University of Mosul
Lecture No.: 7
College of Veterinary Medicine
Date: first term/ 2026-2027
Unit of Scientific Affairs
Website: https://uomosul.edu.iq/veterinarymedicine/

Lecture title: **Animal nutrition: proteins Digestion**

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Summary:

Proteins are complex compounds of high molecular weight, it consists of Carbon, Hydrogen, Oxygen, Nitrogen and generally Sulphur. Dietary protein is hydrolyzed by proteases and peptidases to generate tripeptides, dipeptides, and free amino acids AAs in the lumen of the gastrointestinal tract. animals have dietary requirements for AAs but not protein. The content, digestibility, and proportions of AAs in dietary protein are the determinants of its nutritive quality. Adequate intake of dietary AAs is essential for the optimal growth, development, and health of all animals.

Amino acids commonly found in proteins
Monocarboxylic acid: Glycine, Alanine, valine, serine, therionine, isoleucine.
Dicarboxylic acids: Aspartic acid, glutamic acid, asparagine and glutamine
Sulphur containing amino acids: methionine and cysteine.
Basic amino acids: lysin, arginine and histidine.
Aromatic and heterocyclic amino acids: Proline, tyrosine, tryptophan and phenylalanine.

Essential amino acids
Plants and many other microorganisms are able to synthesize proteins from simple nitrogenous compounds, animals cannot synthesize the amino grouping in order to build up body proteins they must have dietary source of amino acids.
The chickens require dietary source of glycine, birds require arginine because their metabolism does not include the urea cycle.
In ruminants all essential amino acids can be synthesized by microorganisms. The supply of amino acids from microbial proteins is limiting in quantity and quality for maximum rate of growth in young animals and for maximum milk production.

Structural and Physiological Roles of Proteins in Animals:

- Buffering such as Hemoglobin and myoglobin
- Cell and tissue structures such as Collagen, elastin, keratin, mucins,
- Colloidal properties such as Proteins in plasma (albumin and globulins) and gelatin
- Enzyme-catalyzed reactions such as Decarboxylase, dehydrogenase, lipases, proteases
- Gene expression such as DNA-binding proteins, histones.
- Hormone-mediated effects such as insulin, LH, placental lactogen, somatotropin,

- Muscle contraction such as Actin, myosin, tropomyosin, troponin.
- Protection such as Blood clotting factors, immunoglobulins, interferon
- Regulation of cell signaling such as leptin, osteopontin.w
- Storage of nutrients and O2 such as ferritin, metallothionein, myoglobin,
- Transport of nutrients and O2 such as Albumin, hemoglobin, plasma lipoproteins.

Classification Of Proteins

Proteins may be classified into two main groups:

1. simple proteins
2. conjugated proteins

Simple proteins

These proteins produce only amino acids on hydrolysis. They are subdivided into two groups according to **shape**, **solubility** and **chemical composition**:

1-fibrous proteins

2- globular proteins,

1-Fibrous proteins

These proteins are insoluble and are very resistant to animal digestive enzymes. e.g., collagens, elastin and keratins.Collagens are the main proteins of connective tissues, the amino acid hydroxyproline is an important component of collagen. Elastin is the protein found in elastic tissues such as tendons and arteries. The polypeptide chain of elastin is rich in alanine and glycine and is very flexible.

Keratins are classified into two types. The α-keratins are the main proteins of wool and hair. The β-keratins occur in feathers, skin, beaks and scales of most birds. These proteins are very rich in the sulphur-containing amino acid cysteine; wool protein, for example, contains about 4 % of sulphur .

2-Globular proteins

Globular proteins include all the enzymes, antigens and those hormones that are proteins. Its first subgroup, albumins, are water-soluble and heat-coagulable and occur in milk, the blood, eggs and many plants. Protamines are basic proteins of relatively low molecular weight, Protamines are rich in arginine but contain no tyrosine, tryptophan or sulphur-containing amino acids. Globulins occur in milk, eggs and blood, and are the main reserve protein in many seeds.

Conjugated proteins

Some important examples of conjugated proteins are:

1. Glycoproteins
2. Lipoproteins
3. phosphoproteins
4. chromoproteins.

Glycoproteins are components which act as lubricants in many parts of the body.

Lipoproteins, which are proteins conjugated with lipids such as triacylglycerols and cholesterol, are the main components of cell membranes and are also the form in which lipids are transported in the bloodstream to tissues, either for oxidation or for energy storage.
Phosphoproteins it's include the caseins of milk and phosvitin in egg yolk.
Chromoproteins Examples are haemoglobin and cytochromes, in flavoproteins, which contain flavins

Digestion of proteins:

In nonruminants, some digestion of dietary protein starts in the stomach and most digestion occurs in the small intestine. Events of this process include: (1) denaturing of dietary protein and activation of zymogens by gastric acid in the stomach, followed by local digestion with active gastric proteases to form large peptides; and (2) hydrolysis of the large peptides and the undigested proteins in the small intestine by the pancreas- and enterocyte-derived proteases. The protein digestion products are absorbed into the enterocytes via AA and peptide transporters.
The digestibility of dietary protein is affected by:

- **Biological** (e.g., species and strains of animals, physiological status, and individual variations),
- **Environmental** (e.g., ambient temperatures, pollution, and noise),
- **Dietary factors** (e.g., the form, odor, texture, and particle size of feed)

Food protein was hydrolyzed to simple units called peptides and amino acid by rumen flora, some of these amino acids was degraded to organic acids and NH_3 accompanied by CO_2. For example:
Deamination of valine is produced isobutyric acid by the aid of rumen flora, the ammonia and small peptides and free amino acids can by utilized by rumen micro flora to synthesize microbial proteins, some of these microbial proteins will breakdown and its nitrogen is recycled. the greater part of protein will be microbial protein and pass to small intestine. The lesser part will be undegraded protein.

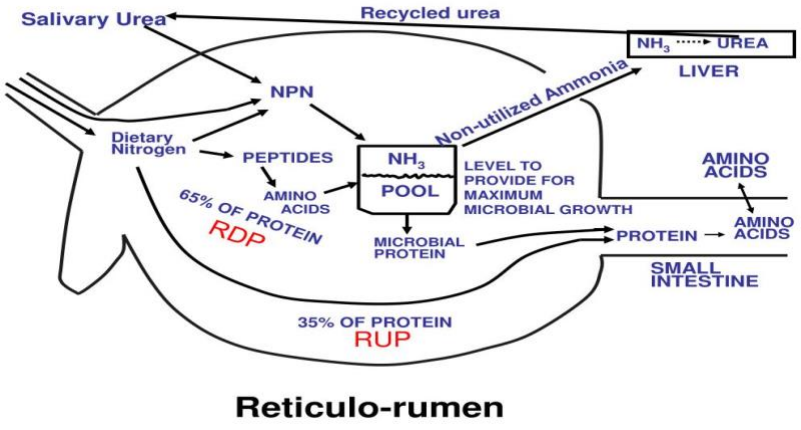

Diagram (1) Digestion of protein compounds in rumen

Digestion and metabolism of nitrogenous compounds in the rumen:

The concentration of ammonia will be low in rumen reach to about 50 mg/l if:

- the diet is difficient in protein.
- the protein resist degradation

As a result of these changes the growth of rumen micro flora will be slow, and the breakdown of carbohydrates will be retarded.

In the other hand the ammonia will accumulate in rumen liqour (optimum concentration) if protein degradation more than the synthesis in this case the ammonia will absorbed into blood stream and then to the liver where it converted to urea, the greater part will excrete in urine but some of urea may be returned back to the rumen via saliva.

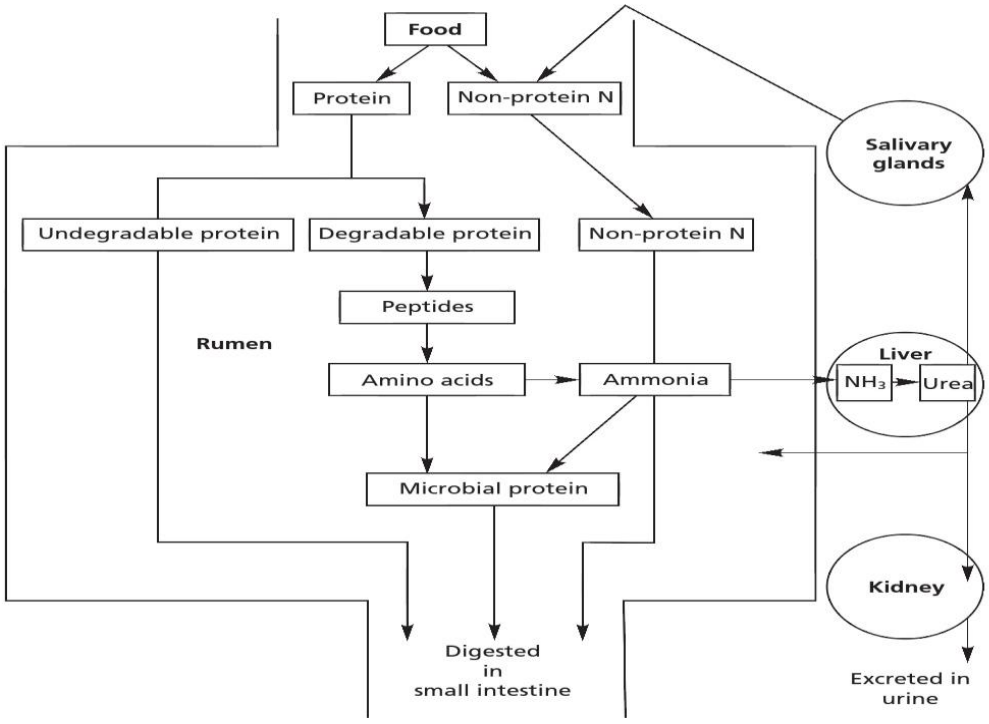

Diagram (2) Digestion and metabolism of nitrogenous compounds in the rumen

The optimum concentration of ammonia in rumen liquor varies from 85 mg/l -300mg / l. This recycled nitrogen is converted to microbial protein and the ruminant is able to conserve nitrogen by returning to the rumen urea .Each kilogram of organic matter digested in rumen yield approximately 200 gm of microbial protein , some rapidly fermented food such as immature forages rich in soluble carbohydrates yield more microbial protein up to 260 gm / kg of digested

organic matter.Silage contain nutrients partly fermented , one of the major products of silage fermentation is the lactic acid and the yield of rumen microbial protein / unit of organic matter is lower compared with other foods .

Rumen microflora also have the ability to convert non protein nitrogenous compounds NPN to protein by adding some substances to diet and the most commonly one is the urea which is rapidly hydrolyzed to ammonia by the presence of uricase enzyme with the aid of rumen flora but it is important to avoid over consumption of urea in forages because the absorption of ammonia from rumen will be over the ability of liver to convert it to urea as a result this will cause increase ammonia concentration in blood lead to high toxic levels .Biuret is less rapidly hydrolyzed required several weeks for rumen microorganisms to adapted to it .IBDU isobutylidene diurea , additional NPN utilized by rumen bacteria is Uric acid which increase in poultry excreta . Protein synthesis requires activation of amino acids, initiation of peptide chain formation, chain elongation and termination, all of which have an energy cost.

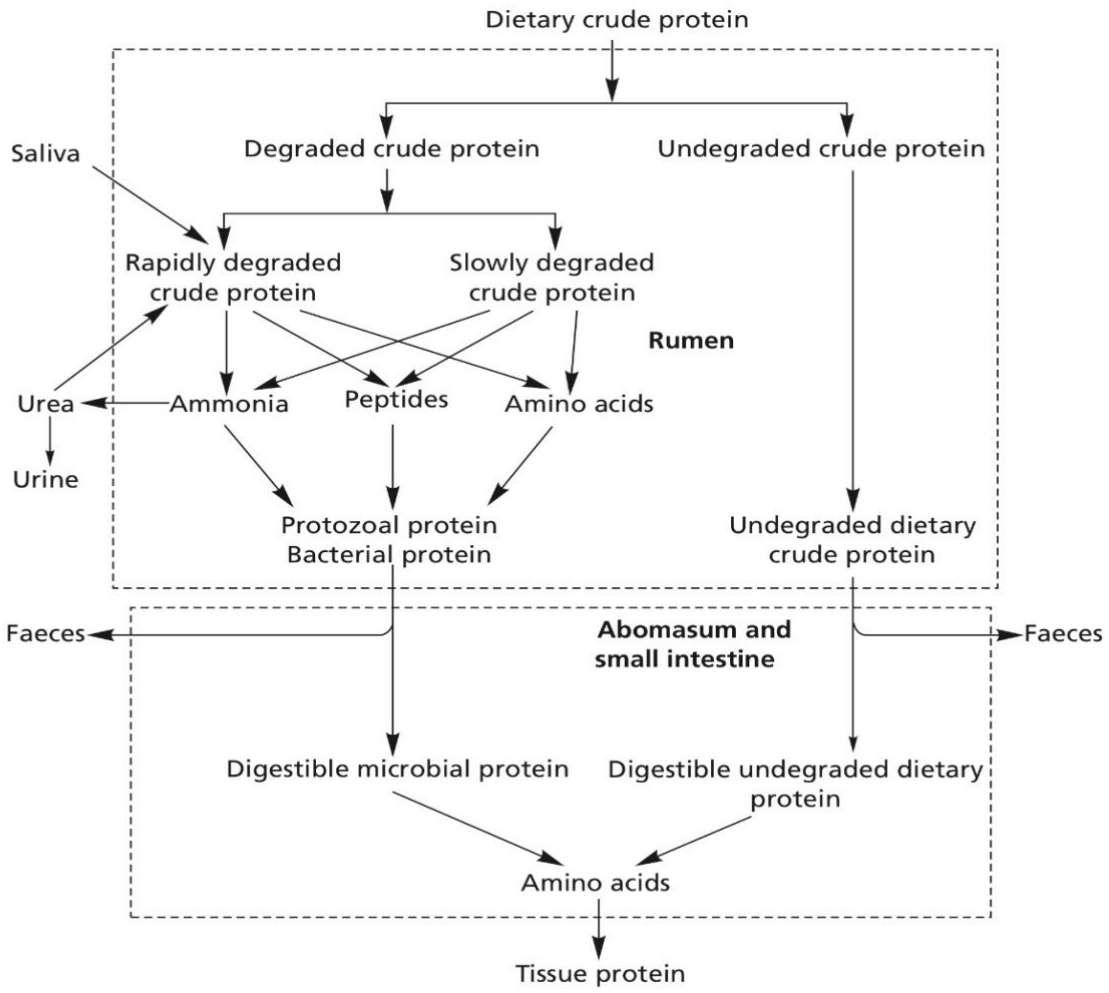

Diagram (3) The fate of dietary crude proteins in ruminant animals