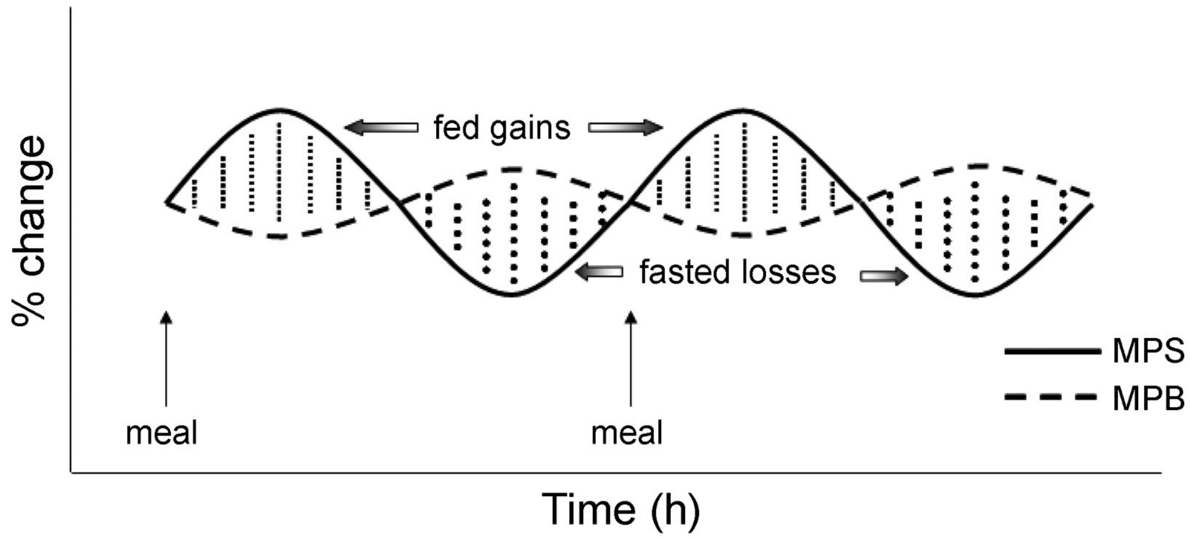

Figure 3. Effect of feeding (Protein) on MPS and MPB.

What is it about feeding protein that enables MPS to happen? What stimulates MPS? The answer lies in stimulation of what is known as the mTOR pathway by the amino acid leucine. Figure 3 highlights, rather simplistically, how leucine affects a muscle cell – once inside a muscle cell, leucine stimulates the so-called mTOR pathway, which in turn leads to stimulation of MPS. mTOR is, in effect, a signalling molecule within a cell that can be activated and so sets in motion a raft of changes resulting in an increase in MPS.

Now you will also note that the hormone, insulin, also promotes the mTOR pathway. Some of the amino acids present in proteins are insulinogenic in so far as they stimulate insulin secretion. The BCAAs and glutamine do just that – so any protein containing significant amounts of BCAAs and glutamine can help to 'drive' MPS.

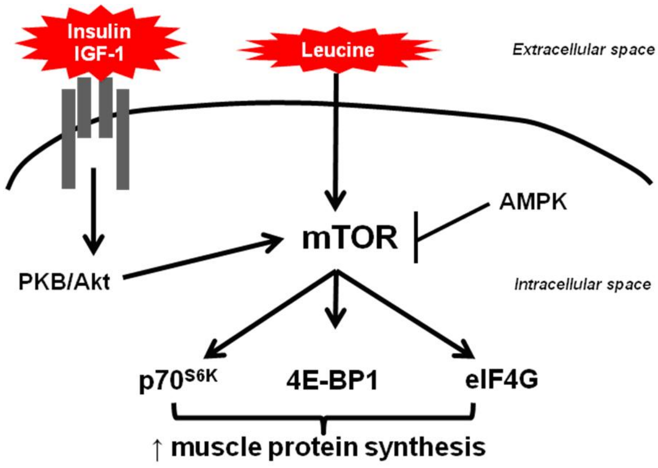

Figure 3. Schematic of leucine and insulin activation of MPS via the mTOR pathway.

You should also remember that stimulation of MPS is fine BUT other amino acids are required in order to repair and build muscle protein – in other words the building blocks of muscle (various essential amino acids) must be available for the process to become complete. Good quality proteins should therefore be capable of not just stimulating MPS but also of building the muscle with the right 'mix' of other amino acids – in essence have a good amount of the essential amino acids (EAAs).

How much protein should an athlete ingest in order to stimulate MPS? Figure 4 provides an overview with regard to the amount of protein required at a serving. Based on a 70 kg person it would seem that 10g is not enough and that 40g is too much (at least 40g does not provide any additional benefit) whilst 20g of protein seems appropriate. As a rule of thumb an amount of about 0.25 to 0.3g per kg body mass of protein is suitable at any 'meal' - for a 70kg person this is 17.5 to 21g of protein whereas for a 100kg athlete an amount of 25 to 30g is required (Aragon & Schoenfeld, 2013; Stokes et al., 2018). So, an athlete could ingest 1 serving before training (30-60 minutes beforehand) and a further serving within 30 minutes after training. The gap between such servings after accounting for the training session (say 60-90 minutes) is likely to be around 3-h.

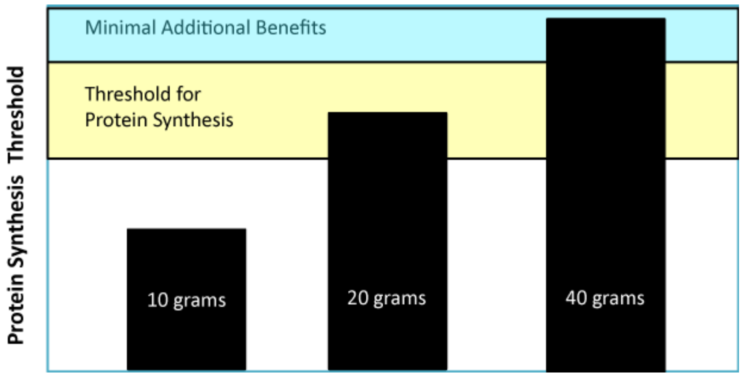

Figure 4. Protein requirements to stimulate MPS.

Now that we have established how much protein is needed in order to stimulate MPS, is there any preference with regard to the type of protein? (You may wish to read the NutritionX article "Whey or casein: which is best?"). Table 1 highlights the key amino acids (i.e. essential amino acids – EAAs – as well as the BCAAs) contained in types of protein supplements. From the data it is evident that whey proteins have an advantage both in terms of the EAAs and BCAAs i.e. the amino acids needed to both stimulate MPS and to provide the building material for muscle. Athletes should consider ingesting good quality whey protein as part of their nutrition practice in relation to training.

Table 1. Approximate Essential Amino Acid profile of various protein supplements (based on 100g of the supplement).

ESSENTIAL AMINO ACID	MILK PROTEIN ISOLATE	WHEY PROTEIN ISOLATE	WHEY PROTEIN HYDROL.	CASEIN	SOY PROTEIN ISOLATE	EGG PROTEIN
Isoleucine	4.4	6.1	5.5	4.7	4.9	5.7
Leucine	10.3	12.2	14.2	8.9	8.2	8.4
Lysine	8.1	10.2	10.2	7.6	6.3	6.8
Methionine	3.3	3.3	2.4	3.0	1.3	3.4
Phenylalanine	5.0	3.0	3.8	5.1	5.2	5.8
Threonine	4.5	6.8	5.5	4.4	3.8	4.6
Tryptophan	1.4	1.8	2.3	1.2	1.3	1.2
Valine	5.7	5.9	5.9	5.9	5.0	6.4
Total BCAAs	**20.4**	**24.2**	**25.6**	**19.5**	**18.1**	**20.4**
Total EAAs	**42.7**	**49.2**	**49.8**	**40.7**	**36.0**	**42.3**

Some early evidence (Tipton et al., 1999) clearly shows that EAAs are preferable to a similar amount of mixed amino acids taken after a resistance training session, which in turn are better than a non-protein placebo. Figure 5 highlights key findings from this investigation – note the effectiveness of the EAAs not only to stimulate MPS but also to reduce MPB. The overall effect is that net protein balance is more positive with EAA. You should also notice that the non-protein placebo resulted in a NEGATIVE protein balance – clearly not advisable for an athlete! Taking some form of protein after training is definitely required if negative protein balance is to be avoided. Furthermore, protein supplements in which the EAAs (which include the BCAAs) are relatively high is advantageous to a protein source of lower quality. In fact, Volpi et al. (2003) observed that MPS due to elevated levels of AAs was entirely as a result of the EAAs and that leucine was the major 'driver'.

Is it necessary to merely take an EAA supplement? It depends on how much you want to pay since an EAA product would need to be derived from a full protein which then has the other amino acids removed or the EAAs extracted – either way the product is likely to be rather expensive! Good quality whey protein in an appropriate dose is a cheaper and more than suitable way of achieving the necessary requirements.

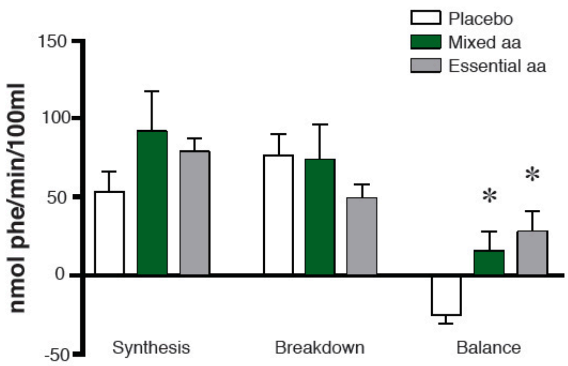

Figure 5. MPS, MPB, and net protein balance after resistance training using a placebo, mixed amino acids or an equivalent dose of EAAs (after Tipton et al., 1999).

The key 'driver' for stimulation of MPS is the amino acid leucine – one of the three BCAAs (see article on "Leucine"). Any protein supplement which either has a high natural level of leucine or one to which leucine has been added would be preferable. It appears that a dose of about 5g per serving is needed. Figure 6 illustrates the effect of similar doses of whey, soy, and casein on blood concentrations of leucine (Tang et al., 2009). It is quite clear that whey protein results in significantly higher levels of leucine. Consequently, it seems pertinent to ingest whey protein if there is a requirement for stimulation of MPS.

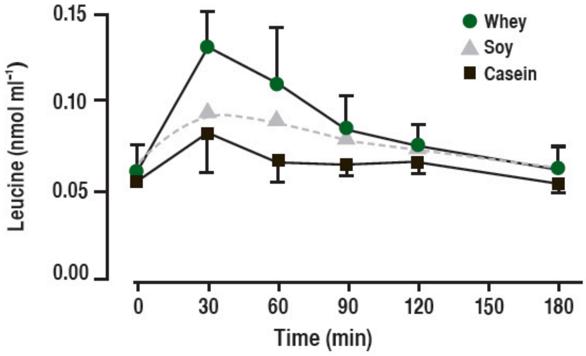

Figure 6. Effect of equal amounts of whey, soy, and casein on blood leucine concentrations (after Tang et al., 2009).

In fact, if you refer back to Table 1, you can see the amount of leucine present in whey proteins is about 12g per 100g of protein. This means that a 40g serving of whey protein, for example, will contain around 5g of leucine.

Whey Protein before or after exercise?

An early study (Tipton et al., 2001) on providing 6g of EAA before a resistance bout of exercise or immediately after exercise showed an advantage of taking the EAA before exercise – there was a greater net protein balance in a 4-h window when the EAA was taken 1-h before exercise. More recently however, the same author (Tipton et al., 2007) found there was no significant difference when 20g of whey protein was taken before or immediately after resistance exercise. Net protein balance was positive in both groups – but no difference between the groups.

The researchers suggested a good time to ingest whey protein before exercise might be 30 to 45 minutes prior to exercise in order to allow for the digestion and absorption of the amino acids. The logical conclusion from this research is to consume whey protein at both time points (both pre- and post-exercise) for maximizing MPS, minimising MPB, and thereby enhancing net protein balance.

Daily protein intake.

The daily protein requirement for a sedentary individual is recommended to be 0.8g per kg body weight – so for a 70kg person this amounts to 56g of protein per day. However, for athletes the amount recommended is around 1.6-2.2g per day. For those engaged in endurance activities the lower value is suggested whereas the higher amounts desirable for those engaged in strength and power training. For the latter athletes, this would mean an intake of ~165g per day for a 70kg person. This can be achieved by eating nutritious meals containing protein with additional support from protein supplementation. Figure 7 illustrates how regular feeding of protein through the day can ensure target protein intakes can be achieved. The key is to encourage athletes to eat 5-6 meals/snacks through the day (based around training and work) with gaps of no more than 3-4 hours between these meals/snacks – remember eating protein alone stimulates MPS (see Figure 3).

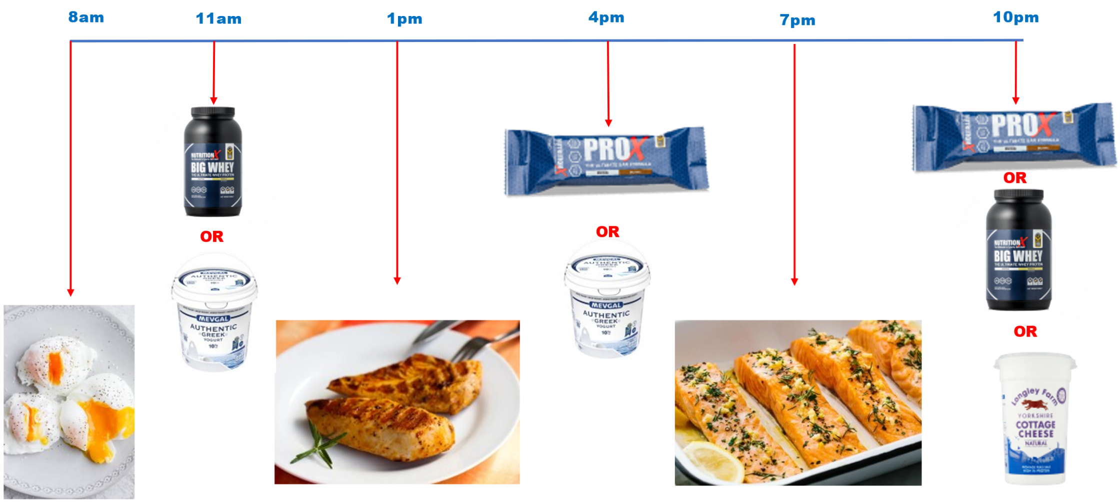

Figure 7. Schematic to illustrate how sufficient protein can be ingested to meet daily needs when training.

Big Whey: how to use it

Big Whey contains 24.8g of protein incorporating 6.54g of leucine. Together these constituents form the ideal basis for stimulation of MPS for any athlete up to 100kg in body mass (heavier athletes are advised to increase the portion pro rata). As such this means that muscle recovery is aided and indeed growth may be promoted with appropriate training. Leucine provides the actual stimulus for MPS, whilst the other amino acids (notably EAAs) provide the building blocks. Since the carbohydrate content is (deliberately) low, Big Whey maybe used as a so-called snack between meals or as a supper (see Figure 7) without leading to fat gains.

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