Topic 2: Proteins

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Relevance of the topic: Protein is one of the powerful nutrient. It is part of every living cell, and it plays a major role in your body — from building school-aged children's body tissues to making important hormones. An adequate protein intake in the diet is important across the life cycle.

Aim of the topic: Give information to you about proteins, amino acids and the required amount of protein per a day.

Questions for prepare:

1. What are proteins and what do they do?
2. Why does the school-aged children's body need protein?
3. What are amino acids?
4. How much protein does school-aged children's body need?

2.1 Role of Proteins

Proteins are large, complex molecules that have many critical roles in the body. They are composed of amino acids and bound together by peptide bonds.

Proteins are used in many different ways throughout the body:

- Part of DNA
- Part of haemoglobin
- Creating neurotransmitters
- Creating antibodies in blood
- part of keratin in hair and nails
- creating enzymes throughout the body

In the gastrointestinal tract proteins undergo hydrolysis via proteolytic enzymes resulting in amino acids.

2.2 Amino acids

Protein is an important macronutrient used by the body for building, repairing and maintaining tissues. Proteins are part of every cell, tissue, and organ in our bodies. Proteins are made up of amino acids, which are the building blocks of protein. The proteins in our bodies are constantly being broken down and replaced. The body does not store amino acids like it does carbohydrates and fats, so the body needs a daily supply of amino acids to make new proteins. The protein in the foods we eat is digested into amino acids that can be used to replace the proteins in our bodies.

There are 20 different amino acids needed by the body. These amino acids join together to make all different types of protein.

- **Essential**: cannot be made by the body, and must be supplied by the diet.

- **Non-essential**: are made by the body from essential amino acids or in the normal breakdown of proteins.

Of the 20 amino acids common to all life forms, the eight amino acids humans cannot synthesize are phenylalanine, valine, threonine, tryptophan, methionine, leucine, isoleucine, lysine. Histidine and arginine are considered to be essential in children.

Five other amino acids are considered conditionally essential in the human diet, meaning their synthesis can be limited under special pathophysiological conditions, such as prematurity in the infant or individuals in severe catabolic distress. These 5 are cysteine, glycine, glutamine, proline, and tyrosine. Six amino acids are non-essential (dispensable) in humans, meaning they can be synthesized in sufficient quantities in the body. These six are alanine, aspartic acid, asparagine, glutamic acid, serine and selenocysteine (considered the 21st amino acid). Pyrrolysine (considered the 22nd amino acid) is not used by humans; thus, it is non-essential.

Functions of Essential Amino Acids

- **Phenylalanine**: Phenylalanine is a precursor for the neurotransmitters tyrosine, dopamine, epinephrine and norepinephrine. It plays an integral role in the structure and function of proteins and enzymes and the production of other amino acids.
- **Valine:** Valine is one of three branched-chain amino acids, meaning it has a chain branching off to one side of its molecular structure. Valine helps stimulate muscle growth and regeneration and is involved in energy production.
- **Threonine:** Threonine is a principal part of structural proteins such as collagen and elastin, which are important components of the skin and connective tissue. It also plays a role in fat metabolism and immune function.
- **Tryptophan**: Though often associated with causing drowsiness, tryptophan has many other functions. It's needed to maintain proper nitrogen balance and is a precursor to serotonin, a neurotransmitter that regulates your appetite, sleep and mood.
- **Methionine**: Methionine plays an important role in metabolism and detoxification. It's also necessary for tissue growth and the absorption of zinc and selenium, minerals that are vital to your health.
- **Leucine**: Like valine, leucine is a branched-chain amino acid that is critical for protein synthesis and muscle repair. It also helps regulate blood sugar levels, stimulates wound healing and produces growth hormones.
- **Isoleucine**: The last of the three branched-chain amino acids, isoleucine is involved in muscle metabolism and is heavily concentrated in muscle tissue. It's also important for immune function, hemoglobin production and energy regulation.
- **Lysine**: Lysine plays major roles in protein synthesis, hormone and enzyme production and the absorption of calcium. It's also important for energy production, immune function and the production of collagen and elastin.

- **Histidine**: Histidine is used to produce histamine, a neurotransmitter that is vital to immune response, digestion, sexual function and sleep-wake cycles. It's critical for maintaining the myelin sheath, a protective barrier that surrounds your nerve cells.

Functions of Non-Essential Amino Acids:

- **Alanine** removes toxic substances released from breakdown of muscle protein during intensive exercise. Side effects: Excessive alanine level in the body is associated with chronic fatigue.
- **Cysteine** is a **c**omponent of a protein type abundant in nails, skin and hair. It acts as antioxidant (free radical scavenger), and has synergetic effect when taken with other antioxidants such as vitamin E and selenium.
- **Cystine,** the same as cysteine, helos in removal of toxins and formation of skin.
- **Glutamine** promotes healthy brain function. It is also necessary for the synthesis of RNA and DNA molecules.
- **Glutathione** is antioxidant and has anti-aging effect. It is useful in removal of toxins.
- **Glycine** is a component of skin and is beneficial for wound healing. It acts as neurotransmitter. The side effect of high level glycine in the body is that it may cause fatigue.
- **Histidine** is important for the synthesis of red and white blood cells. It is a precursor for histamine which is good for sexual arousal. Improve blood flow. Side effects of high dosage of histidine include stress and anxiety.
- **Serine** is constituent of brain proteins and aids in the synthesis of immune system proteins. It is also good for muscle growth. See here for serine food sources.
- **Taurine** is necessary for proper brain function and synthesis of amino acids. It is important in the assimilation of mineral nutrients such as magnesium, calcium and potassium.
- **Threonine** balances protein level in the body. It promotes immune system. It is also beneficial for the synthesis of tooth enamel and collagen. See here for foods high in threonine.
- **Asparagine** helps promote equilibrium in the central nervous system—aids in balancing state of emotion.
- **Apartic acid** enhances stamina, aids in removal of toxins and ammonia from the body, and beneficial in the synthesis of proteins involved in the immune system. See here for asparic food sources.
- **Proline** plays role in intracellular signalling.
- **L-arginine** plays role in blood vessel relaxation, stimulating and maintaining erection in men, production of ejaculate, and removal of excess ammonia from the body. Argenine is non-essential for healthy persons but It is essential amino acid for infants and adults with heavily compromised health condition, thus it is called sem-essential amino acid (Table 1).

Table 1. Food sources of Essential and Non-essential amino acids

Essential aminoacids	
Phenylalanine	Chicken, sour-milk products, milk, cheese, chanterelles, porcini mushrooms, soy, bananas, figs, apricots, parsley, peanuts, sesame seeds
Valine	Meat, eggs, milk, rice, oats, nuts
Threonine	Meat, sea oily fish, poultry, eggs, cheese, feta cheese, buckwheat, rye, barley, mushrooms
Tryptophan	Meat, fish, sour-milk products, milk, cheese, mushrooms, dates, banana, oatmeal, soy, sesame, nuts
Methionine	Meat, eggs, milk, beans, corn, wheat grains, nuts
Leucine	Eggs, milk, corn, oats, millet, nuts
Isoleucine	Meat, sea fish, eggs, milk, cheese, legumes, liver, rye, soy, buckwheat, almonds, cashews, brown bread
Lysine	Meat, poultry, eggs, milk, dairy products, cheese, feta cheese, legumes
Essential amino acids in children	
Histidine	Meat, horse mackerel, squid, eggs, cottage cheese, milk, cheese, legumes, rice, wheat, nuts
Arginine	Meat, tuna, eggs, cottage cheese, milk, peas, snails, pumpkin seeds, sesame seeds, peanuts, nuts
Non-essential amino acids	
Cysteine	Meat, salmon, eggs, milk, red pepper, garlic, Brussels sprouts, broccoli, corn, rice, beans, walnuts, sunflower seeds
Glycine	Quail eggs, chickpeas, ginger, walnuts
Glutamine	Fish, seafood, mushrooms, cheese, yogurt, dried fruits, tomatoes, walnuts, juice, beer
Proline	Meat, herring, tuna, reptiles, crayfish, seafood, cheese, rice, wheat, oats, flax seed, rye
Tyrosine	Meat, fish, seafood, eggs, dairy and sour-milk products, cheese, oatmeal, wheat, soy, bananas, avocados, nuts
Alanine	Meat, fish, squid, poultry, eggs, turtles, jellied meat, cheese, feta cheese
Aspartic acid	Meat, eggs, potatoes, legumes, coconut, fruit juices, vegetables, peanuts

Asparagine	Meat, eggs, potatoes, legumes, coconut, fruit juices, vegetables, peanuts
Glutamic acid	Fish, seafood, mushrooms, cheese, yogurt, dried fruits, tomatoes, walnuts, juice, beer
Serine	Meat, poultry, eggs, sea fish, milk, cheese, dairy products, soybeans, cauliflower, chestnut, coconut, corn, nuts

Complete proteins: usually of animal origin, contain all essential amino acids (which the body cannot synthesis itself).

Incomplete proteins: mostly of plant origin, they are deficient in one or more of the essential amino acids. The capacity of proteins is called their *supplementary value*.

Food sources from animals (meat, fish, eggs, dairy) usually score highly on the amino acid profile and are subsequently regarded as "high-quality proteins". Some vegetables are good sources of protein, such as beans, peas, lentils, and seaweed. For vegetarians and vegans, the most complete protein comes from soya beans.

2.3 Requirements

The recommended daily allowance of protein for:

Age	Grams of protein per day
Children 4 to 8 years	19g
Children 9 to 13 years	34g
Teens 14 to 18 years Boys	52g
Teens 14 to 18 years Girls	46g

The school-aged children's body is unable to store extra protein. An upper limit of safe protein intake has not yet been established but an intake of more than 2g/kg body weight leads to increased levels of nitrogenous substances, increased glomerular filtration and changes in liver function.

Protein deficiency is a state of malnutrition in which an insufficient amount of protein is taken in for the school-aged children's body to utilize in order to produce energy. This condition is largely responsible for the high incidence of starvation and disease in many developing countries. However, protein deficiency also occurs in developed countries, primarily due to poverty. Certain individuals may also become prone to protein deficiency, such as crash dieters and vegetarians who neglect to properly balance their diet.

A deficiency can also arise if a school-aged children has a health condition, such as:

- an eating disorder, for example, anorexia nervosa,
- certain genetic conditions,
- the later stages of cancer,
- difficulty absorbing nutrients, due, for example, to irritable bowel syndrome (IBS) or gastric bypass surgery.

Very low protein intake can lead to:

- weak muscle tone,
- edema, which is swelling due to fluid retention,
- Thin and brittlehair,
- skinlesions,
- in children, stunted growth.

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