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**MATRIC NUMBER: 19/MHS03/015**

**COURSE CODE: BCH 204**

1. Biological value (BV) is a measure of the proportion of absorbed 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 in the cells of the organism. Proteins are the major source of 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 of nitrogen incorporated into the body over nitrogen absorbed gives a measure of protein "usability" – the BV.

Unlike some measures of protein usability, biological value does not take into account how readily the protein can be digested and absorbed (largely by the small intestine). This is reflected in the experimental methods used to determine BV.

BV uses two similar scales:

The true percentage utilization (usually shown with a percent symbol).

The percentage utilization relative to a readily utilizable protein source, often egg (usually shown as unitless).

These two values will be similar but not identical.

1. Protein quality describes characteristics of a protein in relation to its ability to achieve defined metabolic actions.

**Methods of Estimating/Assessing Protein Quality**.

Biological Value (BV)

Net Protein Utilization (NPU)

Amino Acid Score.

Critique.

Other Methods of Estimating Protein Quality.

Protein Efficiency Ratio (PER)

Net Protein Ration (NPR)

**Nitrogen Balance and Protein Metabolism**

Nitrogen is a fundamental component of amino acids, which are the molecular building blocks of protein. Therefore, measuring nitrogen inputs and losses can be used to study protein metabolism.

Positive nitrogen balance is associated with periods of growth, hypothyroidism, tissue repair, and pregnancy. This means that the intake of nitrogen into the body is greater than the loss of nitrogen from the body, so there is an increase in the total body pool of protein.

Negative nitrogen balance is associated with burns, serious tissue injuries, fevers, hyperthyroidism, wasting diseases, and during periods of fasting. This means that the amount of nitrogen excreted from the body is greater than the amount of nitrogen ingested. A negative nitrogen balance can be used as part of a clinical evaluation of malnutrition.

Nitrogen balance is the traditional method of determining dietary protein requirements. Determining dietary protein requirements using nitrogen balance requires that all nitrogen inputs and losses are carefully collected, to ensure that all nitrogen exchange is accounted for. In order to control nitrogen inputs and losses, nitrogen balance studies usually require participants to eat very specific diets (so total nitrogen intake is known) and stay in the study location for the duration of the study (to collect all nitrogen losses). Because of these conditions, it can be difficult to study the dietary protein requirements of certain populations using the nitrogen balance technique (e.g. children).

Dietary nitrogen, from metabolising proteins and other nitrogen-containing compounds, has been linked to changes in genome evolution. Species which primarily obtain energy from metabolising nitrogen-rich compounds use more nitrogen in their DNA than species which primarily break down carbohydrates for their energy [citation needed]. Dietary nitrogen alters codon bias and genome composition in parasitic microorganisms.

**BODY PROTEIN METABOLISM**

Assessing protein quality with respect to its efficiency in supporting body protein metabolism should include consideration of the capacity of the diet to provide substrate needs for protein synthesis and any other biosynthetic pathways, i.e., a suitable source of nitrogen and IAA (lysine, threonine, valine, isoleucine, leucine, methionine, phenylalanine, tryptophan, and histidine). However, to this assessment method should be added provision of sufficient signal amino acids, (e.g., leucine), required for those regulatory steps whereby metabolism is optimized and anabolism is stimulated. It is arguable that current methods used for assessing protein quality have only evaluated substrate needs rather than any provision of regulatory amino acids.

Evaluation of protein quality with the PDCAAS approach measures the protein's metabolic effectiveness at a dietary intake that meets minimum requirements. By this measure, protein requirements are low compared with most nutritionally complete habitual diets. Indeed, applying an adaptive metabolic demand model of protein homeostasis, protein requirements may be even lower after complete adaptation to the extent that a dietary recommendation based on the true minimum intake for nitrogen equilibrium would become of questionable nutritional significance.

**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

**Protein Efficiency Ratio (PER)**

As has been indicated, qualitative differences in protein quality can be demonstrated by many methods. Protein Efficiency Ratio (PER) has been the method most widely used because of its simplicity. Observations were made that young rats fed certain proteins gained little weight and ate little protein whereas those which were fed better quality proteins gained more weight and consumed more protein. In an attempt to compensate for the difference in food intake, they calculated the gain in weight per gram of protein eaten and this has been called PER. It is known that the PER for any protein is dependent upon the amount of protein incorporated in the test diet.

In spite of its simplicity PER has been severely criticized as a measure of protein quality. The most common criticisms have been that some dietary protein is required for the maintenance of the animal and this is not credited to the protein in the measurement of PER and that body composition may vary and not be an adequate measure of nitrogen retention. From the theoretical point of view the major criticisms of PER are that it is not a direct function of the nutritive value of the protein but is related to the weight gain, the amount of food consumed, the amount of protein in the diet, and the nutritive quality of the protein in the diet. The relationship between these is complex and undefined. PER also has the disadvantage that even under standardized conditions it is not reproducible in different laboratories. It is of interest that in the collaborative study corrected PER values showed larger differences between laboratories than the uncorrected values indicating that this correction was not appropriate and of no advantage.

**Net Protein Ration (NPR)**

A major criticism of the PER has been that it does not take into account the protein required for maintenance since only gain in weight is used in the calculation. This criticism could be avoided by the inclusion in each test of a group of animals fed a protein-free diet. Net Protein Ratio (NPR) was then calculated as the overall difference in gain (gain in weight of the test group plus loss in weight of the protein-free group) divided by the protein eaten. It is apparent that if body composition is constant, this procedure is identical to NPU except that it is expressed in arbitrary units which are less useful than the percentage of protein utilized. The weaknesses are, of course, identical with those discussed under NPU.

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". a procedure was proposed 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 (13-16), 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.