

Total Protein Requirements of Beef Cattle I: The Rumen and Microorganisms¹

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Beef cattle along with many other animals are unique in the animal kingdom because of their ability to utilize roughages or fiber as sources of nutrition. These animals, called ruminants, have microorganisms that live in the large compartment of the stomach known as the rumen. These microorganisms are capable of degrading fibrous components of plants, like cellulose, into valuable nutrients for cattle such as protein and fatty acids. Therefore, the primary necessity for all ruminant diets, including beef cattle, is to provide the rumen microorganisms with the nutrients they need, and they will in turn provide nutrients for the animal. The rumen and its microorganisms are what make ruminants unique among livestock.

Rumen microorganisms provide cattle with the primary source of protein they utilize which is known as microbial crude protein (MCP). The microorganisms that reside in the rumen degrade consumed feedstuffs and utilize the resulting energy and protein to divide and multiply, thereby producing more MCP and continue the rumen degradation process. The microorganisms require a source of energy which is provided by the feedstuff consumed

and a source of protein/nitrogen. Regardless of the feed protein source provided—a manufactured protein supplement from the feed store, soybean hulls, corn gluten feed, or liquid molasses with urea—ruminal microorganisms digest the protein in the feed and reassemble them to produce MCP. Therefore, the digestion of feedstuffs in the rumen will alter the diet's nutrient profile from what the cattle consumed to what the animal actually absorbs after full digestion. This alteration in protein profile can be beneficial when feeding low-protein, low-quality diets; however, when diets are high-quality and/or high-protein, the nutritional density of the diet can be decreased as a result of rumen protein digestion by the microorganisms. As rumen digestion progresses, the microorganisms leave the rumen and are digested in the lower gastrointestinal system. MCP comprises one of two protein sources available to the ruminant animal, the other being rumen undegradable protein (RUP), both of which are further digested and absorbed. The microbes are a useful source of protein (equal to 20–60% crude protein themselves) to the animal. These microorganisms can provide up to 50% of the amino acids for growing cattle and are a source of other important nutrients.

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Ruminant animals have a unique advantage, even if inadequate protein is provided in the diet, the microorganisms are capable of providing a source of protein to the cattle. Nitrogen, a necessary ingredient for protein synthesis, is continually transferred from the bloodstream into the rumen, via the urea-ammonia pathway, where it is utilized by rumen microorganisms to make additional MCP. Ruminants are able to recycle the nitrogen and conserve the limited protein substrate allowing the animal to survive on very low protein diets because of this mechanism.

Providing adequate amounts of nutrients for the rumen microorganism is fundamental to supporting forage digestibility, intake, and ultimately supplying the animal with an adequate plane of nutrition. The rumen microorganisms will utilize dietary fiber, protein, and/or nitrogen to produce energy and protein available for the cattle to utilize. Maintaining an optimal rumen environment is critical to providing beef cattle the opportunity to meet production goals.

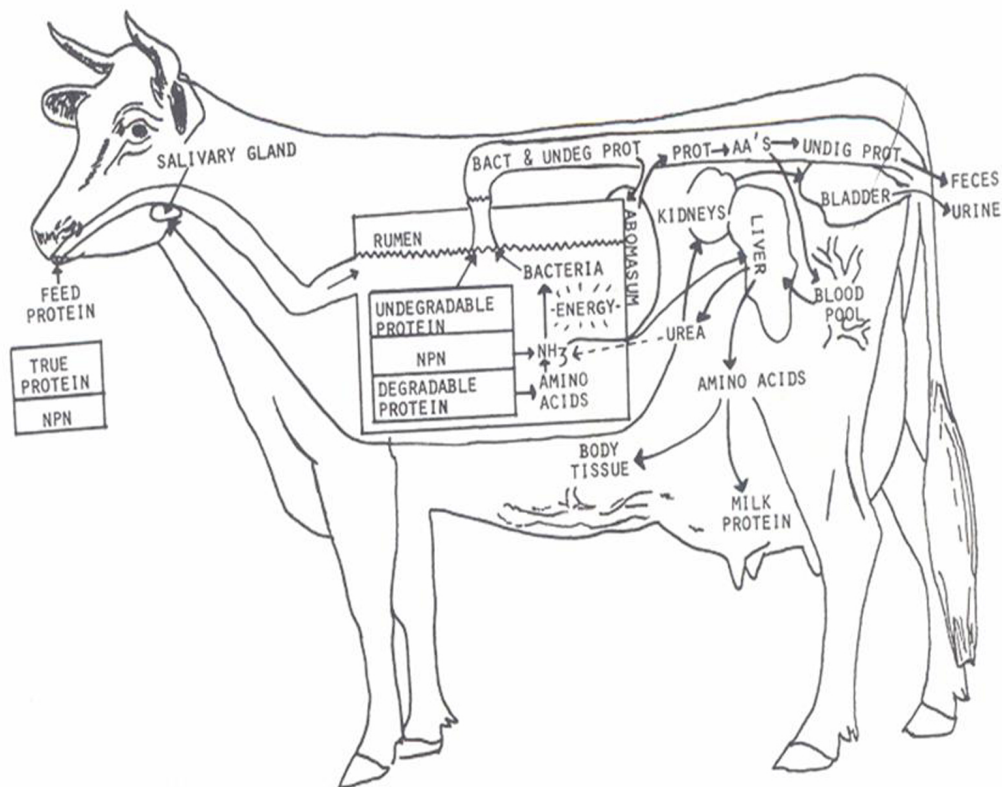


Figure 1. This diagram depicts the path of dietary protein from consumption to digestion and absorption and even nutrient recycling in the lactating beef or dairy cow (adapted from *The Ruminant Animal: Digestive Physiology and Nutrition*. Prentice-Hall, Copyright © 1988).