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The Role of Nutrition in Promoting Physiological Functions and Maintaining General Health

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I. Abstract :

The complex relationship between food and health is rooted in the intricate biological mechanisms at the root of human biology. This review highlights the importance of nutrients, metabolic pathways, and cellular activities in illustrating how food components affect health outcomes, with emphasis on micronutrients and minerals serving as cofactors in homeostasis reactions, while macronutriENTs are digested to provide energy and build tissues. Additionally, the paper emphasizes the importance of dietary patterns in controlling crucial physiological systems such as the cardiovascular, immunological, and endocrine systems. Additional research studies are needed to examine these systems' effects. The consumption of excessive saturated fats and processed carbohydrates is connected to atherosclerosis and insulin resistance, whereas high fiber, antioxidant, and omega-3 fatty acid diets promote vascular health and reduce inflammation. Researchers have investigated how the gut microbiota serves as a link between nutrition and health, impacting metabolism, immune system, and nutrient absorption.' This study examines the connection between nutrient deficiencies and disorders like anemia, osteoporosis, and metabolic syndrome. In addition, the paper highlights how a well-balanced diet can aid in managing bodily functions and prevent illness. The comprehension of these physiological principles is essential for devising effective dietary strategies and public health initiatives that aim to improve overall health outcomes. The objective of this review is to thoroughly investigate the physiological mechanisms behind the link between diet and health.

1.*Importance of food in human health*

Human life depends on food. It provides energy and supplies nutrients that are essential for growth, repair, and overall body function.. The relationship between food and well-being is intricate. It involves multiple processes that control food digestion, absorption, metabolism, and the storage of nutrients(1).

Understanding these processes is key to showing how different foods affect health outcomes, prevent illnesses, and support overall well-being (2). While the main role of the gastrointestinal tract is nutrient absorption, it also carries out several other functions.

Digestive system has two main parts, the gastro intestinal tract and accessory structures and organs

The digestion tube or alimentary canal are various nicknames for the gastrointestinal tract. The oral cavity, where food enters the mouth, is where this long channel begins. The food then flows via the stomach, esophagus,

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pharynx, small and large intestines, and finally the rectum and anus. Waste products leave the body as feces through the anus. Food is vital for human health.

Food is essential for human survival it provides energy but also supplies many critical nutrients that are needed for growth, repair, and proper functioning of the body needs to function. The nature of food and health is complex but involves many levels of physiological processes for digestion, absorption, metabolism, and storage of nutrients and understanding these processes is important for understanding the effect of different foods on health, disease prevention, and health promotion (2). The gastrointestinal tract, although it's main job is to absorb nutrients, can also has many other jobs ,the tract is a sequence of organs including the mouth, esophagus, stomach, small intestine, colon, and anus and serves the following purposes .

1- Absorption of nutrients: This follows the breakdown of carbohydrates, proteins, fats, vitamins, and minerals, necessary for energy production, cellular upkeep, growth, and repair. (3) .

2- Egestion of waste and toxins :This releases waste matter, but also removes toxins and materials the body is .unable to digest, thus freeing the body of hazardous components.

3- Influencing Behavior : The gastrointestinal tract is a major system of the gut brain axis, which is crucial for behavior-regulating actions and higher functions of the brain

4- Maintaining hormonal balance : Hormonal balance is vital, and the gastrointestinal tract plays a huge role in appetite regulation, fullness, and metabolism.

5- provides a line of defense against pathogens : as there are immune cells in the gastrointestinal mucosa that assist in maintaining a balance between tolerance and reactivity. (4).

The accessory structures and organs of the digestive system include the salivary glands, mucus glands, tongue, teeth, liver, gall bladder, and pancreas. Each one of these has a specific role in digestion. The gastrointestinal tract (G.I.) helps to propel the food along its length. Each of the walls of the gastrointestinal tract are made of muscles which propel food through the tract by peristalsis. Many accessory structures assist the tract by secreting enzymes or substances to assist in transforming, digesting and absorb and transporting material along the tract. The gastrointestinal tract is primarily used to digest the large nutrients (polymers) of the (semi-solid) food into smaller units (monomers). Once nutrients break down into their smallest units, they then may cross the epithelial lining in the body and be absorbed, beyond this nutrients and material can be used to do many things, one is provide energy to the body.

2.*Fundamental Concepts in Physiology and Nutrition*:

Nutrients (Macronutrient and Micronutrient)

Macronutrients: Carbohydrates, proteins, and fats are the body's primary sources of energy. Carbohydrates are the body's energy source of choice. They break down into glucose, which is used to power the cells and the brain. Proteins are a source of amino acids, which are needed to build and repair tissue, and to synthesize enzymes and hormones to support the immune response. Fats are often denigrated, but they are essential to absorb nutrients, regulate hormones, and provide insulation (5).

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Micronutrients : Small compounds that contain vitamins and minerals that can literally function as a "spark plug" for various physiological processes. For example, vitamin C is an important factor in collagen synthesis, wound healing, and immune function....Calcium is the basis of our bone health, muscle contraction, and nerve transmission. One of iron's most prominent roles is oxygen transport, while zinc is critical for immune function and wound healing. Micronutrients are not necessary in large amounts as macronutrients, but adequate micronutrient intake is significant to general health (6).

Role of gut microbiota: The gut microbiome, which is made up of trillions of microorganisms, is essential to digestion, nutrient absorption, and immune response. Diet rich in fiber, prebiotics, and probiotics is ideal for maintaining a diverse and thriving gut microbiota, which is beneficial for the entire physiological system. Meanwhile, the consumption of items low in fiber, high in processed ingredients, and fat can drastically alter the gut microbiota balance and lead to inflammation, gastrointestinal problems, and a compromised immune system (7).

Energy metabolism: Refers to the numerous chemical reactions that occur in cells that change food into energy which can be used by the body for a variety of functions. Proteins, fats and carbohydrates are all foods that enter the body's chemicals which break the foods down into smaller units. The process of energy metabolism is predominately assistance reaction to produce adenosine triphosphate (ATP), the main energy source of body. ATP can be used by the body for key cellular functions such as muscle movement, nerve signaling, and synthesis of compounds. The production of ATP is just one of several important functions that energy metabolism serves in the body. Energy metabolism influences your body's thermoregulation, helps with maintaining cellular homeostasis, and contributes to your immune function, for example. Energy metabolism also affects synthesis of other important compounds such as lipids, nucleotides, and amino acids. To maintain energy balance for the best health of an organism, the management of energy metabolism is crucial in regulating the input of energy and the output of energy. Hormones and signaling pathways, such as insulin, glucagon, and adiponectin, have a profound influence on how nutrients are absorbed and utilized and how energy is liberated from stored fuels (8).

Steps of energy metabolism: Collectively, a series of interrelated pathways, and reactions will ultimately yield ATP (adenosine triphosphate), the main energy currency of the body. The process of energy metabolism involves various connected steps including glycolysis, the citric acid cycle, and oxidative phosphorylation. Different chemicals and metabolites formed during metabolism will regulate each of these metabolic steps.

The four fundamental processes of energy metabolism are as follows:

1-Digestion and Absorption: The process of energy metabolism begins with digestion and absorption of nutrients from food. This involves breaking down lipids, proteins and carbohydrates into smaller molecules that can be absorbed by the body and delivered to cells.

2-Glycolysis and the Citric Acid Cycle: Once the gut has released the nutrients into the blood, each cell handles them in two linked stages. In the watery part of the cell, the glycolysis sequence splits a sugar molecule into two identical pyruvate fragments. Those fragments move into the mitochondria, where the citric acid cycle completes their breakdown. The cycle yields energy rich carriers, NADH besides $FADH_2$.

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3-Oxidative Phosphorylation: ATP forms when oxidative phosphorylation uses the energy rich molecules that glycolysis and the citric acid cycle create. For ATP to appear, electrons must move from NADH besides FADH2 to a series of protein complexes plus electron carriers.

4-Utilization of ATP: Cells rely on ATP to carry out their normal tasks , this is the final step in how the body uses food energy. ATP powers muscle shortening, nerve signal travel and the building of new molecules.

3. The Physiological Basis of Food's Impact on Health

Digestive and Absorptive Processes: Digestion splits food into small units , absorption moves those units from the gut cavity into the body. The chief substances taken up are carbohydrate, protein plus fat. Minerals and vitamins also cross the gastrointestinal lining.

Carbohydrates are broken down into monosaccharides by enzymes, these monosaccharides are absorbed through the small intestine's lining. Fructose is absorbed passively, while glucose and galactose are absorbed actively. Similarly, proteins are broken down from polypeptide chains into individual amino acids, as well as dipeptides and tripeptides. Their absorption depends on their chemical structure and occurs through both passive and active processes that involve different membrane transporters . Fat and fat soluble vit are primary need due to emulsification with bile salts to absorb. Water flows in osmotic gradients made by absorbing .Because gut has to do mechanical and chem actions which can hurt muc, it made a lot of types of protection, including mucous and cell wall renewal frm the inside. Digestion is where food breaks down into detail so tiny they can pas through cell wall of the gut and go wedy around in the body by the blood. Mag is done by both chem and mech whih starts in the mouth and almost all of it ends in the small int, which absorbs 90%. In most cases the rest of it absorbs in the stomach and large int, that requires the help of the gut bacteria. It is also thought that a tiny bit of absorption also happens in the mouth. Chem digestion happens in the mouth by chewing, and continues with segmental muscle contraction in the stomach and guts. Chemical digestion it mainly uses enzymes that are in the liquids from the salivary glands, stomach and pancreas; also, in the lining of the small intestine. The good thing you get from food is four, main groups of nutrients of food: carbs, proteins, lipids and vitamins, each of them digests and absorb them in their own way.

Food digestion, absorption, and fermentation processes in the human body

all the work done on the digestion absorption fermentation of food is too much but important for human health and balance in life. these are the ways that break down of food into small parts that can be absorbed by the body and used for growth and for some parts of the body to work, the absorption and digestion does is help the healthy bugs in the gut stay healthy, which is key to the health of different things like the immune system, mental health, and how to help the body stay away from the health problems. The process of digesting food and absorbing it goes through many parts and stages. It starts on the mouth and ends in your intestine. It all begins with the food breaking down and coming apart in the guts, and then the food is press down and broken apart and the nutrients are used (8,9).

The digestive process involves both physical and chemical breakdown of food. Physical digestion begins with the mechanical breakdown in the mouth and continues in the stomach. Food is broken down into smaller components by various digestive glands through chemical digestion, which are subsequently absorbed into the small part of the gut in the large intestine. Additionally, microbial fermentation occurs not only in the large intestine but also in

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other parts of the intestinal tract, such as the appendix. The overall digestion process is aided by these microbes(8). Digestion begins in the mouth. By chewing solid food and combining it with saliva to form a soft bolus, the process is accomplished. This bolus is made by the combination of teeth, tongue, and cheeks.

working together to prepare the food for swallowing. Saliva contains an enzyme called amylase, which starts the chemical breakdown of starches into simpler sugars. Once swallowed, the bolus travels down the esophagus to the stomach, where more physical and chemical digestion occurs. The stomach's muscular walls churn the food, breaking it down into even smaller pieces. Digestive enzymes, like pepsin and gastric lipase, further break down proteins and fats, respectively. It's important to remember that salivary amylase may continue to work on carbohydrates in the stomach, depending on its interaction with stomach fluids and the amount of stomach acid produced (10,11). Eventually, these small food particles, usually less than 2 millimeters in size, pass through the pylorus into the duodenum, the first part of the small intestine, for further digestion (11,9) .The small intestine serves as the primary site for food digestion and nutrient absorption. Within this organ, the highly acidic chyme, originating from the stomach, is neutralized by sodium bicarbonate released from the pancreas. Complex substances like proteins, carbohydrates, and fats are broken down into smaller components such as amino acids, small peptides, simple sugars, and double sugars through the action of enzymes found in pancreatic, biliary, and intestinal fluids, coupled with the rhythmic contractions of the intestine (peristalsis) that aid absorption (8). The process of absorption occurs alongside transport within the small intestine, leading to more efficient nutrient uptake.

Microorganisms living in the colon can ferment undigested food particles and extract more nutrients. In the mouth, digestion begins as food is broken down by chewing and enzymes begin to break down carbohydrates. Once food reaches the stomach, modifications are made to its structure of proteins and digestion of these occurs. Most of the nutrients are absorbed in the small intestine. Byproducts are produced by the pancreas and digestive tract walls, which work to further break down nutrients into simpler units. The body takes in the basic sugars, which are used as building blocks for proteins and fats.

Metabolic Pathways and Nutrient Utilization:

All the nutrients that we consume are brought into our bloodstream and then distributed to various tissues in the body. These nutrients are then metabolized in different areas. Species that require energy will utilize the glucose present in the bloodstream. They can also convert this glucose into fat or glycogen for later storage. Amino acids are used to build proteins, and the breakdown of these amino acids results in carbon dioxide as a byproduct. Fatty acids can be transformed into building blocks for phospholipids or stored as triglycerides.

Role of Gut Microbiota: The community of microorganisms residing in the gut plays a crucial role in breaking down dietary fibers we can't digest ourselves .These microbes also produce vitamins and influence the activity of our immune system. When the balance of these gut bacteria is disrupted, a condition known as dysbiosis, it can be linked to metabolic disorders, excess weight gain, and inflammatory conditions.

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Hormonal regulation of appetite and metabolism: A complex network of hormones is responsible for appetite and metabolism regulation, where each hormone is considered to be the main player in energy balance, food intake, and metabolic processes.

Food Components and Their Physiological Effects:

Carbohydrates are mainly found in many common foods like bread, rice, pasta, fruits, and vegetables. The breakdown of carbs into simpler sugars is initiated by an enzyme in your saliva, which occurs in the mouth. While the acidity in the stomach reduces it, the breakdown continues in our stomach. When an enzyme from pancreas enters the small intestine, it further breaks down the starches. Enzymes in the lining of the small intestine then transform these sugars into even simpler sugars, such as glucose. These simple sugars are then absorbed into blood. As glucose enters the blood, blood sugar levels rise. pancreas detects this rise and releases insulin. Insulin supports the absorption of glucose into cells in your muscles, fat, and liver for energy consumption or storage for future use.

The body's balance can be maintained by incorporating insulin into the process of stabilizing blood sugar levels. Protein is composed of important large molecules made up of amino acids. Their contribution is crucial in building and fixing tissues, maintaining the immune system, and acting as enzymes and hormones. Additionally, they are considered extremely important. Consider the amino acids in protein form.? The number of species is 20, and nine of them are considered "essential," which implies that they must be derived from our diets. Protein synthesis and various bodily functions require the presence of these amino acids. Body systems use MPS, which is the process of synthesising muscle proteins. In order to activate MPS effectively, we must consume sufficient protein and amino acids, with leucine being a key component in muscle growth and recovery .

The importance of consuming fats cannot be overstated in terms of maintaining good health They contain the necessary fatty acids and have a significant impact on heart health by significantly lowering cholesterol levels.

Since our bodies can't make these fatty acids, we need to get them from food. Omega-3 and omega-6 fatty acids are the main ones, and they're necessary for brain function, thinking clearly, reducing swelling, and keeping our cells healthy (12). Cholesterol, on the other hand, is a waxy substance similar to fat that doesn't dissolve in water. It's found in all of cells and is needed to make hormones, vitamin D, and to digest fats. It's also a key part of bile acids. However, too much cholesterol, especially LDL (low-density lipoprotein), can raise the risk of heart problems because it can cause a buildup in the arteries .

Vitamins and minerals are crucial for our health, serving as cofactors in the enzymatic reactions that keep bodies running smoothly through various biochemical processes.

Vitamins as Cofactors:

Coenzymes, which are organic compounds found in many vitamins, play a crucial role in supporting enzymes during their functions . When carbohydrates are broken down in our bodies, Vitamin B1 (Thiamine) is involved in the conversion of pyruvate to acetyl-CoA. The production of FMN and FAD requires Vitamin B2 (Riboflavin) for electron transfer reactions. NAD+ and NADP+ are produced solely in conjunction with vitamin B3 (Niacin),

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which is also necessary for these reactions. The coenzyme function of Vitamin B6 (Pyridoxine) is essential for amino acid breakdown and utilization, whereas Vitamin A2 (Cobalamin) plays a crucial role in DNA formation or fat processing. In addition to being an antioxidant, ascorbic acid in Vitamin C aids in the formation of collagen.

Minerals as Cofactors:

A significant proportion of enzymes rely on inorganic minerals; by acting as cofactors, they maintain the structure of the enzyme and play a direct role in speeding up reactions. Hemoglobin relies on iron, which is essential for electron transport and redox reactions. Copper is a crucial component in electron transfer reactions, particularly in enzymes such as cytochrome c oxidase. Calcium also plays a critical role in cell signaling and .contributes to the structure of various biological components.

Phytochemicals:

Plant-derived compounds not only give fruits and vegetables their color and taste, but also help plants protect themselves from diseases. The various biological activities of these compounds may also have health benefits for humans.

Antioxidants :

Compounds known as antioxidants shield cells from damage or retard it. Unstable atoms called free radicals, which are a natural byproduct of metabolism or arise from environmental causes like pollution and sunlight, cause this damage. Numerous plant-based compounds or phytochemicals work as antioxidants. Protecting the body from oxidative stress, these antioxidants promote general health.

5.The Interplay Between Food Intake and Disease Prevention

1-*Cardiovascular disease:*

A major danger to world health, cardiovascular disease (CVD) can be prevented by means of dietary choices.Research suggests that approximately 40% of CVD cases may be linked to dietary factors. Both macronutrients and micronutrients influence the development of CVD through various pathways, affecting factors such as blood lipids, blood pressure, blood clotting, blood sugar levels, body weight, and the composition of the gut microbiome .

CVD is a leading cause of death worldwide, accounting for a substantial portion of global mortality. Given the clear connection between food, nutrition, and human health, diet plays an essential part in an individual's cardiometabolic well-being. Substandard dietary habits are strongly associated with an increased risk of CVD-related illness and death. Nutrition is also key to the development of major cardiovascular problems such as high blood pressure and atherosclerosis. A person's diet and nutrition are key factors in preventing heart disease. In particular, eating habits have a significant impact on the risk of developing heart problems. For instance, consuming high levels of saturated and trans fats can elevate blood cholesterol and increase the likelihood of heart attacks, whereas incorporating polyunsaturated and monounsaturated fats into one's diet can help lower that risk

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. Furthermore, obesity, especially when body fat is concentrated around the abdomen (an "apple" shape), is associated with a greater risk of heart attacks. High cholesterol levels can also lead to plaque buildup in the arteries, restricting blood flow and increasing the potential for heart disorders.

2-*Diabetes mellitus*:

Diabetes is a long-term health problem that affects how body processes sugar. It happens either because the pancreas doesn't make enough insulin, or because the body can't properly use the insulin it does make. Insulin is a crucial hormone that helps sugar from food get into your cells for energy. The main sign of diabetes is high blood sugar, which occurs when there's too much glucose in the bloodstream. This can be caused by problems with the pancreas and its ability to release insulin. The rise in diabetes is almost certainly linked to what we eat and how active we are. We know that poor diets and not enough exercise play a big role in how common diabetes has become. This increase is definitely connected to diet and lifestyle, specifically physical activity. A significant factor contributing to the widespread occurrence of diabetes is poor dietary choices and insufficient exercise.

3-*Obesity*: Disturbances in energy metabolism can lead to various metabolic disorders. A higher consumption of highly processed foods has been associated with an increased risk of overweight and obesity. Obesity is fundamentally a result of excess calorie intake, often from calorie-dense, sugary foods like candy, pastries, sweetened beverages, and chocolate. The growing popularity of fast-food restaurants and increased consumption of soft drinks can be seen as indicators of a diet high in calorie-rich, unhealthy foods . Dietary choices significantly impact the risk of obesity; a diet rich in fats or refined sugars increases this risk . Studies suggest that excessive consumption of refined carbohydrates, high-cholesterol fats, trans fats, and insufficient fiber can negatively affect the body's energy utilization, leading to fat storage.

4-***Osteoporosis*** : Osteoporosis is a prevalent long-term condition marked by reduced bone density, weakened bone structure, and a greater chance of fractures from minor injuries. This leads to significant illness, death, and increased medical expenses. The development of osteoporosis is largely influenced by lifestyle choices, genetics, metabolism, diet, and hormone levels.

Related to metabolic syndrome (MetS), variables like too much stomach fat, aberrant blood fats, high blood sugar, and high blood pressure are also related to osteoporosis. Each of these elements can affect bone health differently. For instance, too much belly fat has been related to lower-than-normal bone density and osteoporosis. Osteoporosis causes frail bones and a greater risk of fractures owing to reduced bone mass and deterioration of the internal bone structure It's a metabolic bone disorder affecting both men and women, especially as they age. Osteoporosis is a major health concern because it results in significant illness, death, and substantial healthcare costs. Calcium and vitamin D are essential components of bone, forming calcium phosphate crystals that contribute to bone strength .A balanced diet is the preferred way to get enough calcium. Other nutrients, like potassium and magnesium, also play a role in maintaining healthy bones. Protein intake is also crucial, as bones are partly composed of proteins. Vitamin K helps with bone formation during the hardening process, and Vitamin

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C, with its antioxidant properties, can improve bone health by reducing the activity of cells that break down bone (13).

5- ***Cancer***: Cancer, a group of serious and often deadly diseases, is a major cause of death globally. Nutrition has a significant and two-way connection to how cancer develops and progresses. Because components in food can both start cancer and help prevent it, the link between diet and cancer development involves intricate interactions within the body .

Diets that include a lot of processed meat, sugary foods, and unhealthy fats, especially those common in Western countries, have been associated with a higher risk of cancer. Conversely, diets rich in whole grains, fruits, vegetables, and healthy fats appear to offer protection against cancer.

Research has identified several substances in food that may potentially cause cancer. However, beneficial substances like strong antioxidants, which fight damaging free radicals, and dietary fiber, which helps eliminate potentially cancer-causing substances from the body, can help lower the risk.

Studies have connected different kinds of cancer to components in food, contaminants, foreign substances in food and their byproducts, and cancer-causing agents found in food. "Carcinogenic food" refers to any food component, whether naturally present or introduced from outside sources, that increases the risk of cancer when consumed.

The potential for food to cause cancer can arise from various sources, including substances naturally present in food, natural compounds, pollutants introduced during food production and processing, and chemicals created during heating and preservation.

How these foods and their specific components contribute to cancer development is complex and varies. These processes can directly damage DNA, alter gene expression, disrupt cell communication, and trigger chronic inflammation, all of which can eventually lead to cancer.

6.*Food, Hormones, Metabolic regulation:*

1-*Insulin and glucagon*:

The endocrine system is a vital part of how our bodies maintain overall health. It generates hormones regulating vital activities including development, reproduction, and energy consumption. Crucially for how our bodies use

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and store nutrients are hormones like insulin, glucagon, thyroid hormones, and cortisol. Insulin Made by the pancreas enables cells to store glucose for energy and helps to control blood sugar levels. Particularly after we eat, the equilibrium between insulin and glucagon helps to stabilize our blood sugar. Diseases such diabetes, which significantly impact our nutritional needs and food processing, can be caused by defects in insulin control (15).

Maintaining blood sugar equilibrium depends much on our eating patterns. Our systems use insulin to control blood glucose following eating; when this system fails, it causes illnesses like diabetes. Consuming a poor diet rich in processed sugars and simple carbohydrates can cause blood sugar to soar, which results in insulin resistance and chronic health issues. Eating a balanced diet with lean proteins, fiber, good fats, and whole grains can help manage blood sugar and increase insulin sensitivity. Avoiding significant blood sugar fluctuations and eating smaller, more frequent meals can also help to preserve metabolic health. Although dietary fats don't very much directly impact glucagon release, they indirectly impact insulin production. The overall effect on glucagon depends on the complex interplay of hormones and the ratio between insulin and glucagon (16,17). What we eat greatly affects how bodies release insulin, which is essential for keeping blood sugar steady and staying healthy overall. Here's a look at how different parts of our diet impact insulin production.

Carbohydrates play the most important role. Carbs get digested into glucose, which enters your blood and prompts your pancreas to secrete insulin. Fast rises in blood sugar and insulin result from simple carbohydrates including processed grains and sweet foods. Foods with a low glycemic index (GI) take longer to digest and absorb, which results in a softer rise in blood sugar and insulin. High-GI foods, on the other hand, result in quick spikes that stress insulin output and so possibly cause insulin resistance later on.

Proteins also encourage insulin release, though usually less than carbs do. Specific amino acids (like leucine and arginine) can even trigger insulin release without the need for a blood sugar increase.

Fats in our diet have very little immediate impact on insulin secretion, but they can play a role in how sensitive our bodies are to insulin over time.

2-*Thyroid hormones:*

The thyroid gland produces hormones that are essential for controlling metabolism, the process by which your body converts food into energy. These hormones affect how quickly your body burns calories and uses nutrients. An underactive thyroid, or hypothyroidism, can slow down metabolism, causing weight gain and difficulty using nutrients. Conversely, an overactive thyroid, or hyperthyroidism, can lead to rapid weight loss and increased nutrient use. People with thyroid problems often need to modify their diets to manage these metabolic changes. For instance, those with hypothyroidism might benefit from a diet rich in fiber and low in simple sugars to help manage weight and support their overall health .

Effect of Nutrient on Thyroid hormone release:

Food intake affects thyroid hormone release both by influencing thyroid hormone levels and through the central regulation of appetite. Specifically fasting decreases thyroid hormones, while overfeeding increases T3 but not T4.

High-glycemic index diet can negatively impact thyroid function, while a high-protein diet may have a positive effect. Essential nutrients, like iodine and selenium, are crucial for synthesis, and specific foods, such as

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cruciferous vegetables, can inhibit hormone production, particularly in cases of iodine deficiency. Diets high in saturated fatty acids may have a positive effect on thyroid function. Essential micronutrients: Iodine, selenium, iron, zinc, and copper are all vital for thyroid hormone synthesis and regulation. Diet plays a crucial role in maintaining healthy thyroid function and managing thyroid disorders, especially those resulting from deficiencies or excesses in thyroid hormone levels. The main reason for the diet's importance in thyroid function is the requirement for several micronutrients also called trace elements that are essential for thyroid hormone synthesis but cannot be synthesized by the human body. These nutrients have to be furnished by external sources. Iodine and selenium are particularly critical. Iodine is a structural component of thyroid hormones, and its deficiency is a major cause of hypothyroidism. Selenium, in synergy with iodine, supports the activity of enzymes involved in thyroid hormone synthesis and metabolism. Other trace elements such as zinc, copper, and iron also contribute significantly to thyroid hormone production and function, Vitamins, in particular vitamin C may also influence thyroid hormone production.

Leptin and ghrelin: Leptin is a hormone made of 167 amino acids, primarily produced by fat cells. Interestingly, - its structure is very similar across different animal species. Primarily found in fatty tissues, leptin production is linked to the "obese" gene located on chromosome 7. Leptin levels in the body are directly related to the amount of body fat, influencing both how much we eat and how much energy we burn .

Once produced, leptin enters the bloodstream and travels to the brain through the cerebrospinal fluid and a protective barrier called the blood-brain barrier. In the brain, leptin helps manage the body's energy balance by working on specific areas, including the ventromedial nucleus, lateral hypothalamus, and arcuate nucleus. It affects our feelings of hunger, sometimes increasing it and sometimes decreasing it .

A common idea is that obesity and high leptin levels may indicate a resistance to the hormone's effects. Leptin is supposed to help prevent overeating by interacting with specific receptors. However, in obese individuals, the body's response to leptin may be reduced, leading to leptin resistance. This resistance can manifest as reduced feelings of fullness, increased food consumption, and consequently, an increase in body weight, further raising the chances of becoming obese. Many studies have shown that most people who get fat from diet have leptin resistance, a problem where leptin levels are high in the blood but the body stops responding to it. This problem has a link with the BMI of the person and the fat in their body (18,19,20) .The amount of leptin from fat cells may go down, and that may make the fat cells bigger. The link between leptin resistance and T2DM is not simple, and the exact cause is not known yet. But some things may play a role like insulin resistance (21).

Ghrelin: a hormone composed of 28 amino acids, primarily functions as an appetite stimulant. However, it also plays a wide range of roles in the body, influencing processes like the way we handle sugar and fat, the function of the digestive system, heart health, the reproductive system, lung function, bone health, and even the immune system and cell growth(22). Ghrelin is stimulate hunger, thereby increasing food consumption. It likely serves a regulatory role in energy balance, as its production increases during periods of fasting when the body is experiencing an energy deficit, and decreases after eating when the body has a surplus of energy (23,24). Studies using medications support ghrelin's role in promoting appetite. In people, ghrelin levels in the blood roughly double before a meal and decline shortly after, suggesting its involvement in initiating eating. Ghrelin influences both glucagon and insulin levels, indicating a key role in managing blood sugar and, consequently, glucose usage (25), ghrelin signals the hypothalamus when the body needs to use energy more efficiently. Research has

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https://iasj.rdd.edu.iq/journals/journal/issue/18682 https://doi.org/10.54174/utjagr.v13i1.323

demonstrated that in healthy individuals, the increase in ghrelin levels before meals aligns with feelings of hunger, prompting them to begin eating even without external cues related to food or time .Ghrelin has many roles: it helps regulate food intake and energy balance, stimulates gastric acid secretion, gut motility, and pancreatic protein release, and affects cardiovascular function .It also stimulates osteoblast proliferation and bone formation, promotes neurogenesis and myogenesis, influences learning and memory, supports thymopoietin, helps regulate sleep/wake cycles, is linked to ageing, and has a neuroprotective role in neurodegenerative diseases like Parkinson's(26). Ghrelin stimulates GH release by acting directly on pituitary somatotrophs, working together with GHRH, and by activating vagal afferents. At high doses, ghrelin can also increase prolactin, corticotropin, and cortisol secretion in humans.

Hunger and satiety, the feeling of fullness, are regulated by hormones that influence our eating habits. Ghrelin signals hunger, prompting individuals to eat, while leptin signals satiety, helping us stop eating when we've had enough. Imbalances in these signals can result in overeating or undereating, potentially leading to obesity or malnutrition. Dietary changes, like eating more fiber or nutrient-rich foods, can help regulate these hunger and satiety signals, contributing to a healthy weight.

Water: Maintaining excellent health depends mostly on nutrition. For a number of operations including digestion, nutrient absorption, temperature regulation, and waste disposal our bodies need a regular supply of water. Dehydration can interfere with nutrition absorption and impede the body's ability to digest food properly. It can additionally result in exhaustion, diminished mental clarity, and imbalances in electrolytes. Maintaining energy levels, aiding digestion, and guaranteeing the body can correctly utilize the nutrients from food all call for adequate hydration. Drinking enough water throughout the day and eating hydrating foods like fruits and vegetables can help maintain optimal hydration (27).

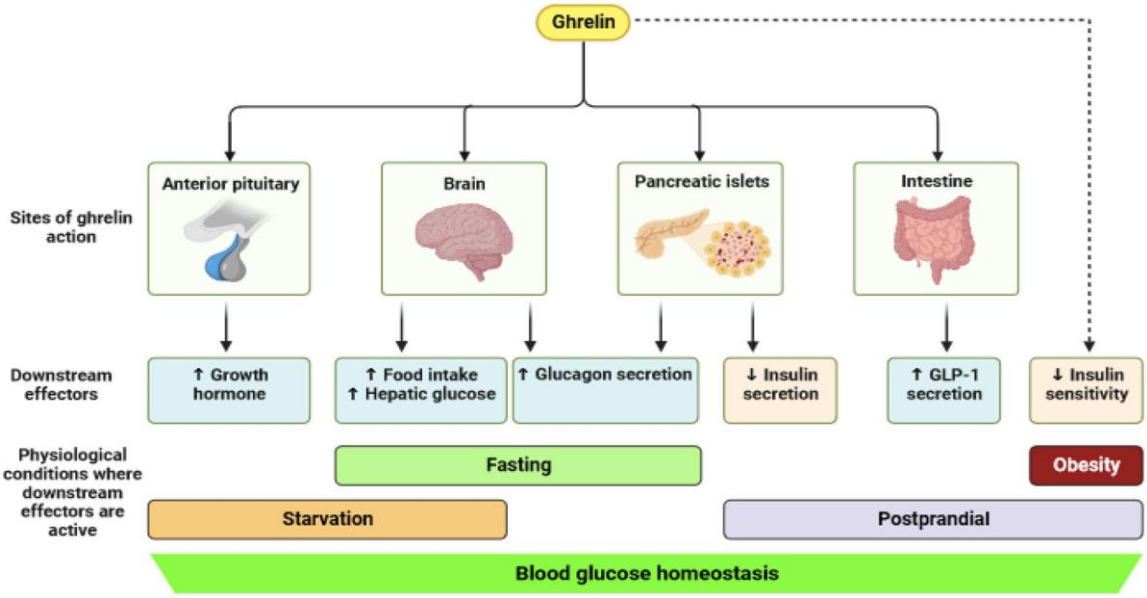

Figure 2:Various actions of ghrelin on glucose homeostasis(28)

7.*Role of physiology in managing food -Related Health :*

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Malnutrition: Malnutrition is described as a condition where inadequate or excessive intake of energy, protein, and essential vitamins and minerals leads to negative changes in the body, affecting its structure (shape, size, and composition), how it functions, and overall health outcomes. However, when considering undernutrition, this definition doesn't always consider *why* someone unintentionally loses weight .

Unintentional weight loss can stem from three main conditions: starvation, sarcopenia, and cachexia (29). Starvation typically results from a shortage of both protein and energy, essentially being the same as protein-energy malnutrition (PEM). The key distinction between starvation and other causes of unintentional weight loss is that it can be reversed by consuming enough energy and protein.

Sarcopenia involves a gradual loss of muscle mass, commonly associated with normal aging, although this is still being actively researched (30,31) . In this case, changes to diet alone may not be sufficient to counteract the weight loss, since sarcopenia is believed to occur regardless of whether someone is consuming enough calories (32,33).

Food allergies and intolerances: A food allergy happens when your body's immune system reacts negatively and consistently to a specific food. Food intolerance, on the other hand, involves negative reactions that aren't caused by the immune system, and can be due to various factors like metabolic issues, toxins, drug-like effects, or other unclear reasons (34). It's a known fact that actual food allergies triggered by IgE antibodies are much rarer than the number of people who believe they have a food allergy. However, even studies trying to track these allergies struggle to pinpoint the true IgE-mediated cases, because many reports don't require a doctor's confirmation of the allergy (35).

Nutritional deficiencies :

The human body needs nutrients to fuel its metabolic processes, repair damaged tissues, grow and develop, and produce the building blocks of heredity. These nutrients are broadly classified as macronutrients and micronutrients Macronutrients, which include carbohydrates, proteins, and fats, are needed in larger quantities and provide a significant source of energy. Micronutrients, such as vitamins and minerals, are required in smaller amounts and primarily support metabolic functions . Certain vital nutrients cannot be produced by the body itself; these are termed essential nutrients. This includes 9 amino acids, 2 fatty acids, 13 vitamins, and 15 minerals. We obtain these essential nutrients through a balanced and varied diet. Insufficient intake of nutrients can lead to nutritional deficiencies. While the body can often cope with short-term deficiencies, prolonged inadequate intake can result in developmental issues, illnesses, and other health problems. A primary deficiency arises specifically from an insufficient dietary intake of essential Nutrient deficiencies can be classified in a few different ways. One common method is to group them based on how serious their effects are. Significant deficiencies can result in substantial health problems, impacting key organs and bodily processes, such as the heart, how cells use energy, eyesight, and normal growth and development. In contrast, less severe deficiencies usually lead to milder problems like skin irritations, muscle and joint discomfort, and issues related to hair, teeth, and nail health.

Secondary deficiencies occur when the body has trouble absorbing nutrients correctly. This can stem from problems within the digestive system that affect hunger and digestion, or from metabolic disorders. Additional elements that can play a role in secondary deficiencies include how nutrients interact with each other, increased

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loss of nutrients, smoking, drinking alcohol, and even exposure to pollution . nutrient deficiencies are generally categorized into three main types: Protein-energy malnutrition (PEM), also referred to as protein-calorie malnutrition, vitamin deficiencies, and mineral deficiencies (36).

Nutrition and genes (diet–gene interaction): Human well-being is influenced by both environmental and inherited characteristics. To sustain a healthy state, both factors should be considered with equal importance. Earlier research often focused on the exclusive impact of environmental elements or heredity alone, rather than examining their combined influence. More recently, investigations have been developed to explore the interplay between genes and diet (37).

The study of nutrition explores how nourishment contributes to maintaining consistent and balanced internal bodily functions at the cellular, tissue, and organ levels. This field requires a comprehension of how nutrients interact at the molecular, genetic, protein synthesis, and metabolic levels (38). So, food study has moved from big group work & how bodies work to small work with cells & genes. Now, there is a new part called food genes. A big gene study helped this new part. It let people who study find links with genes, food, & health. With this, they see how each person's body may act with food(39,40). They looked at the map of the genes in us. They saw that we all have lots of gene traits. To keep our bodies in line, food, how we use it, & how genes work must fit well. Lots of health problems from food are not just from one gene. Many foods & a bunch of genes may work together to make these issues, not just one gene alone(41). Gene change is a key cause for why each one eats & feels food in their own way. Food & our genes work back & forth. Diet can shape genes. Genes can shape how food acts. These both change how our bodies work. These things can make us well or sick. Each food can help or hurt us. Food & genes link to health & risk for being ill(42).

Food genes work with some main thoughts. First, what we eat can be a big risk for some bad health things for some folks when times are right. Next, what is in food can change how genes work or look. This can change our body's map. Third, how each of us is built can change if we stay well or get sick. Last, some genes that change with food can help push or slow down sick things, how long things last, or how they grow worse. So, what we eat & how our body is made both play a part in health & long-term bad things.

Conclusion: This review makes it clear: our diet plays a crucial role in how our bodies function and in maintaining our long-term health. It really underscores why healthcare professionals, policymakers, and frankly, all of us, need to prioritize nutrition both for preventing illness and managing it when it arises. When we make smart food choices and live a healthy lifestyle, we can greatly lower our chances of getting long-term diseases and feel our best.

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