NAME: ESAN FAITH

DEPARTMENT: PHARMAMCOLOGY

MATRIC NUMBER: 18/MHS07/017

COURSE: MEDICAL BIOCHEMISTRY- BCH 204

WHAT DO YOU UNDERSTAND BY THE TERM BIOLOGICAL VALUE OF PROTEINS

**Biological value** (**BV**) is a measure of the proportion of absorbed [protein](https://en.wikipedia.org/wiki/Protein) from a food which becomes incorporated into the proteins of the organism's body. It captures how readily the digested protein can be used in [protein synthesis](https://en.wikipedia.org/wiki/Protein_biosynthesis) in the [cells](https://en.wikipedia.org/wiki/Cell_%28biology%29) of the organism. Proteins are the major source of [nitrogen](https://en.wikipedia.org/wiki/Nitrogen) in food. BV assumes protein is the only source of nitrogen and measures the proportion of this nitrogen absorbed by the body which is then excreted. The remainder must have been incorporated into the proteins of the organism’s body. A [ratio](https://en.wikipedia.org/wiki/Ratio) of nitrogen incorporated into the body over nitrogen absorbed gives a measure of protein "usability" – the BV.

BV uses two similar scales on how it can be readily digested:

1. The true percentage utilization (usually shown with a percent symbol).
2. The percentage utilization relative to a readily utilizable protein source, often [egg](https://en.wikipedia.org/wiki/Egg_%28food%29) (usually shown as unitless).

These two values will be similar but not identical.

The BV of a food varies greatly, and depends on a wide variety of factors. In particular the BV value of a food varies depending on its preparation and the recent diet of the organism. This makes reliable determination of BV difficult and of limited use — fasting prior to testing is universally required in order to ascertain reliable figures.

BV is commonly used in nutrition science in many [mammalian organisms](https://en.wikipedia.org/wiki/Mammals), and is a relevant measure in humans. It is a popular guideline in [bodybuilding](https://en.wikipedia.org/wiki/Bodybuilding) in protein choice.

DETERMINATION OF BV

1. the test organism must only consume the protein or mixture of proteins of interest (the test diet).
2. the test diet must contain no non-protein sources of nitrogen.
3. the test diet must be of suitable content and quantity to avoid use of the protein primarily as an energy source.

These conditions mean the tests are typically carried out over the course of over one week with strict diet control. Fasting prior to testing helps produce consistency between subjects (it removes recent diet as a variable).

There are two scales on which BV is measured; percentage utilization and relative utilization. By convention percentage BV has a percent sign (%) suffix and relative BV has no unit.

### Percentage utilization

Biological value is determined based on this formula.

BV = ( *Nr* / *Na* ) \* 100

Where:

*Na* = nitrogen absorbed in proteins on the test diet

*Nr* = nitrogen incorporated into the body on the test diet

However direct measurement of *Nr* is essentially impossible. It will typically be measured indirectly from nitrogen excretion in [urine](https://en.wikipedia.org/wiki/Urine). [Faecal](https://en.wikipedia.org/wiki/Faeces%22%20%5Co%20%22Faeces) excretion of nitrogen must also be taken into account - this part of the ingested protein is not absorbed by the body and so not included in the calculation of BV. An estimate is used of the amount of the urinary and faecal nitrogen excretion not coming from ingested nitrogen. This may be done by substituting a protein-free diet and observing nitrogen excretion in urine or faeces, but the accuracy of this method of estimation of the amount of nitrogen excretion not coming from ingested nitrogen on a protein-containing diet has been questioned.

BV = ( ( *Ni* - *Ne(f)* - *Ne(u)* ) / (*Ni* - *Ne(f)*) ) \* 100

Where:

*Ni* = nitrogen intake in proteins on the test diet

*Ne(f)* = (nitrogen excreted in faeces whilst on the test diet) - (nitrogen excreted in faeces not from ingested nitrogen)

*Ne(u)* = (nitrogen excreted in urine whilst on the test diet) - (nitrogen excreted in urine not from ingested nitrogen)

Note:

*Nr* = *Ni* - *Ne(f)* - *Ne(u)*

*Na* = *Ni* - *Ne(f)*

This can take any value from 0 to 100, though reported BV could be out of this range if the estimates of nitrogen excretion from non-ingested sources are inaccurate, such as could happen if the endogenous secretion changes with protein intake. A BV of 100% indicates complete utilization of a dietary protein, i.e. 100% of the protein ingested and absorbed is incorporated into proteins into the body. The value of 100% is an absolute maximum, no more than 100% of the protein ingested can be utilized (in the equation above *Ne(u)* and *Ne(f)* cannot go negative, setting 100% as the maximum BV).

### Relative utilization

Due to experimental limitations BV is often measured *relative* to an easily utilizable protein. Normally [egg](https://en.wikipedia.org/wiki/Egg_%28food%29) protein is assumed to be the most readily utilizable protein and given a BV of 100. For example:

Two tests of BV are carried out on the same person; one with the test protein source and one with a reference protein (egg protein).

relative BV = ( *BV(test)* / *BV(egg)* ) \* 100

Where:

*BV(test)* = percentage BV of the test diet for that individual

*BV(egg)* = percentage BV of the reference (egg) diet for that individual

This is not restricted to values of less than 100. The percentage BV of egg protein is only 93.7% which allows other proteins with true percentage BV between 93.7% and 100% to take a relative BV of over 100. For example, [whey protein](https://en.wikipedia.org/wiki/Whey_protein) takes a relative BV of 104, while its percentage BV is under 100%.

The principal advantage of measuring BV relative to another protein diet is accuracy; it helps account for some of the metabolic variability between individuals. In a simplistic sense the egg diet is testing the maximum efficiency the individual can take up protein, the BV is then provided as a percentage taking this as the maximum.

### Conversion

Providing it is known which protein measurements were made relative to it is simple to convert from relative BV to percentage BV:

*BV(relative)* = ( *BV(percentage)* / *BV(reference)* ) \* 100

*BV(percentage)* = ( *BV(relative)* / 100 ) \* *BV(reference)*

Where:

*BV(relative)* = relative BV of the test protein

*BV(reference)* = percentage BV of reference protein (typically egg: 93.7%).

*BV(percentage)* = percentage BV of the test protein

While this conversion is simple it is not strictly valid due to the differences between the experimental methods. It is, however, suitable for use as a guideline.

## Factors that affect BV

Factors which affect BV can be grouped into properties of the protein source and properties of the species or individual consuming the protein.

### Properties of the protein source

* Amino acid composition, and the limiting amino acid, which is usually lysine
* Preparation (cooking)
* Vitamin and mineral content

Amino acid composition is the principal effect. All proteins are made up of combinations of the 21 biological amino acids. Some of these can be synthesised or converted in the body, whereas others cannot and must be ingested in the diet. These are known as essential amino acids (EAAs), of which there are 9 in humans. EAAs missing from the diet prevent the synthesis of proteins that require them. If a protein source is missing critical EAAs, then its biological value will be low as the missing EAAs form a bottleneck in protein synthesis. In a related way if amino acids are missing from the protein source which are particularly slow or energy consuming to synthesise this can result in a low BV. Methods of food preparation also affect the availability of amino acids in a food source. Some of food preparation may damage or destroy some EAAs, reducing the BV of the protein source .Many vitamins and minerals are vital for the correct function of cells in the test organism

### Properties of the test species or individual

#### Under test conditions: Variations in BV under test conditions are dominated by the [metabolism](https://en.wikipedia.org/wiki/Metabolism) of the individuals or species being tested. In particular differences in the essential amino acids (EAAs) species to species has a significant effect, although even minor variations in amino acid metabolism individual to individual have a large effect. The fine dependence on the individual's metabolism makes measurement of BV a vital tool in diagnosing some [metabolic diseases](https://en.wikipedia.org/wiki/Metabolic_diseases).

#### In everyday life

The principal effect on BV in everyday life is the organism's current diet, although many other factors such as age, health, weight, sex, etc. all have an effect. In short any condition which can affect the organism's metabolism will vary the BV of a protein source.

In particular, whilst on a high protein diet the BV of all foods consumed is reduced — the limiting rate at which the amino acids may be incorporated into the body is not the availability of amino acids but the rate of protein synthesis possible in cells. This is a major point of criticism of BV as a test; the test diet is artificially protein rich and may have unusual effects.

### Factors with no effect

BV is designed to ignore variation in digestibility of a food — which in turn largely depends on the food preparation. For example, compare raw soy beans and extracted soy bean protein. The raw soy beans, with tough [cell walls](https://en.wikipedia.org/wiki/Cell_wall) protecting the protein, have a far lower digestibility than the purified, unprotected, soy bean protein extract. As a foodstuff far more protein can be absorbed from the extract than the raw beans, however the BV will be the same.

The exclusion of digestibility is a point of misunderstanding and leads to misrepresentation of the meaning of a high or low BV

## Advantages and disadvantages

BV provides a good measure of the usability of proteins in a diet and also plays a valuable role in detection of some metabolic diseases. BV is, however, a scientific variable determined under very strict and unnatural conditions. It is not a test designed to evaluate the usability of proteins whilst an organism is in everyday life — indeed the BV of a diet will vary greatly depending on age, weight, health, sex, recent diet, current metabolism, etc. of the organism. In addition BV of the same food varies significantly species to species. Given these limitations BV is still relevant to everyday diet to some extent. No matter the individual or their conditions a protein source with high BV, such as egg, will always be more easily used than a protein source with low BV.

### In comparison to other methods known

* [Net protein Utilization](https://en.wikipedia.org/wiki/Net_protein_utilization) (NPU)
* [Protein Efficiency Ratio](https://en.wikipedia.org/wiki/Protein_efficiency_ratio) (PER)
* [Nitrogen Balance](https://en.wikipedia.org/wiki/Nitrogen_balance) (NB)
* [Protein digestibility](https://en.wikipedia.org/wiki/Protein_digestibility) (PD)
* [Protein Digestibility Corrected Amino Acid Score](https://en.wikipedia.org/wiki/Protein_Digestibility_Corrected_Amino_Acid_Score) (PDCAAS)

## In animals

The Biological Value method is also used for analysis in animals such as cattle, poultry, and various laboratory animals such as rats. It was used by the poultry industry to determine which mixtures of feed were utilized most efficiently by developing chicken. Although the process remains the same, the biological values of particular proteins in humans differs from their biological values in animals due to physiological variations.

## Typical values

Common foodstuffs and their values: (Note: this scale uses 100 as 100% of the nitrogen incorporated.)

* Whey Protein: 96
* Whole Soy Bean: 96
* Human milk: 95
* Chicken egg: 94
* Soybean milk: 91
* [Buckwheat](https://en.wikipedia.org/wiki/Buckwheat): 90+
* Cow milk: 90
* Cheese: 84
* Quinoa: 83
* Rice: 83
* Defatted soy flour: 81
* Fish: 76
* Beef: 74.3
* Immature bean: 65
* Full-fat soy flour: 64
* Soybean curd ([tofu](https://en.wikipedia.org/wiki/Tofu)): 64
* Whole wheat: 64
* White flour: 41

Common foodstuffs and their values: (Note: These values use "whole egg" as a value of 100, so foodstuffs that provide even more nitrogen than whole eggs, can have a value of more than 100. 100, does not mean that 100% of the nitrogen in the food is incorporated into the body, and not excreted, as in other charts.)

* Whey protein concentrate: 104
* Whole egg: 100
* Cow milk: 91
* Beef: 80
* Casein: 77
* Soy: 74
* Wheat gluten: 64

By combining different foods it is possible to maximize the score, because the different components favor each other:

* 85 % rice and 15 % yeast: 118
* 55 % soy and 45 % rice: 111
* 55 % potatoes and 45 % soy: 103
* 52 % beans and 48 % corn: 101

LIST AND EXPLAIN THE VARIOUS METHODS OF ASSESSMENT OF PROTEIN QUALITY

Biological Value

Net Protein Utilization

Amino Acid Score Block and Mitchell

Biological value(BV) Biological value,has long been considered the method of choice for estimating the nutritive value of proteins. It has been defined as the "percentage of absorbed nitrogen retained in the body" and a complete evaluation of the dietary protein includes measurement of the Biological Value and the Digestibility. These values are obtained by measuring the fecal and urinary nitrogen when the test protein is fed and correcting for the amounts excreted when a nitrogen-free diet is fed. True digestibility is defined as the percentage of food nitrogen absorbed from the gut and Biological Value as where I = Nitrogen intake of test protein F = Fecal nitrogen Fo = Fecal nitrogen on nitrogen-free diet (Metabolic N) U = Urinary nitrogen Uo = Urinary nitrogen on nitrogen-free diet (Endogenous N) In practice Mitchell found that the endogenous N was very similar to that obtained when a small amount of very high quality protein was fed and preferred to feed limited amounts of egg protein rather than a nitrogen-free diet in order to prevent severe weight loss. The basic assumption made in the measurement of Biological Value is that the endogenous N and metabolic N are constant values and can be legitimately subtracted from the test values as shown in the equation. There is limited information to suggest that this may not always be true. For example, the excretion of urinary nitrogen in rats and dogs on a nitrogen-free diet may be lowered substantially by the administration of methionine yielding a Biological Value of methionine alone much above 100%. This may not happen in man but has not been thoroughly studied. Also, Mitchell et al. found the Biological Value of gelatin to be 20%, i.e., 20% as satisfactory as the best quality proteins. Since animals will not survive on gelatin alone, this must be an overestimate of the real nutritive value.

Net Protein Utilization (NPU) Like Biological Value, NPU estimates nitrogen retention but in this case by determining the difference between the body nitrogen content of animals fed no protein and those fed a test protein. This value divided by the amount of protein consumed is the NPU which is defined as the "percentage of the dietary protein retained. proposed a procedure which involved replicate groups of 4 weanling rats housed in group cages which were fed either the "protein-free" or the "test" diet for 10 days. These conditions were chosen empirically and the particular merits of these conditions remain to be demonstrated. Since in young animals there is a high correlation between body nitrogen and body water content, the substitution of body water measurements for body nitrogen measurements has been widely used. Indeed, measurement of body water may be more accurate than measurement of body nitrogen because sampling errors are eliminated; also, it is much more convenient and less expensive. Since both NPU and BV are based upon estimates of "retained nitrogen", they should measure the same thing except that in the calculation of NPU the denominator is the total protein eaten whereas in the calculation of BV it is the amount absorbed. BV would be expected to be higher than NPU by the amount of nitrogen lost owing to lack of digestibility (lack of absorption). In weanling rats, it is possible that total carcass analysis is a more accurate measure of "retained nitrogen" that can be obtained from nitrogen balance measurements although this has not been proven. It is certainly less tedious. Nitrogen balance measurements must be used in large animals and in studies on man.

Amino Acid Score Block and Mitchell originally proposed that since all amino acids must be present at the site of protein synthesis in adequate amounts if protein synthesis is to proceed, a comparable deficit of any amino acid would limit protein synthesis to the same degree. Thus, they suggested that if the composition of an "ideal protein" was known, i.e., a protein which contained every essential amino acid in sufficient amounts to meet requirements without any excess, then it should be possible to compute the nutritive value of a protein by calculating the deficit of each essential amino acid in the test protein from the amount in the "ideal protein". The "most limiting amino acid", the one in greatest deficit, would presumably determine the nutritive value. In practice they suggested the protein in whole egg as the "ideal" since this was known to have a Biological Value closely approaching 100. They recognized that egg proteins might contain some amino acids in excess of requirements. If so, deficits of these in other proteins calculated by this procedure would be misleadingly high. That is, the calculated nutritive value would be lower than it actually was. However, compared Biological Values which were thought to have been accurately estimated and with "amino acid deficits" calculated using egg protein as the standard found a rather high correlation (r = .86) suggesting the overall validity of this procedure. Amino Acid Scores have been widely used since that time. Generally they have been calculated as the "percentage of adequacy" rather than as deficits as suggested by Block and Mitchell . The FAO Committee of 1957 (1) recognizing again that egg proteins might contain various essential amino acids in excess of the amounts required proposed that Amino Acid Scores be calculated from an amino acid pattern that was based upon estimates of amino acid requirements in man. A similar approach was recommended by the Amino Acid Committee of the Food and Nutrition Board ). However, the second Expert Group of FAO/WHO (2) concluded that the previously suggested pattern was not appropriate in certain respects and that there was not sufficient information to state that egg, cow's milk or human milk proteins differed in nutritional quality. They thus suggested that any of these patterns might be considered "ideal" for the calculation of Amino Acid Scores. Since these three proteins differ substantially in amino acid composition, this suggestion has led to confusion in the calculation of Amino Acid Scores. They also suggested that the ratio of essential amino acid nitrogen to total nitrogen (E/T) was related to, and might be a determinant of, protein quality. Since no method was proposed for combining this ratio with the Amino Acid Score, this has led to further confusion.