

PROTEIN INTAKE

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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. This constitutes ~20g per serving/meal.
- 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 to attain good net protein muscle balance.
- A daily intake of 1.5-2.5g/kg body mass per day is recommended to meet training needs (the higher dose being for those athletes engaged in resistance as well as endurance or power training).
- NutritionX - **Big Whey**, **Pro-X bars** and **Protein Shots** are ideal sources of quality whey protein which is 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 nutrition plans of athletes in order to adequately recover from training and competition.

This article explains the science behind the use and benefits of taking whey protein supplements (such as **Big Whey**, **Pro-X bars** and **Protein Shots**) 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 perhaps 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 protein-fasted state.

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 loses mass. Clearly this is not desirable and so feeding protein after exercise is recommended.

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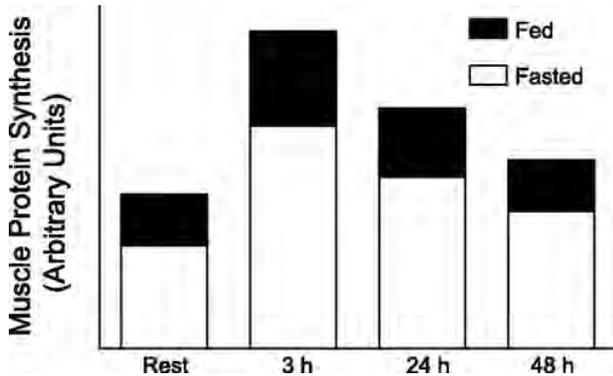


Figure 1: Resistance training effects on muscle protein synthesis (after Bund et al., 2009).

Indeed, there is good evidence that ingesting protein after exercise not only promotes a greater amount of MPS but may also reduce 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 (and the recovery of muscle also needs protein).

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

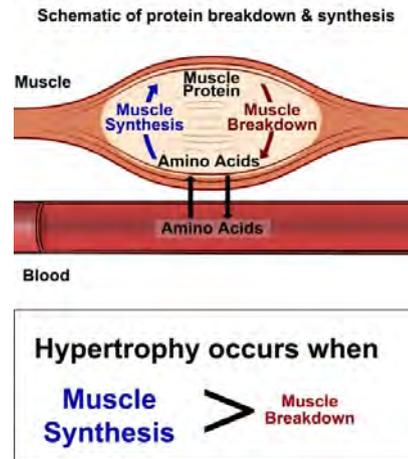


Figure 2: Schematic of relationship between MPS and MPB.

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.

Exercise, diet, and muscle protein balance.

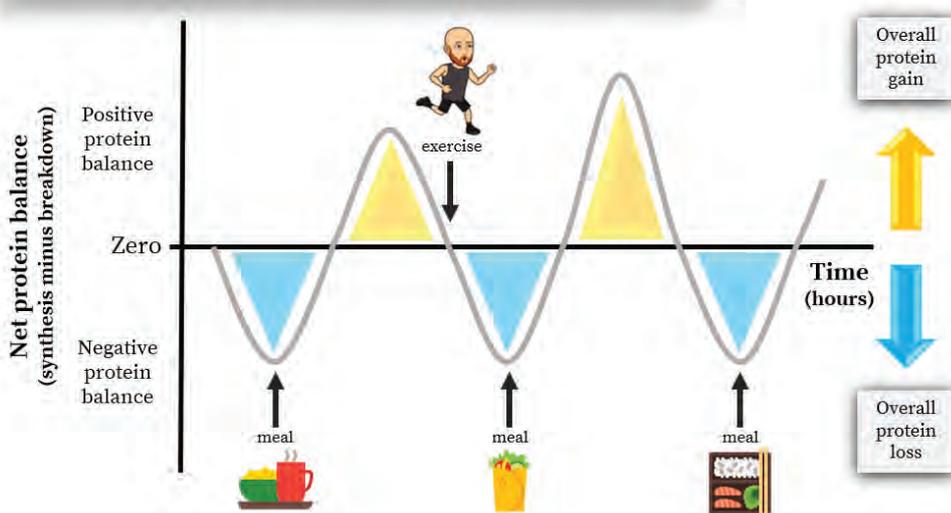


Figure 3: Effect of feeding (Protein) on MPS and MPB.

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Figure 3b highlights, rather simplistically, what about feeding protein enables MPS to happen? What stimulates MPS? The answer lies in stimulation of what is known as the mTOR pathway, in particular by the amino acid leucine. Figure 4 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.

You should also remember that stimulation of MPS is fine BUT other amino acids are required 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). Figure 5 provides a schema for this concept.

How much protein should an athlete ingest to stimulate MPS? Figure 6 provides an overview regarding the amount of protein required at a serving. Based on a 70 kg person, it appears that 10g is not enough and that 50g is too much (at least 50g 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 one 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.

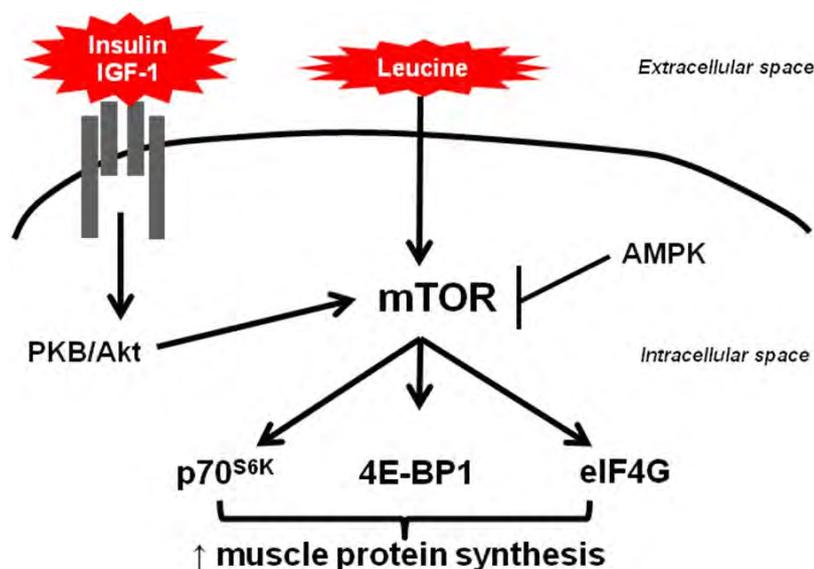


Figure 4: Schematic of leucine and insulin activation of MPS via the mTOR pathway.

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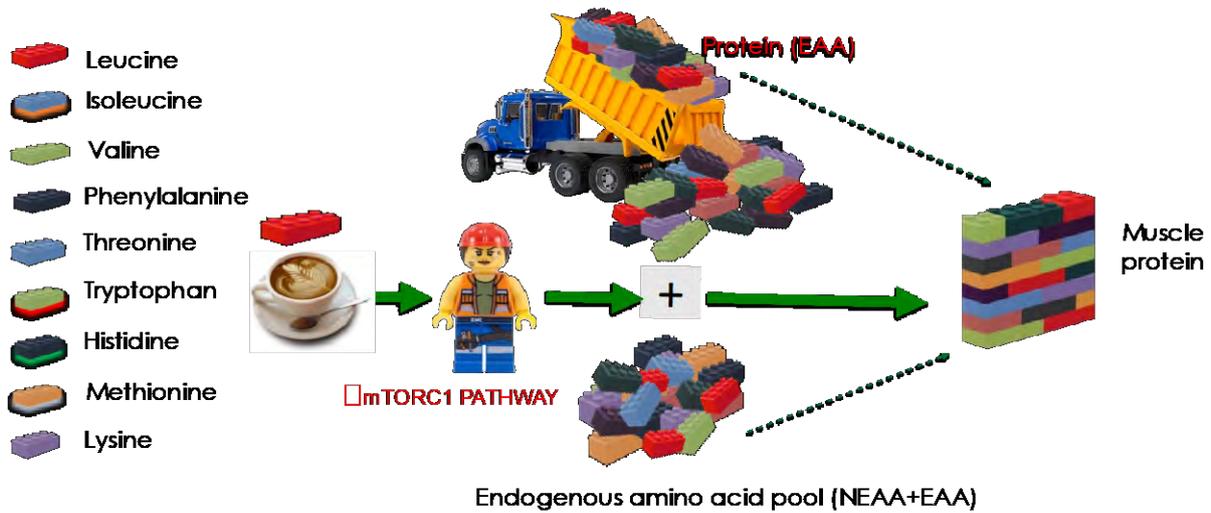


Figure 5: Illustration of the importance of leucine (red tile) for stimulating the mTOR pathway as well as the need for the other essential amino acids (EAAs) for providing the actual components to build muscle (taken from Protein Nutrition for Athletes and Exercisers by O. Witand in Nutrition Xchange, 2022).

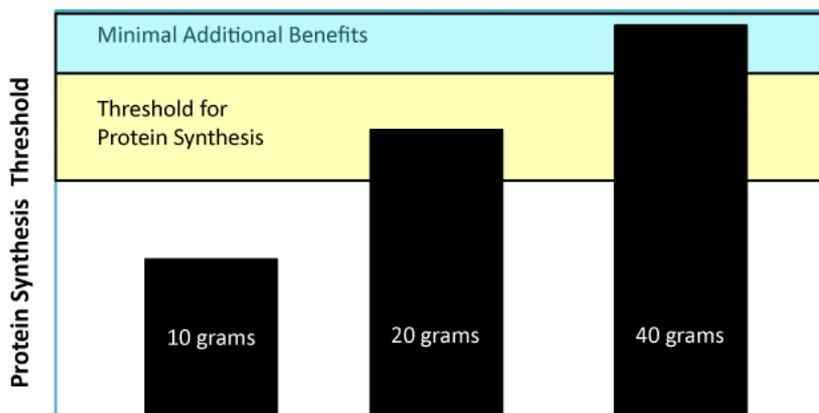


Figure 6: Protein requirements to stimulate MPS.

Figure 7 portrays a bar chart illustrating how protein intake may be consumed over the period of a day. In this concept, the portions of protein consumed through the day are equivalent. In practice, however, it may be that slightly greater portions of protein may be eaten at lunch and at dinner.

Now that we have established how much protein is needed to stimulate MPS, is there any preference regarding 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.

Some early evidence (Tipton et al., 1999) demonstrates 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 8 highlights key findings from this investigation – note the effectiveness of the EAAs not only to stimulate MPS but also to reduce MPB.

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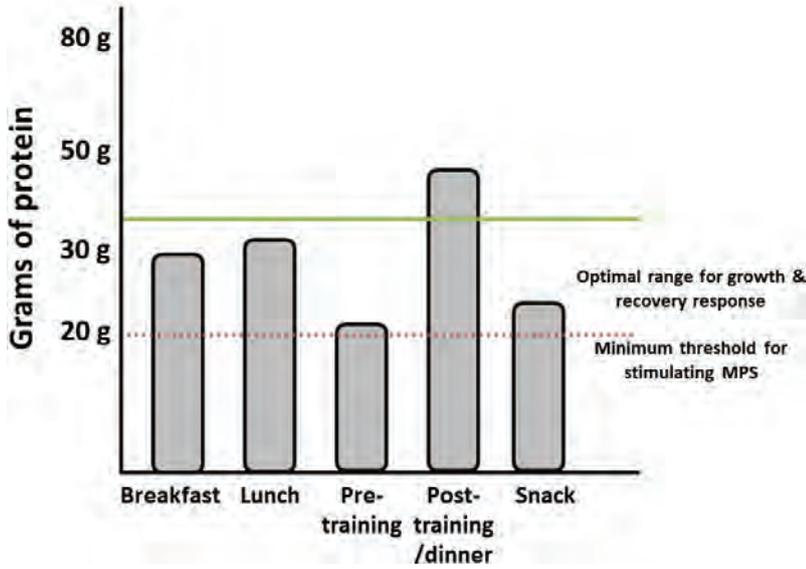


Figure 7: Proposed idea of the distribution of quantity of protein consumed through a day to achieve MPS.

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

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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 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 due to 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.

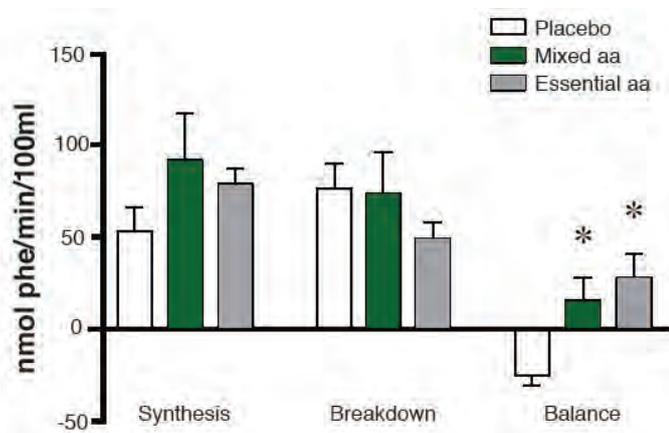


Figure 8: MPS, MPB, and net protein balance after resistance training using a placebo, mixed amino acids or an equivalent dose of EAAs (after Tipton et al., 1999).

The key ‘driver’ for stimulation of MPS is the amino acid leucine – one of the three BCAAs. 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 9 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.

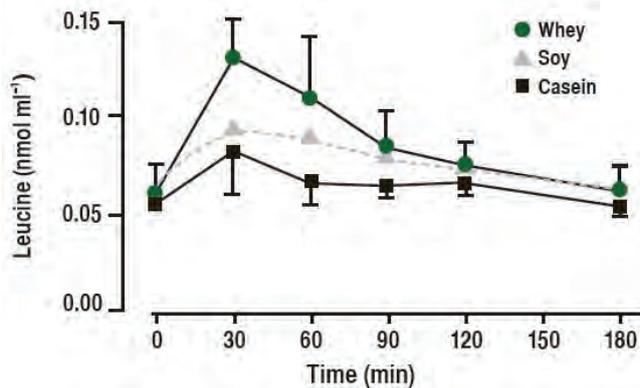


Figure 9: Effect of equal amounts of whey, soy, and casein on blood leucine concentrations (after Tang et al., 2009).

In fact, if you refer 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 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 to allow for the digestion and absorption of the amino acids.

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If we assume that protein should be consumed at regular intervals throughout a day (see Figure 7) then a logical conclusion would be 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

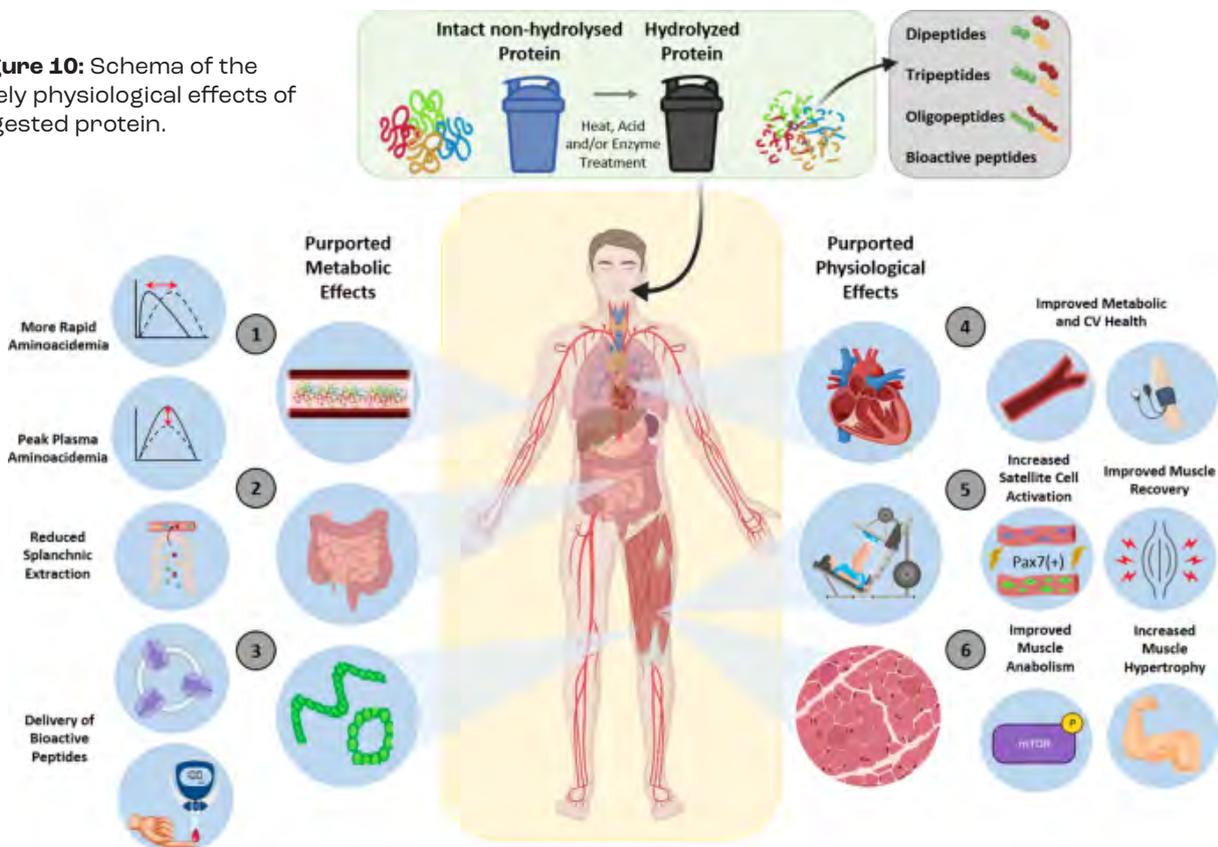
The daily protein requirement for a sedentary individual is recommended to be 0.8g per kg body weight – so, for a 70kg person, this amounts to 56g of protein per day. However, for athletes, the amount recommended is around 1.6-2.2g per day. For those engaged in endurance activities the lower value is suggested, whereas the higher amounts are desirable for those engaged in strength and power training. For the latter athletes, this would mean an intake ~165g per day for a 70kg person. This can be achieved by eating nutritious meals containing protein with additional support from protein supplementation.

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).

CONCLUSION

Protein supplements (such as in Nutrition X **Big Whey**, **Protein bars** and **Protein shots**) contain whey protein which is readily hydrolysed in the gut and absorbed as amino acids, dipeptides, tripeptides and so on, rather than intact proteins i.e. they are broken down to smaller subunits for absorption. Once taken up into the circulation (note that aminoacidemia occurs due to the increase of amino acids in blood), the amino acids may then be used to maintain a healthy heart, enhance muscle recovery after exercise and promote muscle hypertrophy if the right type of exercise is undertaken. Figure 10 provides an overview of the likely physiological effects of ingested protein.

Figure 10: Schema of the likely physiological effects of ingested protein.



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HOW TO USE BIG WHEY, PRO-X BARS AND PROTEIN SHOTS

Big Whey, Pro-x bars and Protein Shots all contain ~20g of protein incorporating ~5g of BCAAs as well as ~12g EAAs (Table 2). Together, these constituents form the ideal basis for stimulation of MPS for any athlete up to 80kg in body mass (heavier athletes are advised to increase the portion pro rata - such as 1.5 servings of Big Whey, 2 Pro-X bars, or 2 protein shots).

As such, this means that muscle recovery is aided, and 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, these NutritionX protein products may be used as a so-called snack between meals, or as a supper or as pre-and post-training supplements.

Table 2: Protein, BCAA, EAA and carbohydrate amounts per serving in Big Whey, Pro-X bar, and Protein shot.

	Big Whey (30g)	Pro-X Bar (55g)	Protein Shot (60ml)
Protein	25g	20g	20g
BCAA	6.5g	4g	5g
EAA	13g	11g	12g
Carbohydrate	2g	10g	0.2g

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