DIETARY PROTEIN

PHAR-432

LECTURE: 9

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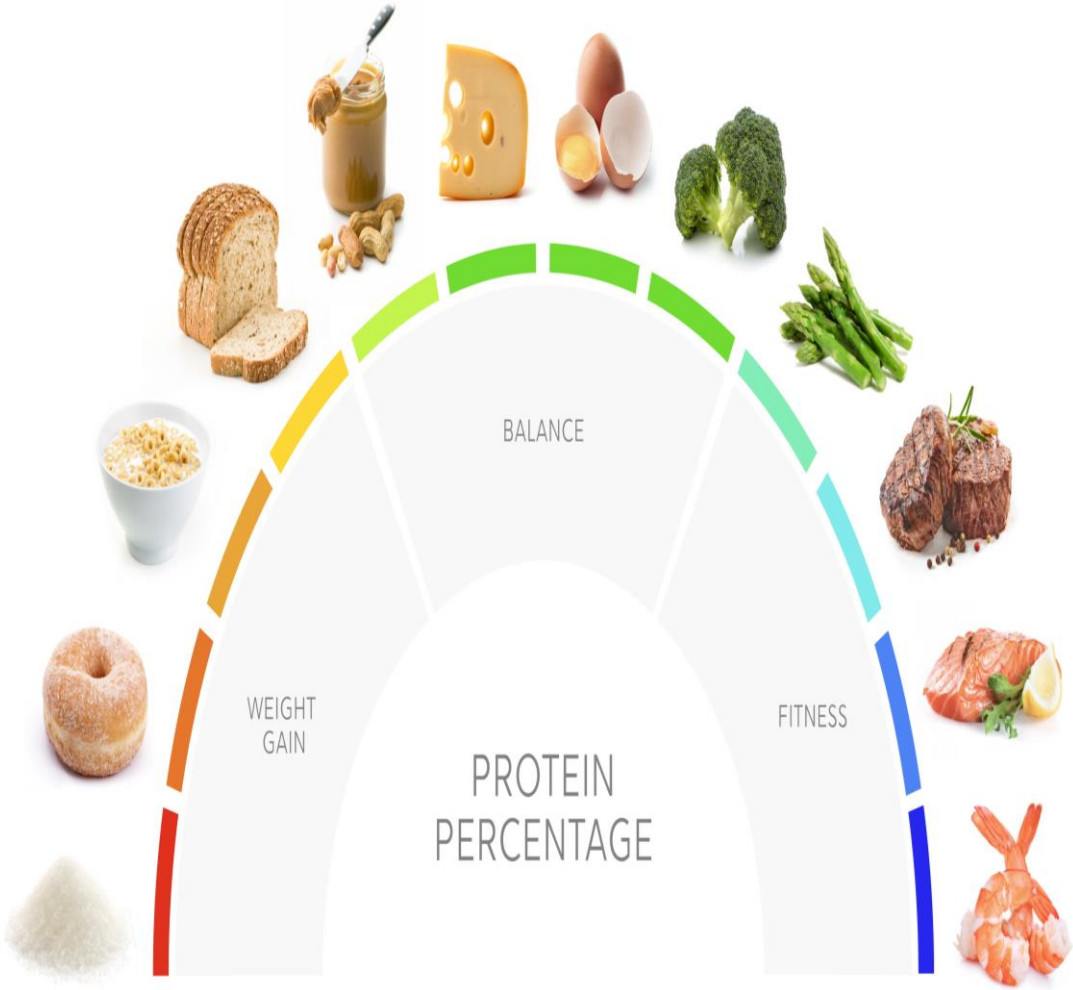
Spring Semester (2023-2024)

Outlines

- Protein
- Function
- Essential and non-essential amino acids
- Amino acid pool
- Protein turnover
- Nitrogen balance



Protein

Proteins are the major components of the living cells.

All contain *Carbon, Hydrogen, Oxygen and Nitrogen.* Most proteins contain *Sulfur* and certain proteins contain additional elements particularly *Phosphorous, Iron, Zinc and Copper.*

The molecular weight of proteins are very high (macromolecules), but on hydrolysis they all give a group of simple organic compounds of low molecular weight called alpha amino acids

Proteins in the Human Body

Proteins in the Immune System
- Antibodies - fight invaders
- Complement System - system of 20 protein molecules that are activated during infections

Signaling Proteins
- Cytokines - communicate with other cells

Proteins in the Muscle
- Actin and Myosin - interactions with each other for muscle movement
- Myoglobin - release oxygen to muscles
- Ferritin - stores and release oxygen

Proteins in the Blood
- Hemoglobin - transports oxygen
- Fibrinogen - clots blood
- Albumin - maintain proper amount of liquid in blood

Enzymes
- Digestive Enzymes - helps break down food

Structural Proteins
- Cytoskeleton - network of protein filaments and tubules that maintain cell shape
- Keratin - found in skin, hair, and nails
- Collagen - provides strength
- Elastin - provides flexibility

Cell Membrane
- Form channels for substances to move through membrane
- Act as enzymes
- Act as receptors
- Three types of proteins: peripheral protein, integral protein, and lipid-bound protein

CLASSIFICATION OF PROTEINS

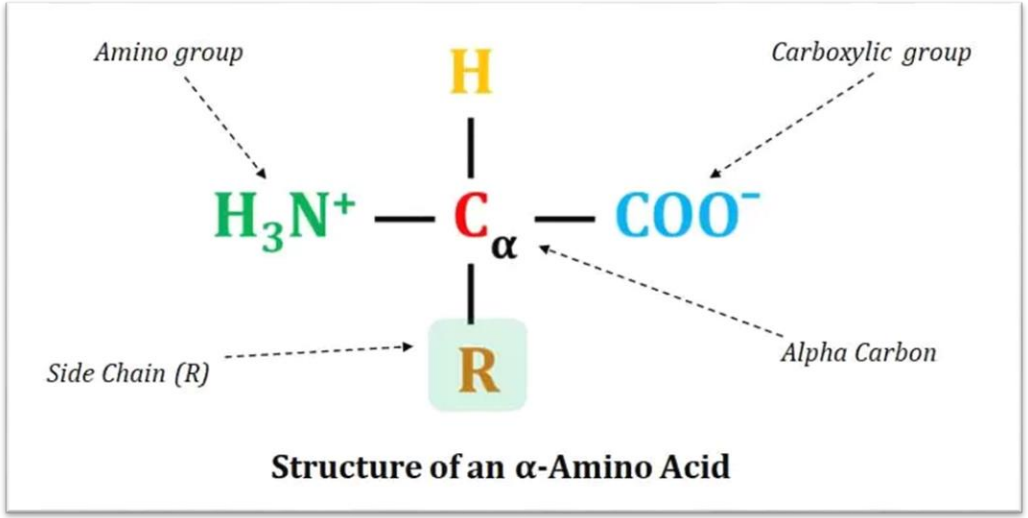
(Depending whether they contain all the essential amino acids or not)

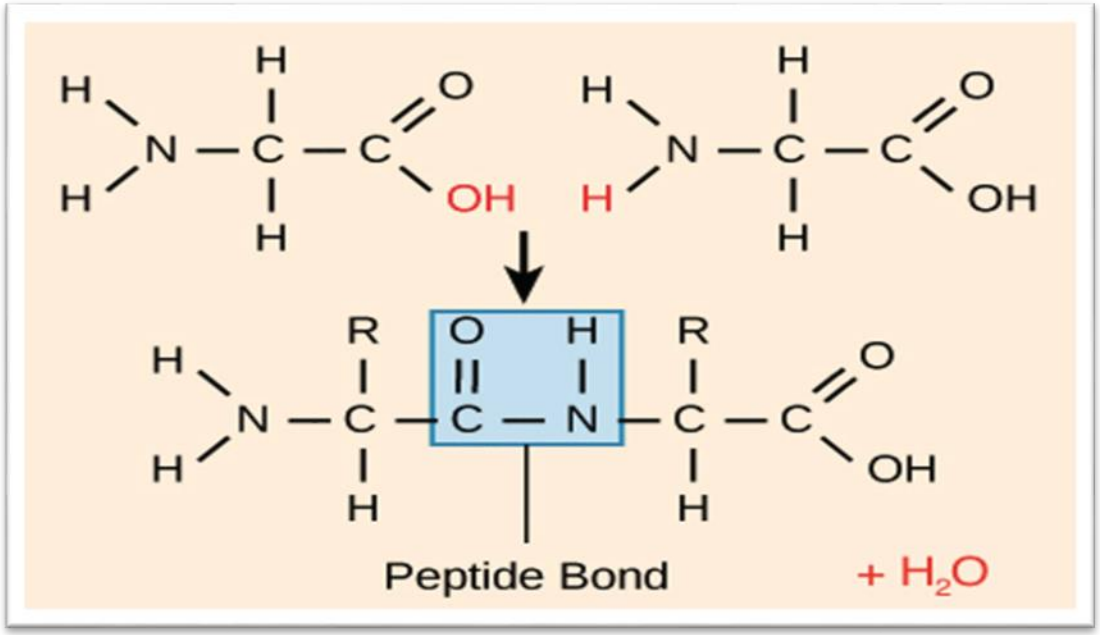
A-Complete proteins : They contain all of the essential amino acids such as animal products : egg, milk, meat, fish, and poultry .

B-Incomplete proteins : They are deficient in one or more of the essential amino acids such as wheat, rice, corn , beans, peas, almond, soy.

Amino acids

- Alpha amino acids are building blocks of proteins.
- Amino acids are linked together to form peptides, polypeptides through an amide linkage called **peptide bond**





Amino Acids Classified on Basis of Nutritional Requirement

I. **Essential amino acids:** Not synthesized in the body and must be supplied in diet.

II. **Non-essential amino acids:** Synthesized in body and there is no diet dependency for them.

III. **Semi-essential amino acids:** Not synthesized in the body in adequate amounts and requires dietary supplementation, ex:- Arginine and Histidine.

ESSENTIAL AMINO ACIDS	NON ESSENTIAL AMINO ACIDS
Valine	Glycine
Leucine	Alanine
Isoleucine	Aspartic acid
Arginine	Aspargine
Histidine	Glutamic acid
Lycine	Glutamine
Threonine	Serine
Methionine	Cysteine
Tryptophan	Tyrosine
Phenyl alanine	Proline

Amino acid pool

Free amino acids are present throughout the body, for example, in cells, blood, and the extracellular fluids

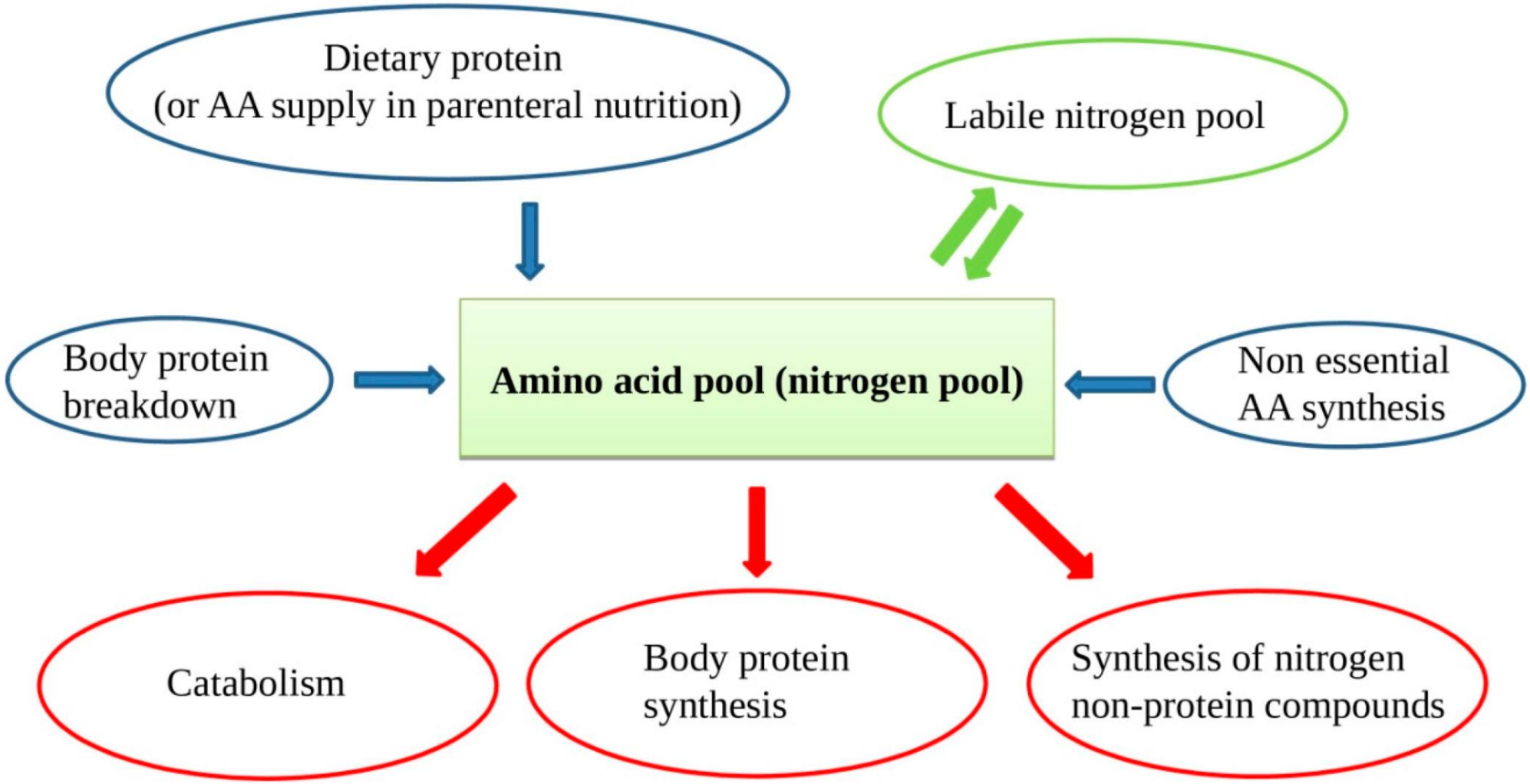
This pool is supplied by three sources:

1. Amino acids provided by the degradation of body proteins (300-400 g)
2. Amino acids derived from dietary protein, and
3. Synthesis of nonessential amino acids from simple intermediates of metabolism.

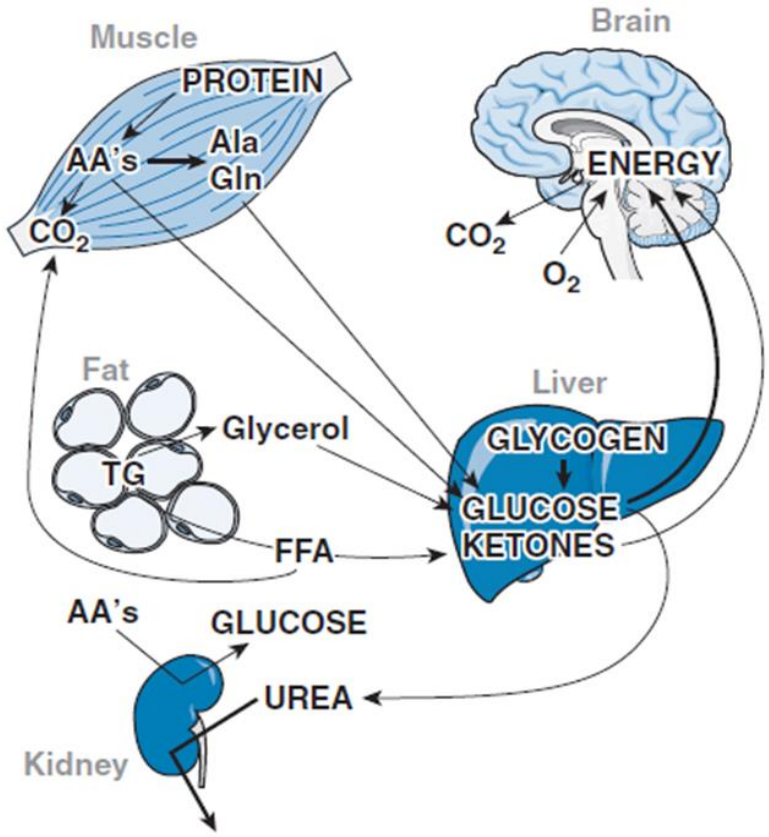
Amino acid pool

Conversely, the amino pool is depleted by three routes:

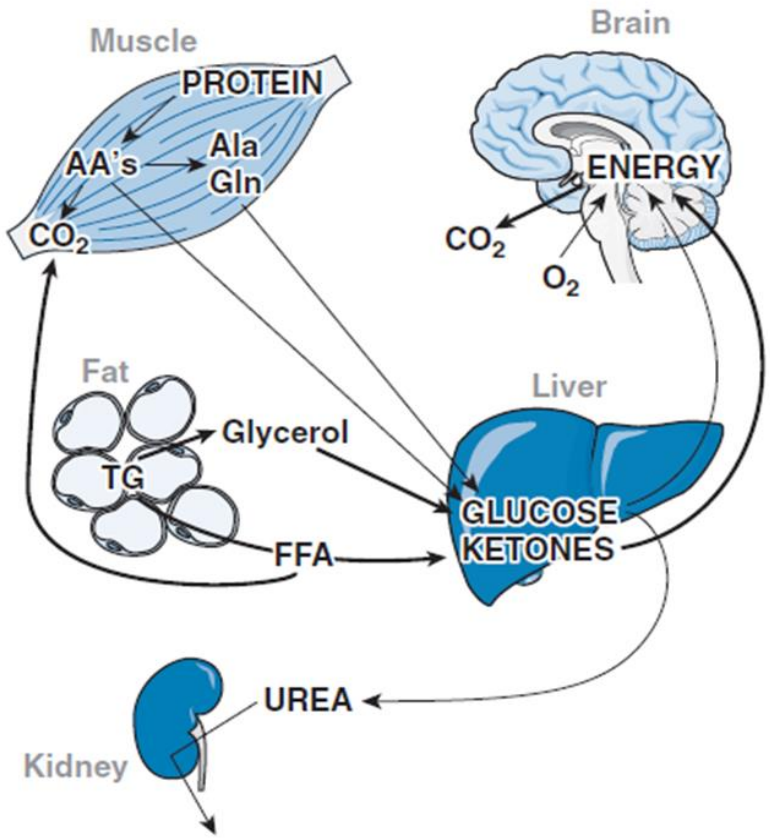
1. Synthesis of body protein (300-400 g)
2. Synthesis of nitrogen-containing small molecules like purine, pyrimidine and creatinine
3. Synthesis of glucose, glycogen, fatty acids, ketone bodies, or CO_2 + H_2O.


Dietary protein
(or AA supply in parenteral nutrition)
Labile nitrogen pool
Body protein
breakdown
Amino acid pool (nitrogen pool)
Non essential
AA synthesis
Catabolism
Body protein
synthesis
Synthesis of nitrogen
non-protein compounds

Metabolic Adaptation to Fasting and Starvation



A Postabsorptive state



B Starvation

The Fed State

- During the fed portion of the day, three things occur to the dietary intake of amino acids and glucose:
- (a) they are used to replete protein and glycogen that were lost during the postabsorptive period; and intake in amounts greater than what is needed to replete nighttime losses is either (b) oxidized or (c) stored to increase protein, glycogen, or fat for growth or for storage of excess calories.

Protein turnover

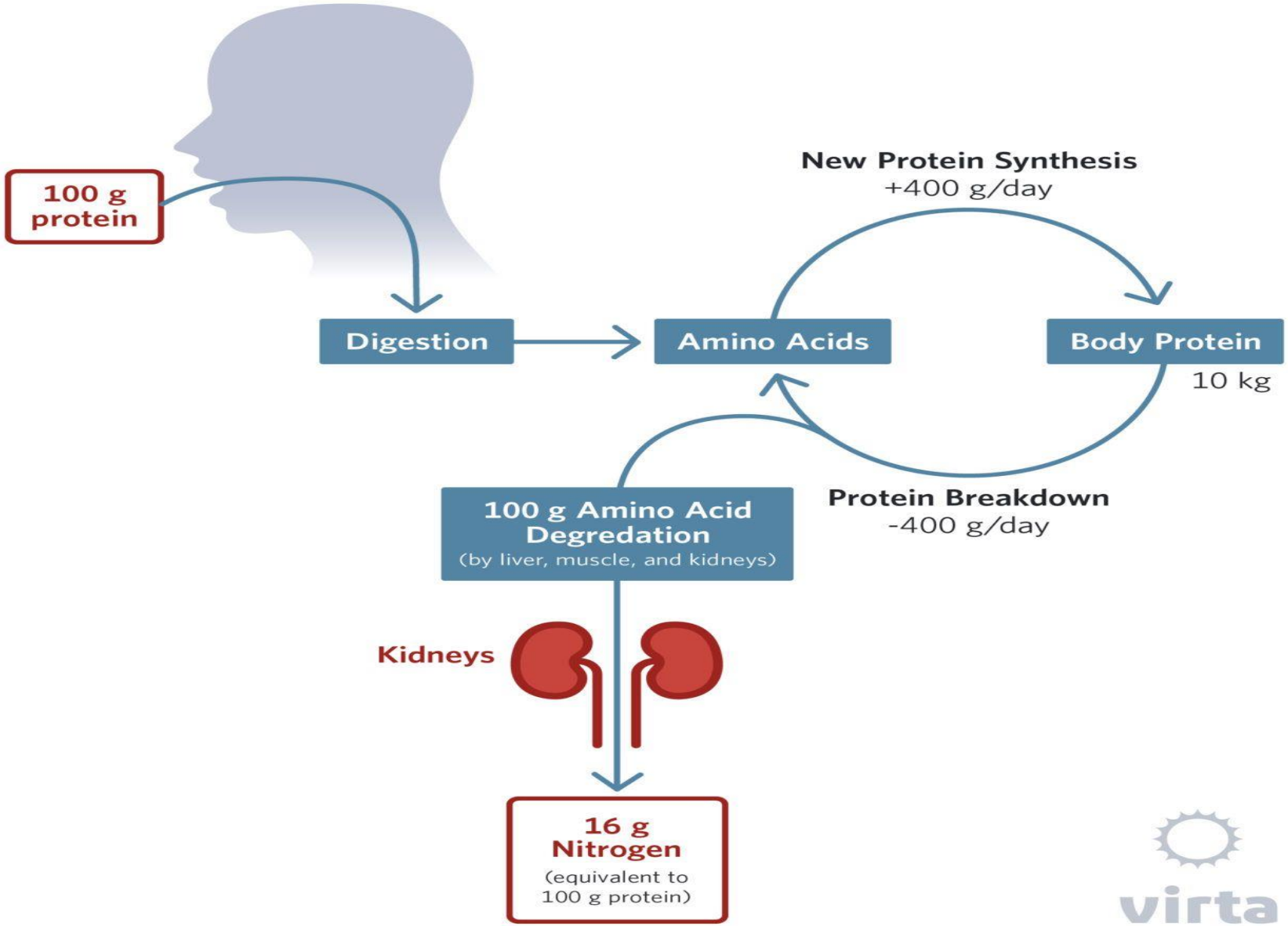
Most proteins in the body are constantly being synthesized and then degraded, permitting the removal of abnormal or unneeded proteins.

In healthy adults, the total amount of protein in the body remains constant because the rate of protein synthesis is just sufficient to replace the protein that is degraded. This process, called protein turnover, leads to the hydrolysis and resynthesize of **300-400 g** of body protein each day.

Protein turnover

- The rate of turnover of individual proteins tends to follow their function in the body;
- That is, those proteins whose concentrations need to be regulated (e.g., Enzymes) or that act as signals (e.g., Peptide hormones) have relatively high rates of synthesis and degradation as a means of regulating concentrations.
- Conversely, structural proteins such as collagen and myofibrillar proteins or secreted plasma proteins have relatively long lifetimes.

Protein Intake and Turnover



Nitrogen Balance

- Since nitrogen is the most characteristic and constant product of protein and protein catabolism, its estimation is necessary to determine the overall process of protein metabolism and consequently nitrogen balance and there will be 3 possibilities:-

The 3 possibilities to determine nitrogen balance

1. If the nitrogen content of foods exceeds that excreted, this means that the body is taking nitrogen principally as tissue proteins and this condition is called **Positive Nitrogen Balance**, such as those occur in cases of **infants, children, pregnancy and athletes.**
2. If the nitrogen excreted is equal to that of the food taken, the condition is called **Nitrogen Balance** in which catabolism = anabolism, and this is usually **the case of adults** .
3. If the nitrogen excreted exceeds that of food eaten, the condition is called **Negative Nitrogen Balance** such as those occur in cases of **illness, starvation, protein deficiency, surgery, advanced cancer.**

Nitrogen removal from amino acids

Metabolism of amino acids requires two processes - Transamination reaction followed by Oxidative Deamination.

Removing the a-amino group is essential for producing energy from any amino acid and is an obligatory step in the catabolism of all amino acids.

Once removed, this nitrogen can be incorporated into other compounds or excreted as urea by urea cycle, with the carbon skeletons being metabolized to yield energy .

Protein Requirements

The recommended daily allowance (RDA) for dietary protein in most countries is 0.8 grams per kg of body weight per day. That amounts to 56 grams for a 70 kg adult.

Normal" protein intake range of 10% to 15% of energy, meals with an average of 20% to 30% of energy from protein are representative of high-protein diets when consumed in energy balance

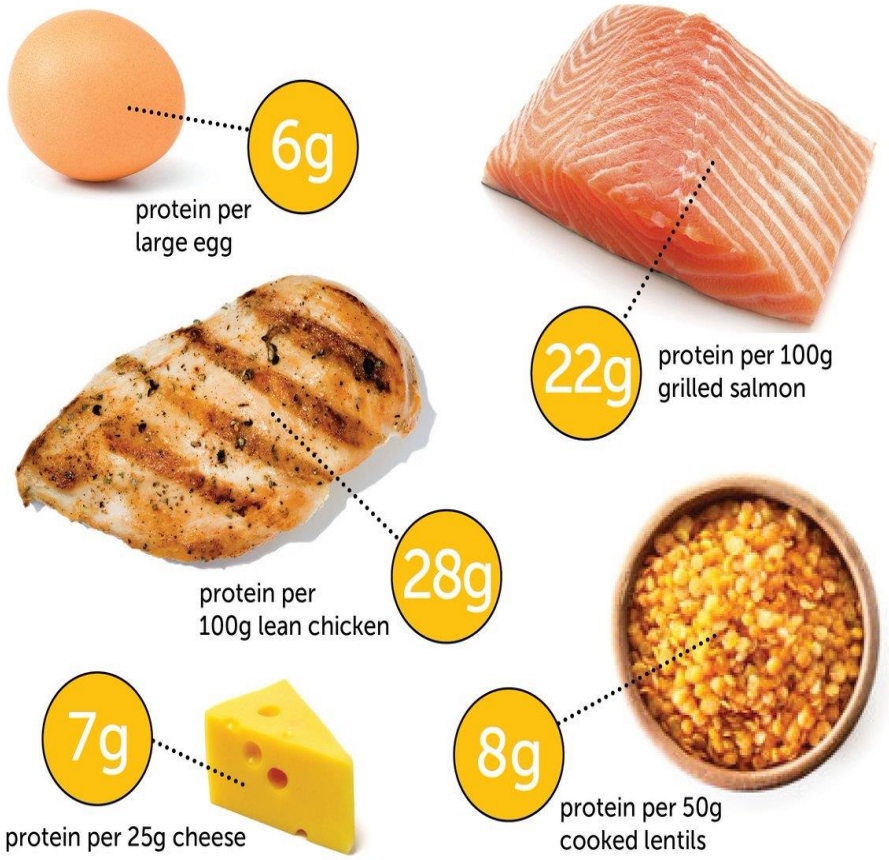


TABLE 1.11 RECOMMENDED INTAKES OF HIGH-QUALITY REFERENCE PROTEIN FOR NORMAL HUMANS

AGE (y)	WEIGHT (kg)		EAR[a] (g/kg/d)	RDA[b] (g/kg/d)
0–0.5	6			1.52[c]
0.5–1	9		1.10	1.50
1–3	13		0.88	1.10
4–8	20		0.76	0.95
9–13	36		0.76	0.95
	Male	Female		
14–18	61	54	0.72	0.85
>18	70	57	0.66	0.80

High protein diet

- After a high-protein lunch, satiety and energy expenditure is significantly Higher than after a normal-protein lunch, without differences in ghrelin and (PYY) responses.
- The lower glucagon like peptide 1 (glp-1) response following the High-protein lunch is due to the comparison with the high-carbohydrate-induced GLP-1 response during the normal-protein lunch.

References

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