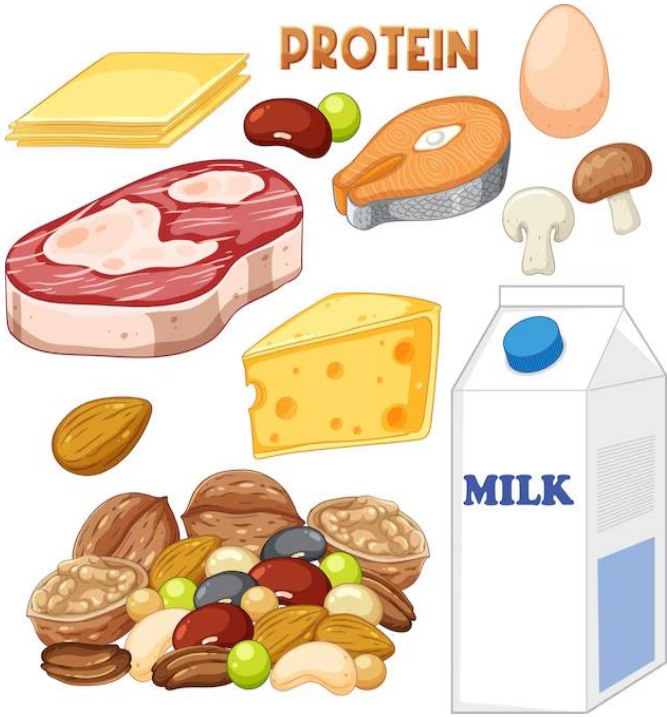
Energy Yielding Nutrient (Proteins)

Learning Objectives

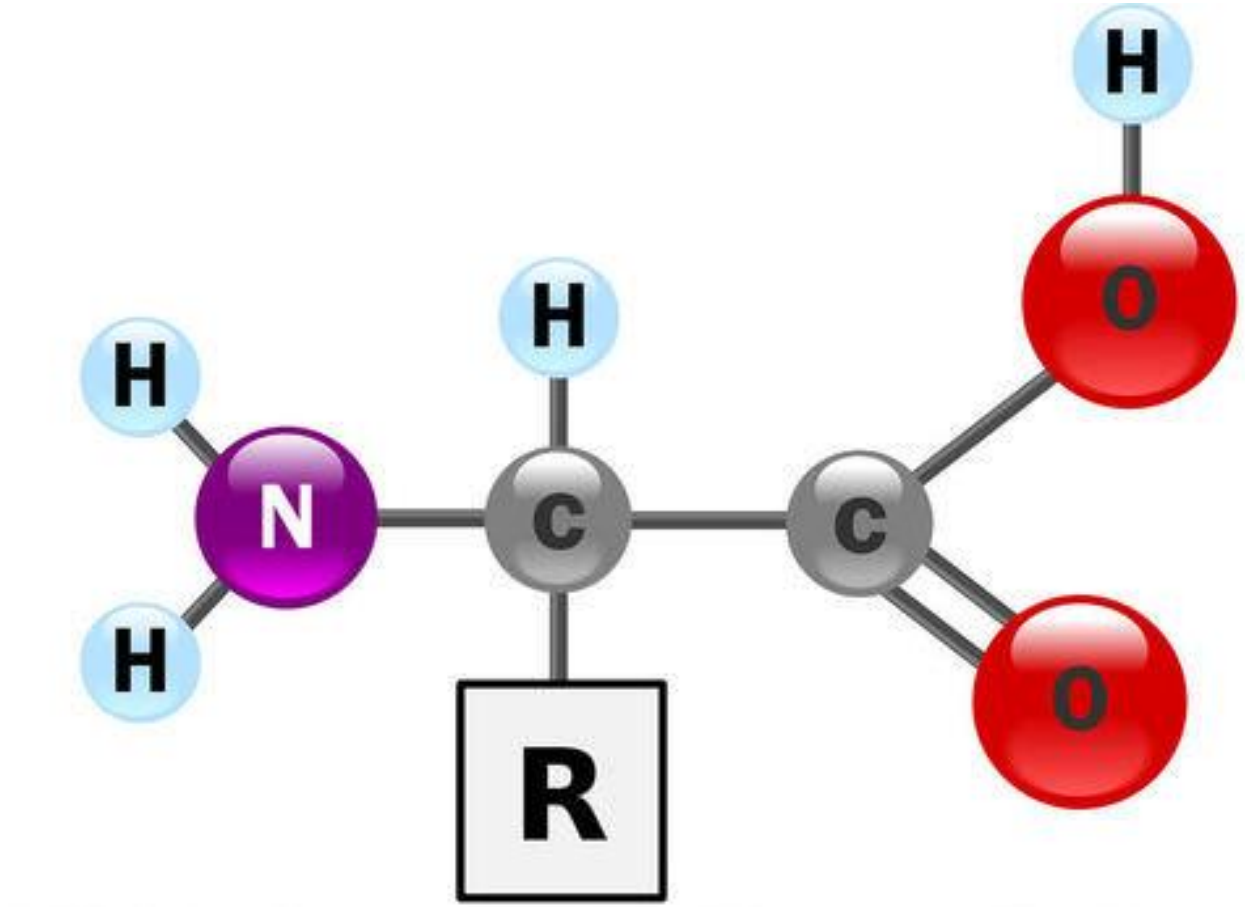


At the end of the class, students should be able to:

- ❖Identify various food sources of protein.
- ❖Explain the key functions of proteins in the body.
- ❖Classify proteins based on their structure and function.
- ❖Distinguish between essential and non-essential amino acids.
- ❖Describe the symptoms of protein deficiency and toxicity.
- ❖ Differentiate between the types of Protein-Calorie Malnutrition (PCM)

Introduction

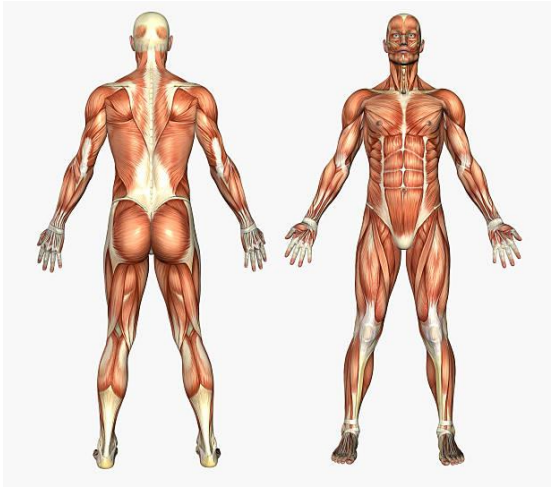
- The major component of body tissues.
- Proteins are large complex organic molecules made up of amino acids bonded together by peptide linkages.
- Contain carbon, hydrogen, oxygen and nitrogen.
- Found in all living organisms
- **Energy: 4kcal/g**

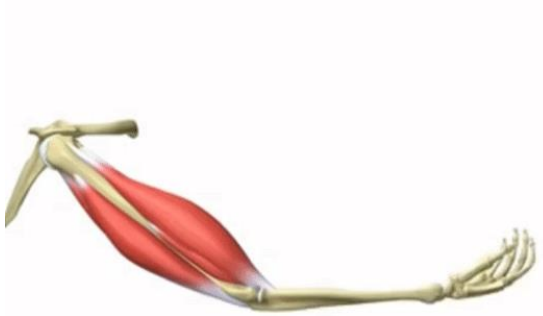


KEY: H = Hydrogen, N = Nitrogen, C = Carbon, O = Oxygen, R = Variable Side Chain

Function of Proteins

Form the building blocks of the body's structure **(Collagen, Keratin, Actin & Myosin)**

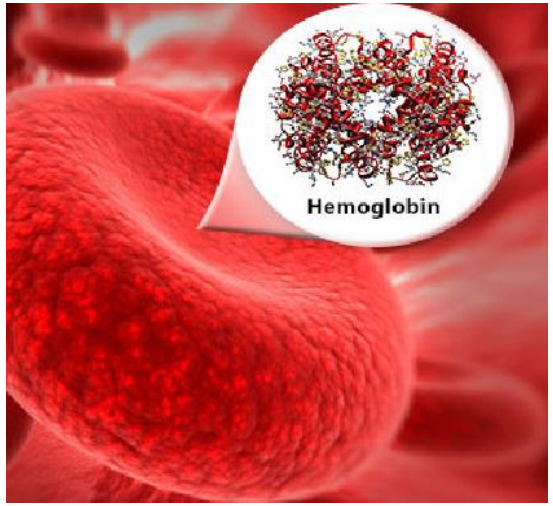


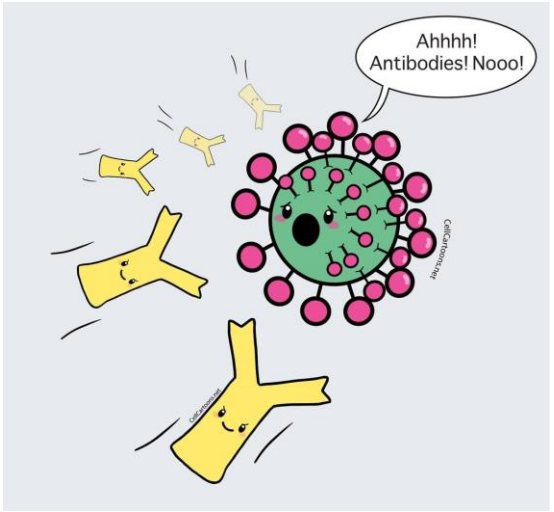


Enable movement both within cells and for the entire body **(Actin & Myosin)**

Hormone production **(Insulin)**

Boost the immune system **(Antibody)**





Act as enzymes, which are catalysts for biochemical reactions **(Amylase, Lipase)**

Transport substances throughout the body and store essential molecules **(Hemoglobin)**

Act as buffers, helping maintain a stable pH in the body

Provide energy when carbohydrates and fats are unavailable

Function of Proteins

TABLE 24-1

Examples of Protein Functions

Class of Protein	Example	Function of Example
structural proteins	collagen, keratin	strengthen tendons, skin, hair, nails
enzymes	DNA polymerase	replicates and repairs DNA
transport proteins	hemoglobin	transports O_2 to the cells
contractile proteins	actin, myosin	cause contraction of muscles
protective proteins	antibodies	complex with foreign proteins
hormones	insulin	regulates glucose metabolism
toxins	snake venoms	incapacitate prey

Recommended Nutrient Intakes (RNI)

- According to the Recommended Nutrient Intake of Malaysia, protein requirement for an average Malaysian adult is **10-20%** of total energy intake.
- An average Malaysian adult needs **1 gram of protein per kilogram** of body weight per day.
- For example, if Mr. Lee is 75kg, he needs 75g of protein daily to meet his dietary protein needs.

Recommended Nutrient Intakes (RNI) for Malaysia 2017 Summary Tables 1. Energy Requirements (by physical activity level) and Protein Requirements

Age	Males					Females				
	Estimated Energy Requirements[1] kcal/day				Protein[2] g/day	Estimated Energy Requirements[1] kcal/day				Protein[2] g/day
Infants										
0 - 2 months	470				8	420				8
3 - 5 months	540				8	500				8
6 - 8 months	630				10	570				10
9 - 11 months	720				10	660				10
	PAL 1.4	**PAL 1.6**	**PAL 1.8**	**PAL 2.0**		**PAL 1.4**	**PAL 1.6**	**PAL 1.8**	**PAL 2.0**	
Children										
1 - 3 years	980				12	900				12
4 - 6 years	1300	1490	1670		16	1210	1380	1560		16
7 - 9 years	1530	1750	1970		23	1410	1610	1810		23
Adolescents										
10 - 12 years	1690	1930	2170	2420	30	1500	1710	1920	2140	31
13 - 15years	1930	2210	2480	2760	45	1580	1810	2040	2260	42
16 -<18 years	2050	2340	2640	2930	51	1660	1890	2130	2370	42
Adults										
≥ 18 - 29 years	1960	2240	2520	2800	62	1610	1840	2080	2310	53
30 - 59 years	1920	2190	2470	2740	61	1660	1900	2130	2370	52
≥ 60 years	1780	2030	2280	2540	58	1550	1770	1990	2220	50
Pregnancy										
1st trimester						+80				+0.5
2nd trimester						+280				+8
3rd trimester						+470				+25
Lactation										
1st six months						+ 500				+19
2nd six months										+ 13

Note: [1] For children aged 4 – 6 years, PAL 1.4 is recommended to be used for the general population. For children above 7 years, adolescents and adults, PAL of 1.6 (i.e. moderately active) is recommended to be used for the general population. For individuals, energy recommendation should be based on individual PAL.

[2] Protein calculated based on reference body weight.

Sources of Proteins

Protein Comparison Chart

	Serving Size	Calories	Protein g	Fat g	Saturated Fat g	Sodium mg	Fiber g	cost per ounce
Seitan	100 grams	370	75	2	0.3	29	0.5	0.81
Chicken, breast	1 each, 4 ounces	198	37	4	1	89	0	0.41
Turkey	4 ounces	214	32	8.4	2.4	117	0	0.51
Tuna	3 ounces	111	25	0.5	0.2	46	0	0.20
Beef, lean	3 ounces	196	24	10	4	74	0	0.68
Pork	3 ounces	202	22	12	4	48	0	0.43
Salmon	100 grams	210	20	13	3	53	0	0.8
Lentils	1 cup	230	18	0.8	0.1	4	16	0.20
Split peas cooked	1 cup	231	16	0.8	0.1	3	16	0.14
Kidney beans	1 cup	225	15	0.9	0.1	1.8	11	0.06
Black Beans	1 cup	241	15	0.7	0.2	5	15	0.06
Farro cooked	1 cup	337	15	2	0.2	5	11	0.31
Eggs	2 large	144	12	9.5	3.2	142	0	0.20
Tempeh	2 ounces	110	11	6	2	8	0	0.44
Tofu	3 ounces	76	9	4.8	0.8	3	0.9	0.11
Peanut butter	2 tablespoons	188	7	16	3	152	1.8	0.12
Jackfruit	1 can	70	4	0	0	900	7	0.25
Walnuts	1 ounce	182	4	18	1.7	0	2	0.37

Notes: store brands were used for cost, cost on beans is canned while lentils and split peas are dried.
Sources: manufacturer's data, USDA Handbook 8.

Food Sources

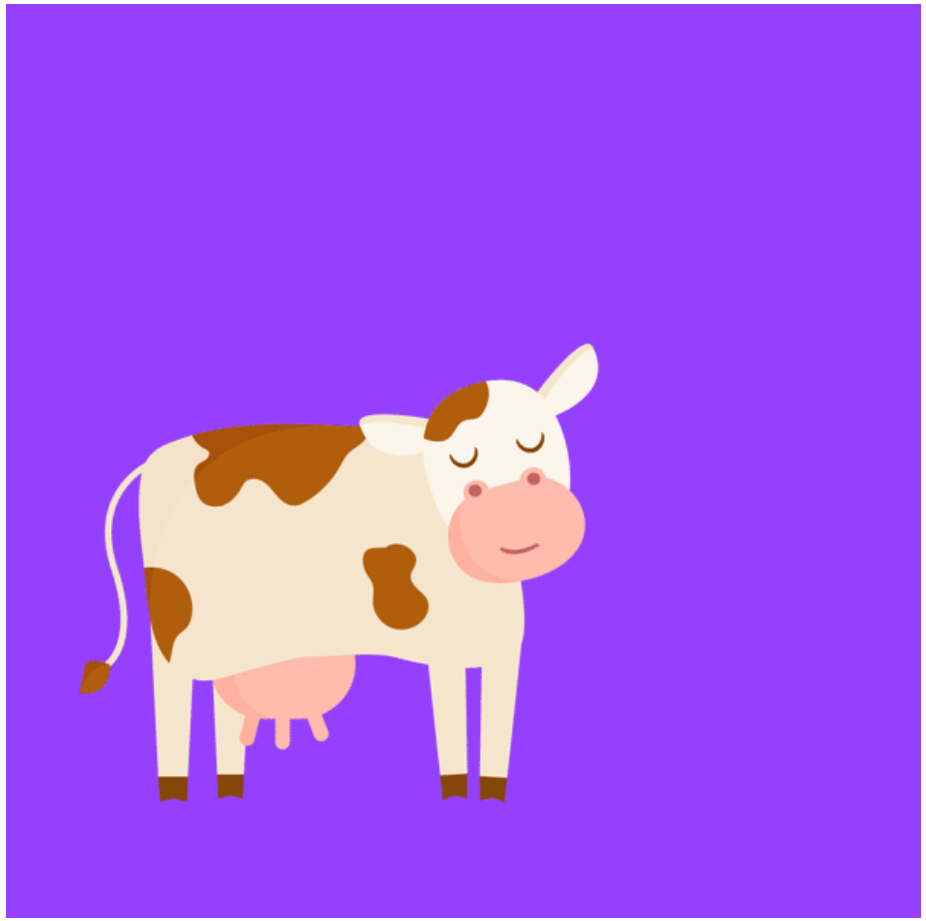


Table 2.1: Protein contents of foods

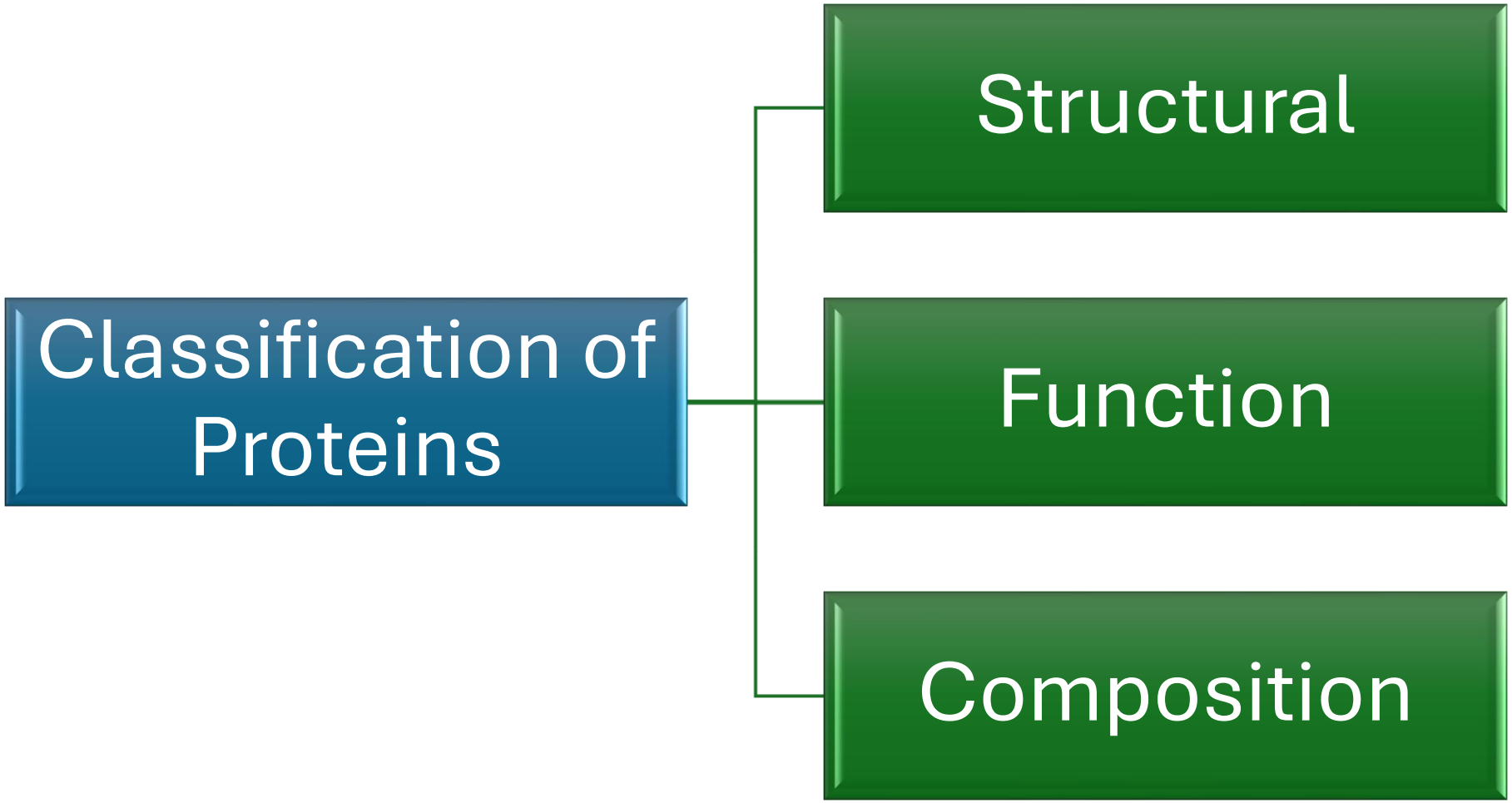
	Foods	Protein (g/100g)
a.	**Legumes and seeds**	
	Chickpea, cooked	20.4
	Yellow dhal, cooked	19.2
	Soyabean cake, fermented	15.9
	Soyabean curd, Tau-kua	10.9
	Soyabean curd, Tau-hoo	7.2
	Soyabean milk, unsweetened	3.7
b.	**Meat and poultry**	
	Liver, Gizzard (chicken)	25.0
	Beef (lean) and beef burger patty	22.6
	Liver (ox)	21.0
	Goat (lean)	20.8
	Mutton (lean)	20.1
	Chicken frankfurter	18.5
	Chicken, breast	18.3
	Beef frankfurter	18.2
	Chicken burger patty	18.0
	Pork (lean)	16.5
	Lung (ox)	15.7
	Chicken, thigh	13.3
	Duck egg	12.9
	Duck, breast	11.4
	Hen egg	11.1
	Quail egg	10.3
	Chicken, wing	7.6
c.	**Fish and seafood**	
	Anchovy, dried, whole	50.0
	Travelly, yellow-banded	15.3
	Mackerel, Spanish	15.2
	Cuttlefish, fresh	14.5
	Fish balls	12.7
	Fish crackers, fried	12.4
	Scad, hairtail	12.1
	Prawn, pink	11.4
	Mackerel, Indian	11.3
	Sardine	10.6
	Bream, African	9.6
	Cockles, boiled	8.5

	Foods	Protein (g/100g)
d.	**Milk and milk products**	
	Milk, powder (Instant, full cream and skim	25.7
	Cheese, processed, cheddar	21.7
	Milk, sweetened condensed	8.4
	Milk, evaporated	7.7
	Milk, UHT, low fat, recombined (g/100 ml)	4.1
	Cow's milk, fresh (g/100 ml)	3.2
	Yogurt, apricot flavor	3.1

Source: Tee *et al.*, (1997).

Recommended Nutrients Intake for Malaysia, 2017

Classification of Proteins



Classification Based on Structure

Simple protein

Protein that consist only of amino acids, without any non-protein components like carbohydrates, lipids, or metal ions.

Albumins

Globulins

Collagens

Conjugated protein

Protein that consist of both a polypeptide chain (the protein portion) and a non-protein component (prosthetic group)

Glycoproteins

Lipoproteins

Nucleoproteins

Derived protein

Proteins that are derived from simple proteins through breakdown or modification of simple proteins

Peptide

Classification Based on Function

Structural Proteins

Provide structural support to cells, tissues, and organs.

Collagen (connective tissues, bones)

Keratin (hair, nails, skin)

Elastin (skin and blood vessel elasticity).

Enzymatic Proteins

Act as enzymes to catalyze biochemical reactions.

Amylase (digests starch).

Lipase (breaks down fats).

DNA Polymerase (helps in DNA replication)

Transport Proteins

Carry molecules or ions across cell membranes or within the bloodstream.

Hemoglobin (carries oxygen in the blood).

Albumin (transports fatty acids, hormones, drugs).

Hormonal Proteins

Act as hormones that regulate physiological processes.

Insulin (regulates blood glucose levels).

Growth Hormone (promotes growth).

Thyroxine (regulates metabolism).

Defensive Proteins

Involved in immune responses and protection against pathogens.

Antibodies (immunoglobulins) – fight infections.

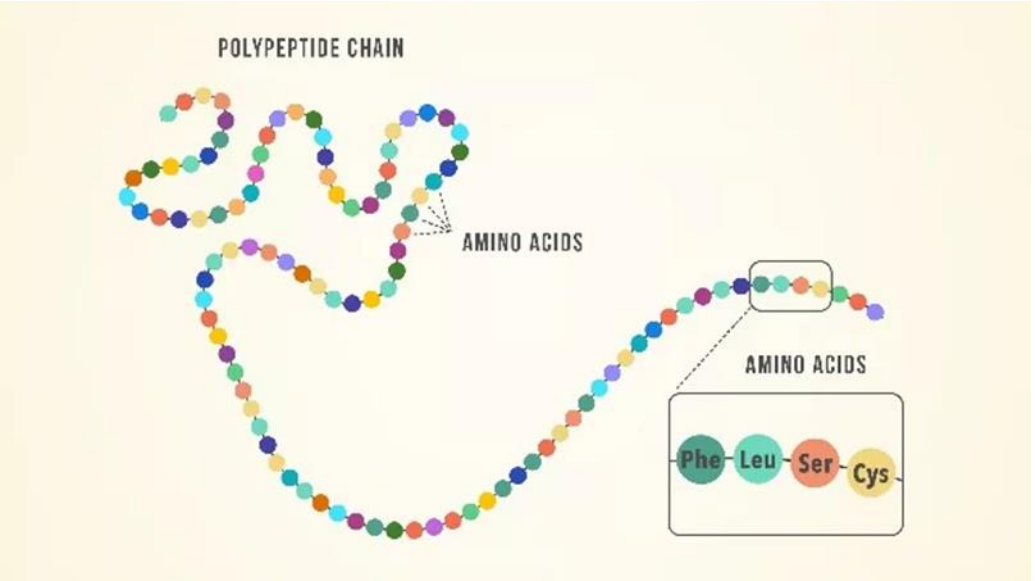
Contractile Proteins

Involved in movement and muscle contraction.

Actin and **Myosin** (involved in muscle contraction).:

Types of Amino Acids

- All the biological active proteins comprise of nearly 22 different amino acids – Building blocks
- Amino acids are joined by peptide bond.



Types of Amino Acids

Essential Amino Acids

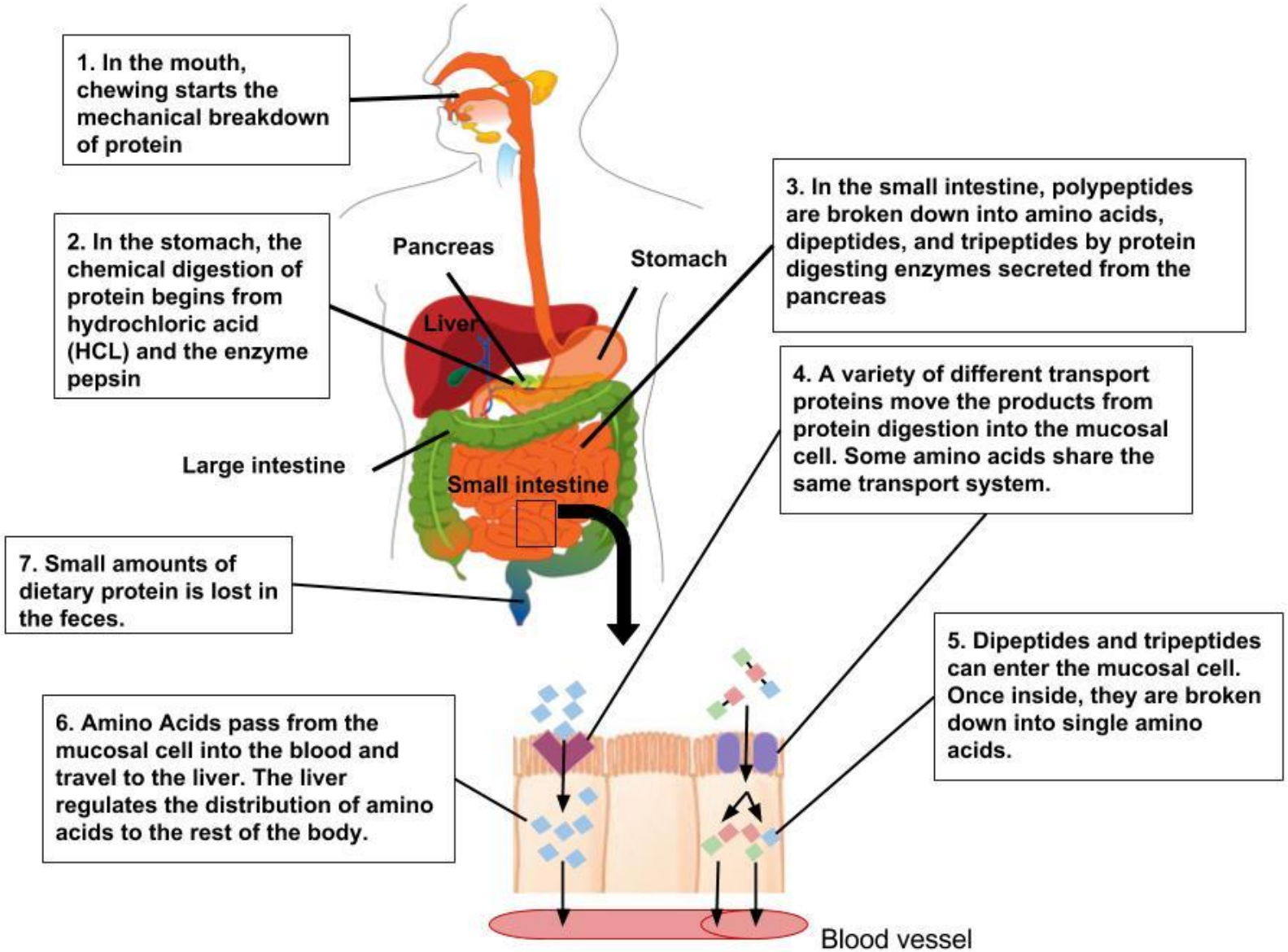
- Amino acids **cannot** be synthesized by the human body and must be obtained from food

Non-essential Amino Acids

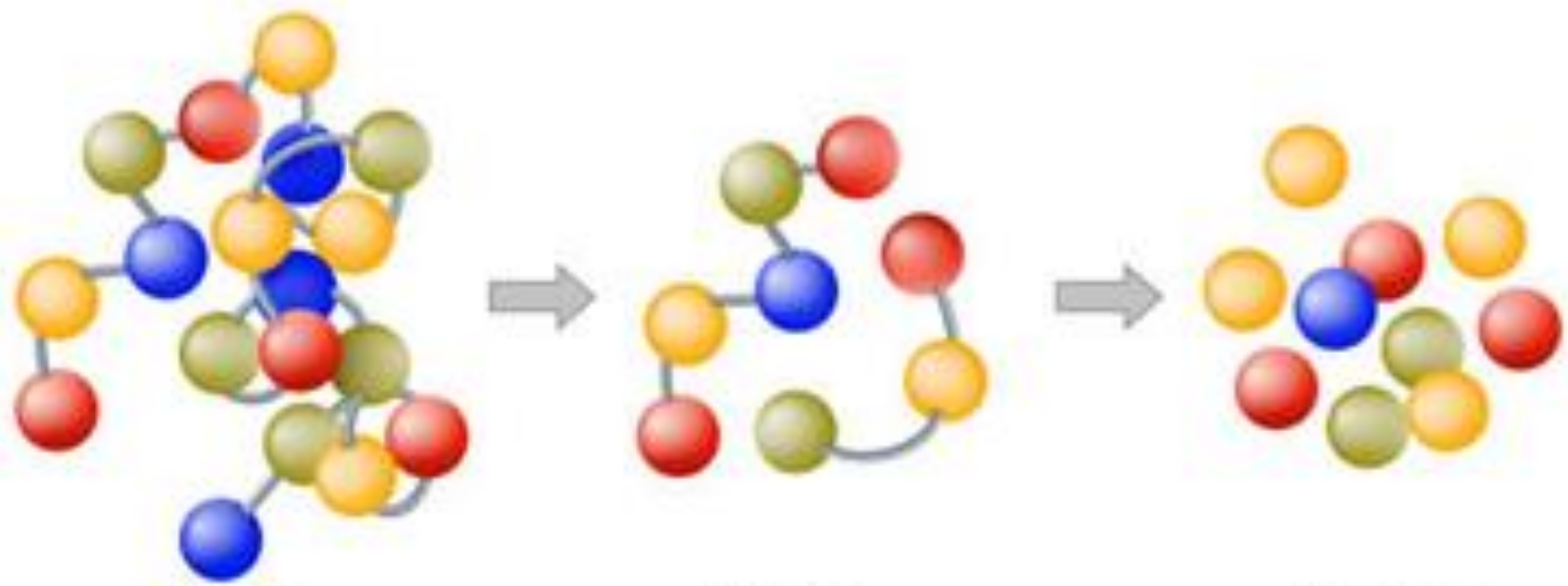
- Amino acids **can** be synthesized by the human body from other compounds.

Table 1. Dietary Requirements for Amino Acids in Humans	
Essential	**Nonessential**
Histidine	Alanine
Isoleucine	Arginine
Leucine	Asparagine
Lysine	Aspartate
Methionine	Cysteine
Phenylalanine	Glutamate
Threonine	Glutamine
Tryptophan	Glycine
Valine	Proline
	Serine
	Tyrosine

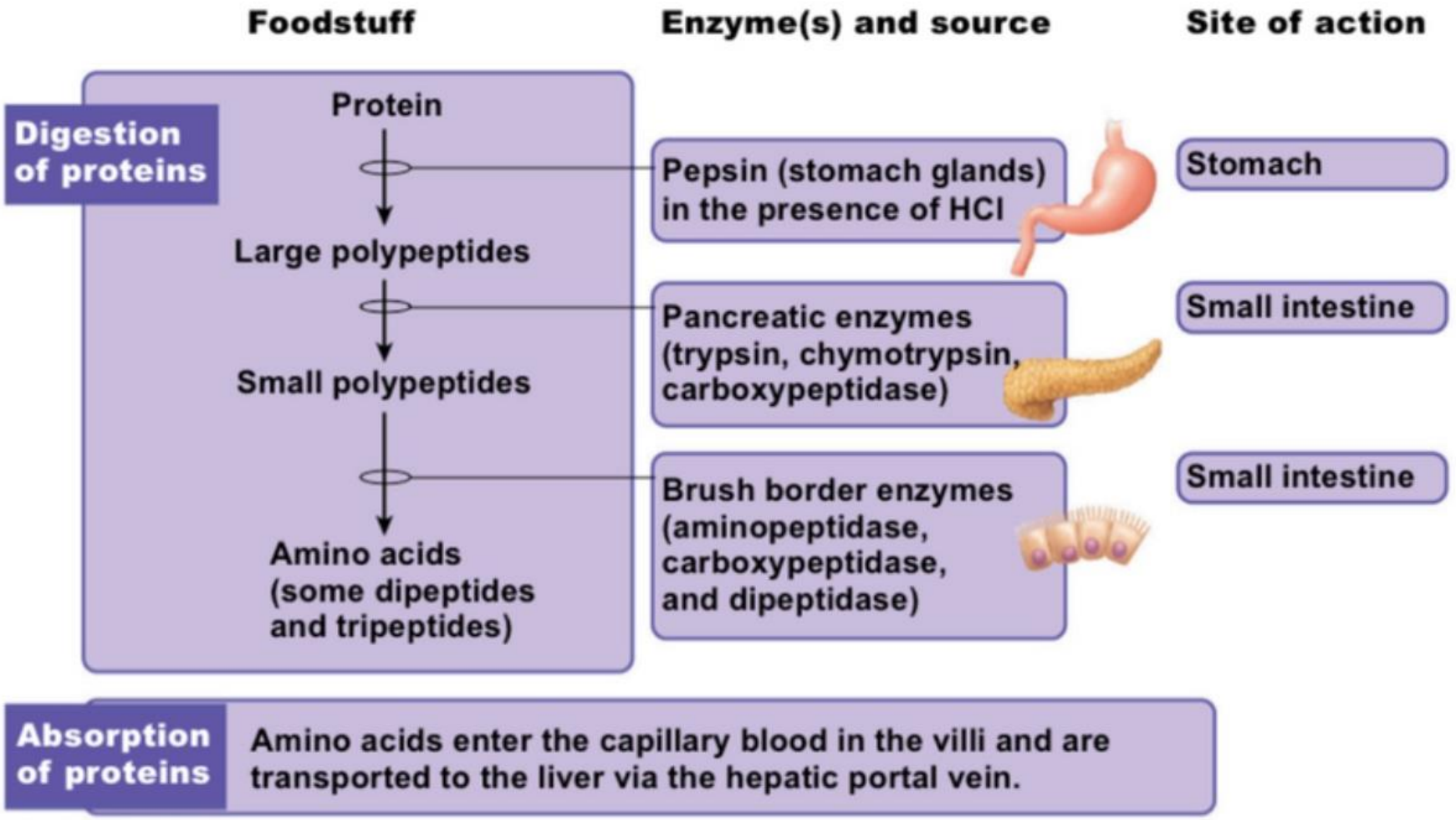
Digestion of Proteins



Digestion of protein



Digestion of Proteins



Deficiency of Proteins

- Protein-Calorie Malnutrition (PCM) =Condition resulting from deficiency in both protein and calorie intake.
- When we don't eat enough protein, our body can't maintain its muscles, produce essential enzymes, or support our immune system.
- If calorie intake is also very low, the body uses up stored fat and even starts breaking down muscle for energy.
- There are two main types of PCM:
  - ❑ **Kwashiorkor** (deficiency of protein of protein but calories are sufficient)
  - ❑ **Marasmus** (deficiency of protein of both protein and calories)

MARASMUS	KWASHIORKOR
	

Kwashiorkor

- Severe form of protein malnutrition
- Characterized by inadequate protein intake with reasonable energy intake
- Usually affects infants and children, most often around the age of weaning (when a child is weaned from breast milk and is fed a diet that is high in carbohydrates but low in protein)
- The extreme lack of protein causes an osmotic imbalance in the gastro-intestinal system causing swelling of the gut diagnosed as an edema or retention of water

Symptoms of Kwashiorkor

- loss of muscle mass
- an enlarged tummy ("pot belly")
- red, inflamed patches of skin that darken and peel or split open
- dry, brittle hair that falls out easily and may lose its colour
- failure to grow in height
- tiredness or irritability
- ridged or cracked nails

Marasmus

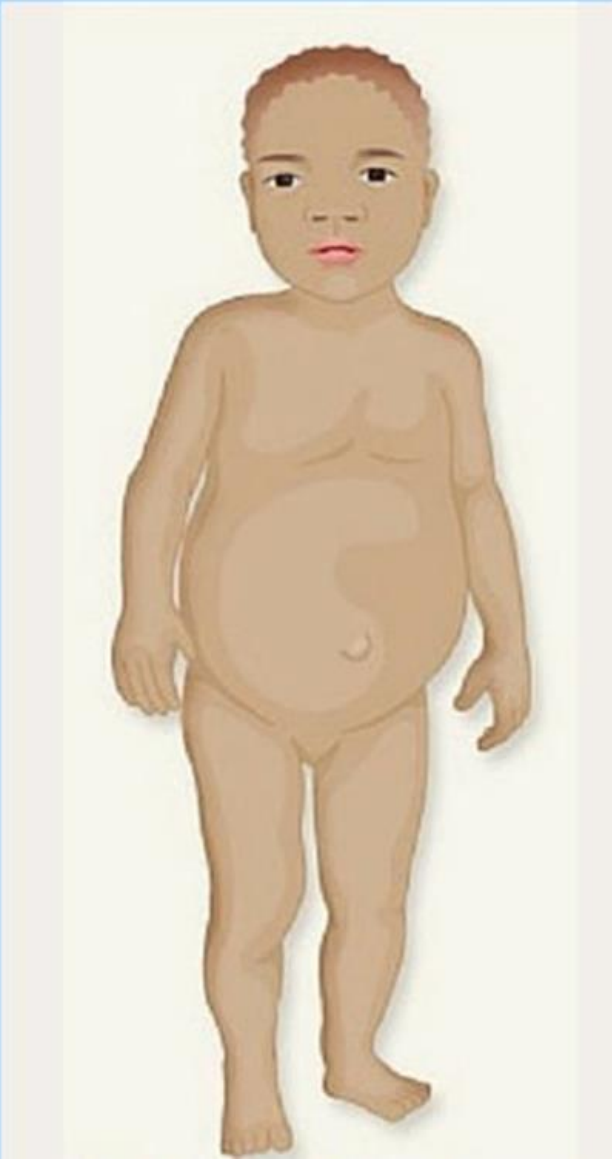
- Severe form of **protein-energy malnutrition (PEM)** caused by a deficiency in both protein and calories (carbohydrates & Fats)
- The body starts breaking down muscle and fat reserves for energy, leading to extreme weight loss and muscle wasting
- Causes:
  - ❑Prolong starvation
  - ❑Poor feeding habits - lack of breast feeding and the use of dilute animal milk
  - ❑A physical defect eg: cleft lip or cleft palate or cardiac abnormalities
  - ❑Diseases which interfere with the intake of food eg: cystic fibrosis
  - ❑Infections
  - ❑Loss of food through vomiting and diarrhea
  - ❑Emotional problems (disturbed mother- child relationship)

Symptoms of Marasmus

- Severe weight loss
- Muscle wasting
- Skin that appears thin and wrinkled
- Growth retardation in children.
- Lethargy and lack of energy.
- Weak immune system
- Visible ribs
- Dry, thin, and dull hair.
- Thin arms and legs with a characteristic "old man" appearance

KWASHIORKOR VS MARASMUS

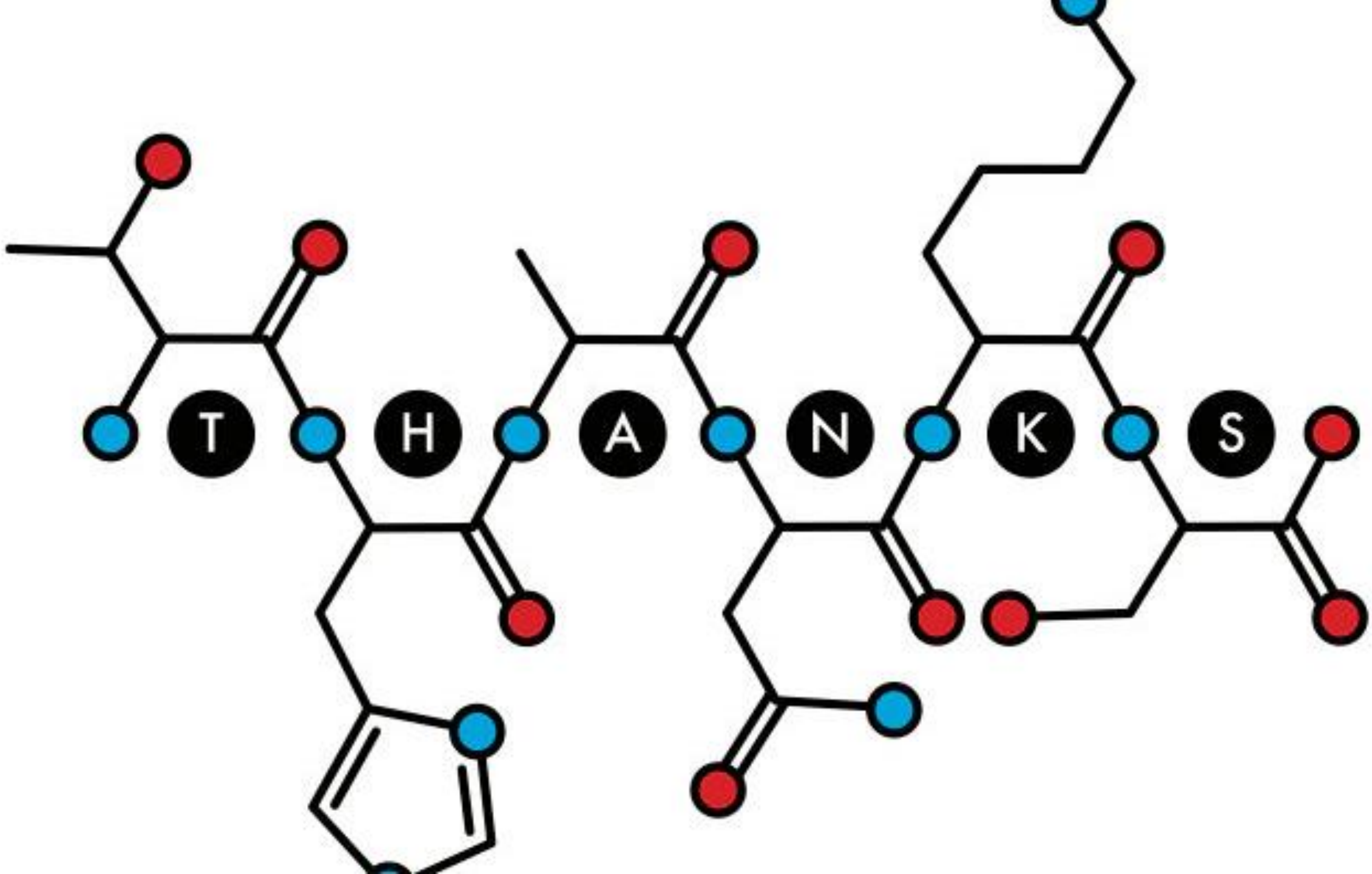
- In preschool children (1-5 years of age)
- Due to low protein intake
- Mild growth retardation
- Mild reduction in body weight
- Protruding abdomen and subcutaneous fat reserved
- Ribs not very prominent
- Poor appetite
- Enlarged fatty liver
- Oedema present
- Moonfacies
- Sparse hair
- Flaky paint-like skin
- Lethargic
- Requires adequate



- In weakened infants(<1 year old)
- Due to low calorie intake
- Severe growth retardation
- Severe reduction in body weight
- Shrunken abdomen and subcutaneous fat not preserved
- Prominent ribs
- Voracious feeder
- No fatty liver
- Oedema not present
- An old man like face
- No hair changes noted
- Dry and wrinkled skin
- Alert but irritable
- Requires adequate

Potential Effects of Excessive Protein Intake

- Increases the kidneys' workload, as they need to filter out excess nitrogen from protein metabolism.
- When the body breaks down protein, nitrogen is produced, and the kidneys must work harder to excrete it. This process requires extra water, which can lead to dehydration if fluid intake is insufficient.
- A diet that is excessively high in protein may lead to a lack of other essential nutrients like fiber, vitamins, and minerals found in carbohydrate and fat-rich foods, potentially resulting in deficiencies.
- Overconsumption of protein can lead to digestive discomfort (bloating, gas, or constipation) due to a lack of dietary fiber.
- Excess protein can contribute to weight gain if it leads to an increase in overall calorie consumption.
- Diets high in animal proteins, especially red and processed meats, can increase the intake of saturated fats and cholesterol, which may increase the risk of heart disease
- Excessive protein intake can lead to a condition called "protein ketosis", where the body starts breaking down fat for energy, producing ketones. This can lead to foul-smelling breath (ketosis breath)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