AMINO ACIDS AND NITROGEN COMPOUNDS pdf

1: LON-CAPA Botany online: Basic Metabolism - Biosyntheses - Amino Acids

Amino acids are organic compounds composed of nitrogen, carbon, hydrogen and oxygen, along with a variable side chain group. Your body needs 20 different amino acids to grow and function properly.

Strings of amino acids make up proteins, of which there are countless varieties. Of the 20 amino acids required for manufacturing the proteins the human body needs, the body itself produces only 12, meaning that we have to meet our requirements for the other eight through nutrition. This is just one example of the importance of amino acids in the functioning of life. Once used in dating objects from the distant past, amino acids have existed on Earth for at least three billion yearsâ€”long before the appearance of the first true organisms. In addition to those two elements, they include nitrogen, oxygen, and, in a few cases, sulfur. The basic structure of an amino-acid molecule consists of a carbon atom bonded to an amino group -NH2 , a carboxyl group -COOH , a hydrogen atom, and a fourth group that differs from one amino acid to another and often is referred to as the-R group or the side chain. The-R group, which can vary widely, is responsible for the differences in chemical properties. This explanation sounds a bit technical and requires a background in chemistry that is beyond the scope of this essay, but let us simplify it somewhat. Imagine that the amino-acid molecule is like the face of a compass, with a carbon atom at the center. Raying out from the center, in the four directions of the compass, are lines representing chemical bonds to other atoms or groups of atoms. These directions are based on models that typically are used to represent amino-acid molecules, though north, south, east, and west, as used in the following illustration, are simply terms to make the molecule easier to visualize. To the south of the carbon atom C is a hydrogen atom H , which, like all the other atoms or groups, is joined to the carbon center by a chemical bond. To the north of the carbon center is what is known as an amino group -NH2. The hyphen at the beginning indicates that such a group does not usually stand alone but normally is attached to some other atom or group. To the east is a carboxyl group , represented as-COOH. In the amino group, two hydrogen atoms are bonded to each other and then to nitrogen, whereas the carboxyl group has two separate oxygen atoms strung between a carbon atom and a hydrogen atom. Hence, they are not represented as O2. Finally, off to the west is the R -group, which can vary widely. It is as though the other portions of the amino acid together formed a standard suffix in the English language , such as -tion. To the front of that suffix can be attached all sorts of terms drawn from root words, such as educate or satisfy or revolt â€”hence, education, satisfaction, and revolution. The variation in the terms attached to the front end is extremely broad, yet the tail end, -tion, is a single formation. Likewise the carbon, hydrogen, amino group, and carboxyl group in an amino acid are more or less constant. The name amino acid, in fact, comes from the amino group and the acid group, which are the most chemically reactive parts of the molecule. Each of the common amino acids has, in addition to its chemical name, a more familiar name and a three-letter abbreviation that frequently is used to identify it. In the present context, we are not concerned with these abbreviations. Amino-acid molecules, which contain an amino group and a carboxyl group, do not behave like typical molecules. They are quite soluble, or capable of being dissolved, in water but are insoluble in nonpolar solvents oil-and all oil-based products , such as benzene or ether. All of the amino acids in the human body, except glycine, are either right-hand or left-hand versions of the same molecule, meaning that in some amino acids the positions of the carboxyl group and the R -group are switched. Interestingly, nearly all of the amino acids occurring in nature are the left-hand versions of the molecules, or the L-forms. There-fore, the model we have described is actually the left-hand model, though the distinctions between "right" and "left"â€”which involve the direction in which light is polarizedâ€”are too complex to discuss here. Right-hand versions D-forms are not found in the proteins of higher organisms, but they are present in some lower forms of life, such as in the cell walls of bacteria. They also are found in some antibiotics, among them, streptomycin, actinomycin, bacitracin, and tetracycline. These antibiotics, several of which are well known to the public at large, can kill bacterial cells by interfering with the formation of proteins necessary for maintaining life and for reproducing. Amino Acids and Proteins A chemical reaction that is characteristic of amino acids involves the formation of a bond, called a peptide linkage, between the carboxyl group of one amino acid and the amino group of a second amino acid.

Very long chains of amino acids can bond together in this way to form proteins, which are the basic building blocks of all living things. The specific properties of each kind of protein are largely dependent on the kind and sequence of the amino acids in it. Other aspects of the chemical behavior of protein molecules are due to interactions between the amino and the carboxyl groups or between the various R -groups along the long chains of amino acids in the molecule. Amino acids function as monomers, or individual units, that join together to form large, chainlike molecules called polymers, which may contain as few as two or as many as 3, amino-acid units. Groups of only two amino acids are called dipeptides, whereas three amino acids bonded together are called tripeptides. If there are more than 10 in a chain, they are termed polypeptides, and if there are 50 or more, these are known as proteins. All the millions of different proteins in living things are formed by the bonding of only 20 amino acids to make up long polymer chains. Like the 26 letters of the alphabet that join together to form different words, depending on which letters are used and in which sequence, the 20 amino acids can join together in different combinations and series to form proteins. But whereas words usually have only about 10 or fewer letters, proteins typically are made from as few as 50 to as many as 3, amino acids. Because each amino acid can be used many times along the chain and because there are no restrictions on the length of the chain, the number of possible combinations for the formation of proteins is truly enormous. There are about two quadrillion different proteins that can exist if each of the 20 amino acids present in humans is used only once. Just as not all sequences of letters make sense, however, not all sequences of amino acids produce functioning proteins. Some other sequences can function and yet cause undesirable effects, as we shall see. In , American medical scientist Thaddeus R. Dryja used amino-acid sequences to identify and isolate the gene for a type of cancer known as retinoblastoma, a fact that illustrates the importance of amino acids in the body. Amino acids are also present in hormones, chemicals that are essential to life. Among these hormones is insulin, which regulates sugar levels in the blood and without which a person would die. Another is adrenaline, which controls blood pressure and gives animals a sudden jolt of energy needed in a high-stress situationâ€”running from a predator in the grasslands or to a use a human example facing a mugger in an alley or a bully on a playground. Biochemical studies of amino-acid sequences in hormones have made it possible for scientists to isolate and produce artificially these and other hormones, including the human growth hormone. Amino Acids and Nutrition Just as proteins form when amino acids bond together in long chains, they can be broken down by a reaction called hydrolysis, the reverse of the formation of the peptide bond. That is exactly what happens in the process of digestion, when special digestive enzymes in the stomach enable the breaking down of the peptide linkage. Enzymes are a type of proteinâ€”see Enzymes. The amino acids, separated once again, are released into the small intestine, from whence they pass into the bloodstream and are carried throughout the organism. Each individual cell of the organism then can use these amino acids to assemble the new and different proteins required for its specific functions. Life thus is an ongoing cycle in which proteins are broken into individual amino-acid units, and new proteins are built up from these amino acids. Out of the many thousands of possible amino acids, humans require only 20 different kinds. Two others appear in the bodies of some animal species, and approximately others can be found in plants. Considering the vast numbers of amino acids and possible combinations that exist in nature, the number of amino acids essential to life is extremely small. Yet of the 20 amino acids required by humans for making protein, only 12 can be produced within the body, whereas the other eightâ€”isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valineâ€”must be obtained from the diet. In addition, adults are capable of synthesizing arginine and histidine, but these amino acids are believed to be essential to growing children, meaning that children cannot produce them on their own. A complete protein is one that contains all of the essential amino acids in quantities sufficient for growth and repair of body tissue. Most proteins from animal sources, gelatin being the only exception, contain all the essential amino acids and are therefore considered complete proteins. On the other hand, many plant proteins do not contain all of the essential amino acids. For example, lysine is absent from corn, rice, and wheat, whereas corn also lacks tryptophan and rice lacks threonine. Soybeans are lacking in methionine. Vegans, or vegetarians who consume no animal proteins in their diets i. Amino Acids, Health, and Disease Amino acids can be used as treatments for all sorts of medical conditions. Taurine is administered to control epileptic seizures, treat high blood pressure and diabetes, and support the functioning of the liver. Numerous other amino acids are used in treating a wide array of other diseases. Sometimes the disease itself involves a problem with amino-acid production or functioning. In the essay Vitamins, there is a discussion of pellagra, a disease resulting from a deficiency of the B-group vitamin known as niacin. Pellagra results from a diet heavy in corn, which, as we have noted, lacks lysine and tryptophan. Its symptoms often are described as the "three Ds": Thanks to a greater understanding of nutrition and health, pellagra has been largely eradicated, but there still exists a condition with almost identical symptoms: Hartnup disease, a genetic disorder named for a British family in the late s who suffered from it. Hartnup disease is characterized by an inability to transport amino acids from the kidneys to the rest of the body. The symptoms at first seemed to suggest to physicians that the disease, which is present in one of about 26, live births, was pellagra. Tests showed that sufferers did not have inadequate tryptophan levels, however, as would have been the case with pellagra. On the other hand, some 14 amino acids have been found in excess within the urine of Hartnup disease sufferers, indicating that rather than properly transporting amino acids, their bodies are simply excreting them. This is a potentially very serious condition, but it can be treated with the B vitamin nicotinamide, also used to treat pellagra. Supplementation of tryptophan in the diet also has shown positive results with some patients. It is also possible for small mistakes to occur in the amino-acid sequence within the body. While these mistakes sometimes can be tolerated in nature without serious problems, at other times a single misplaced amino acid in the polymer chain can bring about an extremely serious condition of protein malfunctioning. An example of this is sickle cell anemia, a fatal disease ultimately caused by a single mistake in the amino acid sequence. In the bodies of sickle cell anemia sufferers, who are typically natives of sub-Saharan Africa or their descendants in the United States or elsewhere, glutamic acid is replaced by valine at the sixth position from the end of the protein chain in the hemoglobin molecule. Hemoglobin is an iron-containing pigment in red blood cells that is responsible for transporting oxygen to the tissues and removing carbon dioxide from them. This small difference makes sickle cell hemoglobin molecules extremely sensitive to oxygen deficiencies. As a result, when the red blood cells release their oxygen to the tissues, as all red blood cells do, they fail to re-oxygenate in a normal fashion and instead twist into the shape that gives sickle cell anemia its name. This causes obstruction of the blood vessels. Before the development of a treatment with the drug hydroxyurea in the mids, the average life expectancy of a person with sickle cell anemia was about 45 years. Amino Acids and the Distant Past The Evolution essay discusses several types of dating, a term referring to scientific efforts directed toward finding the age of a particular item or phenomenon. Methods of dating are either relative i. Whereas relative dating does not involve actual estimates of age in years, absolute dating does. One of the first types of absolute-dating techniques developed was amino-acid racimization, introduced in the s. As noted earlier, there are "left-hand" l-forms and "right-hand" d-forms of all amino acids.

2: Amino acid | Define Amino acid at www.enganchecubano.com

Typically, the compound is given the prefix "amino-" or the suffix: "-amine". The prefix " N -" shows substitution on the nitrogen atom. An organic compound with multiple amino groups is called a diamine, triamine, tetraamine and so forth.

In negative nitrogen balance, the liver may be taxed in handling excess nitrogenous waste. We will revisit this when we discuss pathologies of the nitrogen disposal pathways. AA catabolism - Separate the amino moiety, carbon skeleton: Dealing with the amine: Complicated version, step 1: Transfer amine to pyridoxal phosphate PLP Complicated version, step 2: Transfer amine to acceptor a-keto acid: In peripheral tissues, catabolism of amino acids tends to form glutamate i. The amino group on glutamate can be transferred back to another keto-acid if needed by reversing the above reactions. A specific enzyme in liver mitochondrial matrix Glutamate-aspartate aminotransferase catalyzes exchange of amine groups between glutamate and aspartate. Reaction depicted further down 3. To discard, the amino group in glutamate is transported to the liver via glutamine: Release amino group as ammonia enzyme: Incorporate the ammonia on a separate glutamate to form glutamine enzyme: Glutamine passes through cell membranes via a variety of transports mechanisms, and into the bloodstream, to be taken up by other tissues, most notably for the purposes of the current discussion the liver. In the liver, the enzyme glutaminase releases ammonia by hydrolysis of glutamine, leaving glutamate also occurs in kidney and intestine. The glutamate can go on to form aspartate, via glutamate-aspartate aminotransferase: The urea cycle only in liver makes amine moieties into urea for excretion Executive Summary: This occurs in the liver, partly in the mitochondrial matrix and partly in the cytoplasm. Key amino compounds entering the Urea Cycle: See also breakdown of purines, in a later lecture. Formation of cabamoyl phosphate. Cleavage to form Arginine Catalyzed by Argininosuccinase, a. Argininosuccinate Lyase AL , liver cytoplasm Step 5: Cleavage to release Urea Catalyzed by Arginase no abbreviation ; liver cytoplasm f. Regulation and energetics of the urea cycle i Rule of thumb: Special role for alanine in energy metabolism in muscle: Muscles frequently utilize amino acids as energy sources, They are consequently particularly active for production of glutamine. Under heavy energy demands, muscles convert to anaerobic energy production via simple glycolysis, producing excess pyruvate and lactate. The excess pyruvate and ammonia can be converted to alanine and sent to the liver. There the amino groups are converted to urea and the pyruvate is used in gluconeogenesis to form glucose, which goes back to peripherals via blood. Other organs involved in nitrogen metabolism: Kidneys can break down glutamine: Kidneys and intestines jointly produce arginine - Intestinal CPS 1 and OTC form citrulline, exported in the blood - Kidneys take up citrulline, and forms arginine using Argininosuccinate synthetase , which is again exported to the blood - This mechanism is primarily used to synthesize Arg for purposes OTHER than ureagenesis, e. Why is ammonia toxic? Glutamate level is disturbed; and since it is a neurotransmitter, its levels may be critical to proper neural function. Glutamate is recycled from post-synaptic neuron to pre-synaptic neuron as glutamine via glutamine synthetase , and that step is probably disturbed by high ammonia levels. Glutamate is also the precursor another neurotransmitter, gamma aminobutyric acid GABA , which thus may be affected by hyperammonemia. Alterations in glutamate levels may influence energetics. Generalized features of urea cycle defects: Loss of an enzyme causes substrate to build up The pathway backs up all the way to ammonia, which is toxic b. Complete absence of any of these enzymes causes neonatal death c. If untreated, progresses to spasticity, mental retardation, coma, death. All of the deficiencies may present with hyperammonemia b. Determine which enzyme by substrate concentrations: Dialysis to reduce the blood ammonia levels b. Intravenous sodium benzoate and phenylacetate to provide for nitrogen disposal both compounds bind amino acids and are then excreted. Supplementation of arginine d. Minimize gut production of ammonia - lactulose or antibiotics e. Low protein diet long-term solution C. Amino acid carbon backbone - degraded for metabolic fuel 1. Glucogenic versus ketogenic amino acids 2. Sometimes mere transamination can produce easily-degraded compounds: Degradation of Phenylalanine and Tyrosine: Precursors for other important biomolecules - bioactive amines Tyrosine:

3: General Reactions of Amino Acids | Biochemistry

Amino acids are organic compounds containing amine (-NH 2) and carboxyl (-COOH) functional groups, along with a side chain (R group) specific to each amino acid. The key elements of an amino acid are carbon (C), hydrogen (H), oxygen (O), and nitrogen (N), although other elements are found in the side chains of certain amino acids.

Nitrogen Cycle The nitrogen cycle is dominated by the N2 gas in the atmosphere. Nitrous oxide, N2O is the second common form. N20 the gas commonly known as laughing gas is a greenhouse gas. Seventy-nine percent of the atmosphere is nitrogen in the form of N2 gas. Because N2 has low reactivity, it offsets the high reactivity of oxygen, O2, the other major constituents of the atmosphere. For example when we light a match, the nitrogen does not burn with the oxygen. It does not react with any other element or common compound under ordinary conditions. This property of nitrogen has been called the "fire insurance" of our atmosphere. If the nitrogen was not "diluting" the flammability of 02, every spark from a match could lead to a large fire! Due to its different valences 3,4,5, , nitrogen can form a multiplicity of compounds into the same element. As a group, these oxides are except for N2O5 denoted by NOx. NOx compounds form an important category of air pollutants, for example, as a result of the nitrogen and oxygen combining in the extremely hot environment of an automobile engine. Nitrogen oxides and hydrocarbons, in the presence of sunlight, give rise to the photochemical smog and tropospheric ozone problems, described in the Atmospheric System. Natural and anthropogenic nitrogen oxides also contribute to acid rain. Nitrogen - Essential for Life Nitrogen is an essential element for life. Amino acids, which are the building blocks of proteins, contain nitrogen as NH2, the "amino" part of the molecule. Nitric oxide is a neurotransmitter. Thus all living organisms require large amounts of nitrogen. However, in the form of N2, nitrogen is unusable by all organisms except for a few primitive bacteria that are capable of converting N2 gas to ammonia NH3. This process of conversion is called nitrogen fixation, and makes the nitrogen available for use by organisms. In the atmosphere, nitrogen is fixed i. N2 is converted to NH3 in three ways: Certain bacteria are diazotrophs or more simply, nitrogen-fixers. These bacteria possess an enzyme which converts N2 gas into NH3 or "fixes" the nitrogen. Nitrogen-fixing bacteria on soybean roots Diazotrophs may be symbiotic, living as nodules in roots of plants such as legumes. A type of bacterial called cyanobacteria live on lichens, mosses, and ferns. Some cyanobacteria are free-living and capable of photosynthesis. Thus nitrogen fixation is an important process for biological functioning. Legumes such as peas, clover, and beans have nitrogen-fixing bacteria in their roots. This enables them to grow in nitrogen-poor soil. Plants take up nitrates through their roots, and convert them into proteins and other compounds. Animals get their nitrogen from plants. Wastes and remains of animals and plants contain organic nitrogen compounds which are then broken down by bacteria and converted into compounds such as ammonia NH3. Other bacteria denitrifying bacteria , found especially in waterlogged soils, convert nitrates back into nitrogen gas and make it unavailable again. Plants can not use N2, and the N2 can therefore escape into the atmosphere. Farmers normally try to prevent the soil from becoming waterlogged. This is the problem with over-watering houseplants as well. Lightning is an electrical discharge through the air, and can cause N2 and O2 molecules to change into the atomic form, combine with water to form weak nitric acid HNO3 , and precipitate atmospheric nitrogen to the earth, adding nitrogen to the soil in a usable form nitrate, NO3. Inside plants and other organisms, the nitrates are converted into amino-acids and other vital compounds. Modern agriculture uses artificial fertilizers such as ammonium nitrate NH4NO3 to capture nitrogen. For example, if you examine the box of "plant food" that is a fertilizer designed for "acid-loving" plants such as azaleas or rhododendrons, you see the numbers , where the 30 stands for N, the first 10 for phosphorus, and the second 10 for potassium. While this improves yield, it upsets the natural balance of nitrogen in the ecosystem. Too much of nitrogen added to the soil through fertilizers washes out into ponds and rivers and causes overgrowth of algae in large patches. These algae blooms prevent light from entering the water and smother other aquatic life. The Nitrogen Cycle is shown in Figure N1. Combustion and lightning fix nitrogen in the atmosphere. When plant matter biomass is burned, the organic fixed nitrogen is converted into nitrogen oxides and released. The clearing of forests by fire and burning of leftover debris from farmland creates large emissions of nitrogen oxide. The oceans and sediments also contain large amounts of nitrogen as nitrates. Ammonia NH3 is another form of fixed nitrogen. Ammonia is produced by bacteria after they consume organic matter. Before chlorofluorocarbons were invented, ammonia was the most common refrigerant. While the figure shows the main global routes of cycling nitrogen, in some locations for example the Los Angeles basin, Mexico City, and in other industrial cities , nitrogen oxides NOx and nitric acid HNO3 form a significant fraction of the local tropospheric environment. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

4: Nitrogen metabolism

The disorders cause severe medical complications due to the buildup of toxic amino acids, and or by products of amino acid metabolism in the blood. inherited errors of metabolism illustration Describe the causes of aminoacidopathies.

By Editors Nitrogen Cycle Definition The nitrogen cycle refers to the cycle of nitrogen atoms through the living and non-living systems of Earth. Because nitrogen is a necessary ingredient for life as we know it, the nitrogen cycle is vital to sustaining life on Earth. Nitrogen was originally formed in the hearts of stars through the process of nuclear fusion. When ancient stars exploded, they flung nitrogen-containing gases across the Universe. When the Earth was formed, nitrogen gas was a main ingredient in its atmosphere. This is an ideal balance because too much oxygen can actually be toxic to cells, as well as being highly flammable. Nitrogen, on the other hand, is inert and harmless in its gaseous form. Here we will discuss how nitrogen plays a vital role in the chemistry of life â€” and how it gets from the atmosphere, into living things, and back again. Function of Nitrogen Cycle Nitrogen is an essential ingredient for life as we know it. Its unique chemical bonding properties allow it to create structures such as DNA and RNA nucleotides, and the amino acids from which proteins are built. Without nitrogen, these molecules would not be able to exist. These nitrogen fixers are such a vital part of the ecosystem that agriculture cannot occur without them. Ancient peoples learned that if they did not alternate growing nitrogen-consuming crops with nitrogen-fixing crops, their farms would become fallow and unable to support growth. Today, most artificial fertilizers contain life-giving nitrogen compounds as their main ingredient to make soil more fertile. Nitrogen Cycle Steps The basic steps of the nitrogen cycle are illustrated here: Nitrogen Cycle Steps Nitrogen Fixation In nitrogen fixation, bacteria turn nitrogen gas from the atmosphere into ammonia. As a result, organisms that use it have had to develop oxygen-free compartments in which to perform their nitrogen fixation! Common examples of such nitrogen-free compartment sare the Rhizobium nodules found in the roots of nitrogen-fixing legume plants. The hard casing of these nodules keeps oxygen out of the pockets where Rhizobium bacteria do their valuable work of converting nitrogen gas into ammonia. You can see the oxygen-free Rhizobium nodules, visible as big round lumps, on the roots of this cowpea plant: Nitrification In nitrification, a host of soil bacteria participate in turning ammonia into nitrate â€” the form of nitrogen that can be used by plants and animals. This requires two steps, performed by two different types of bacteria. First, a soil bacteria such as Nitrosomonas or Nitrococcus convert ammonia into nitrogen dioxide. Then another type of soil bacterium, called Nitrobacter, adds a third oxygen atom to create nitrate. By metabolizing nitrogen along with oxygen, they obtain energy to power their own life processes. The process can be thought of as a rough and much less efficient analog to the cellular respiration performed by animals, which extract energy from carbon-hydrogen bonds and use oxygen as the electron acceptor, yielding carbon dioxide at the end of the process. Nitrates â€” the end product of this vital string of bacterial reactions â€” can be made artificially, and are the main ingredient in many soil fertilizers. Assimilation In assimilation, plants finally consume the nitrates made by soil bacteria and use them to make nucleotides, amino acids, and other vital chemicals for life. Plants take up nitrates through their roots and use them to make amino acids and nucleic acids from scratch. Animals that eat the plants are then able to use these amino acids and nucleic acids in their own cells. Ammonification Now we have moved nitrogen from the atmosphere into the cells of plants and animals. In a robust ecosystem like ours, anywhere that energy has been put into creating an organic chemical, there is another form of life that is waiting to extract that energy by breaking those chemical bonds. In the process, these decomposers break down amino acids and nucleic acids into nitrates and ammonia, and release those compounds back into the soil. There, the ammonia may be taken up again by plants and nitrifying bacteria. Orâ€¦ Denitrification In the final step of the nitrogen cycle, anaerobic bacteria can turn nitrates back into nitrogen gas. This process, like the process of turning nitrogen gas into ammonia, must happen in the absence of oxygen. As such it often occurs deep in the soil, or in wet environments where mud and muck keep oxygen at bay. In some ecosystems, this denitrification is a valuable process to prevent nitrogen compounds in the soil from building up to dangerous levels. Like anything else, nitrogen compounds can be toxic in high concentrations. Just like too much oxygen is toxic to air-breathers, plants can suffer harmful effects from nitrogen overdose. Nitrates can also be directly toxic to humans â€" when consumed in large quantities in food or water, nitrates can increase cancer risks and interfere with blood chemistry, leaving blood unable to properly carry oxygen. Another acute worry is the danger of throwing ecosystems out of balance. One concern that has been raised about the use of artificial nitrate fertilizer is that when it gets into rivers, lakes, and even the ocean, it can cause runaway growth of plant life there. More plant life might sound like a good thing â€" but not when aquatic plants include algaes that can block sun and oxygen from getting to other aquatic organisms, and even produce toxins that make humans and other animals sick! The question of how to keep farmlands fertile and feed the hungry without using nitrate fertilizers is still being investigated by scientists. It is hoped that some day, sustainable practices using natural or genetically engineered nitrogen-fixing plants may allow farmers to produce high crop yields without adding high concentrations of artificial nitrates to the soil. Examples of the Nitrogen Cycle The Story of Thanksgiving The story of the first Thanksgiving goes that the pilgrims feasted with the Indians to celebrate their first harvest in the New World. But why was this harvest a big enough deal to throw a feast over. And why, exactly, was it important that the Indians and the European settlers ate together? When the European settlers came to the Americas, they had very little idea of how to survive here. Having worked farms in back in England for generations, the pilgrims assumed that farming here would be very much the same. That turned out not to be the case. The pilgrims had a difficult time growing or finding enough food to last them through the winter. One of the reasons for that was that there was not much nitrogen in the soil where the pilgrims landed. After trying in frustration to grow crops in the American soil, the Europeans were shown how to solve their problems by the American Indians. As a result, their crops flourished â€" and the first European settlers learned from the American Indians how to survive in the New World. The Three Sisters Some tribes of Native Americans traditionally grow three crops together â€" corn, beans, and squash. For one, eating these three plants in combination provides humans with proteins containing all the essential amino acids â€" just like eating meat would do. For another, it includes a nitrogen-fixing plant â€" beans. Just like burying fish in the fields, growing beans alongside corn and squash assures that the soil does not become too depleted to grow new plants. Even a single crop of corn or squash may grow better alongside nitrogen-fixing beans, as their Rhizobium bacteria nurtures the surrounding soil! Artificial Fertilizer Humans first began fertilizing their crops using natural nitrogen-containing substances such, such as dead fish and animal manure. These waste products of animal life contained proteins, amino acids, and nucleotides which soil bacteria and plants could use to grow. Today, humans have discovered industrial processes which can turn ammonia into nitrates just like those produced by soil bacteria. Plants can use these nitrates directly, and human industry can produce them in large quantities. Unfortunately, human-made changes to the environment can have un-intended consequences. This can be especially problematic when artificial fertilizers are carried by rainwater from farmlands and lawns into rivers and lakes, where the result can be the growth of toxic algaes that can strangle wetlands and even get into human drinking water. Which of the following is NOT a reason why plants and animals need nitrogen? Amino acids are needed for the construction of proteins. Plants and animals store energy primarily in the form of nitrogen bonds. Answer to Question 1 D is correct. Plants and animals primarily store energy in bonds between carbon and other atoms â€" not in nitrogen bonds. Energy-storage molecules like sugars and fats actually contain no nitrogen at all! However, some bacteria do obtain their energy from bonds between nitrogen and other atoms. How do scientists think was life on Earth able to begin without the enzyme nitrogenase to convert nitrogen gas into ammonia? Nitrogenase was one of the first enzymes to be created through natural processes. Amino acids and nucleotide bases can be naturally created in small quantities by high-energy phenomenon like lightning strikes. None of the above. Answer to Question 2 C is correct. The earliest life is thought to have begun with RNA or amino acids, which are nitrogen-containing compounds. But the Miller-Urey experiment and other experiments have proved that these compounds could have been created in small amounts under the atmospheric conditions of early Earth. Life likely did not begin to proliferate until it evolved the necessary machinery to create these organic compounds from scratch instead of relying on these natural processes. What would happen if nitrogen compounds were not broken down by decomposers and denitrifiers at the end of the nitrogen cycle? Atmospheric nitrogen levels could drop. There might be less atmospheric nitrogen available for nitrogen-fixers, slowing down the process of nitrogen fixation. There might be fewer nitrates in the soil for plants to use, because nitrogen might remain tied up in amino acids within animal cells. All of the above. Answer to Question 3 D is correct. All of the above are possible consequences if nitrogen remained bound in the form of amino acids and nucleotides after being fixed there by plants and animals. References The Nitrogen Cycle. Retrieved May 11, , from http: The Global Nitrogen Cycle. Treatise on Geochemistry,

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5: Chemistry of amino acids and protein structure (article) | Khan Academy

Key amino compounds entering the Urea Cycle: Aspartate (typically from transamination of oxaloacetate; see IIA2 and IIA3d, above) Ammonia, which may come from many sources, especially hydrolysis of glutamine (see IIA3a, above) and oxidative deamination of glutamate (see IIA3d, above).

W H Freeman ; Search term Section Any not needed as building blocks are degraded to specific compounds. The major site of amino acid degradation in mammals is the liver. The amino group must be removed, inasmuch as there are no nitrogenous compounds in energy-transduction pathways. This reaction is catalyzed by glutamate dehydrogenase. The reaction proceeds by dehydrogenation of the C -N bond, followed by hydrolysis of the resulting Schiff base. The equilibrium for this reaction favors glutamate; the reaction is driven by the consumption of ammonia. Glutamate dehydrogenase is located in mitochondria, as are some of the other enzymes required for the production of urea. This compartmentalization sequesters free ammonia, which is toxic. In vertebrates, the activity of glutamate dehydrogenase is allosterically regulated. The enzyme consists of six identical subunits. Guanosine triphosphate and adenosine triphosphate are allosteric inhibitors, whereas guanosine diphosphate and adenosine diphosphate are allosteric activators. Hence, a lowering of the energy charge accelerates the oxidation of amino acids. Pyridoxal phosphate includes a pyridine ring that is slightly basic as well as a phenolic hydroxyl group that is slightly acidic. Thus, pyridoxal phosphate derivatives can form stable tautomeric forms in which the pyridine nitrogen atom is protonated and, hence, positively charged while the hydroxyl group is deprotonated, forming a phenolate. The most important functional group on PLP is the aldehyde. This group allows PLP to form covalent Schiff-base intermediates with amino acid substrates. A new Schiff-base linkage is formed on addition of an amino acid substrate. These Schiff-base linkages are often protonated, with the positive charge stabilized by interaction with the negatively charged phenolate group of PLP. In other words, an internal aldimine becomes an external aldimine. The amino acid- PLP Schiff base that is formed remains tightly bound to the enzyme by multiple noncovalent interactions. The external aldimine loses a proton to form a quinonoid intermediate. Reprotonation of this intermediate at the aldehyde carbon atom yields a ketimine. The negative charge that is left on the amino acid is stabilized by delocalization into the pyridinium ring. These steps constitute half of the transamination reaction. The second half takes place by the reverse of the preceding pathway. The sum of these partial reactions is Aspartate Aminotransferase Is a Member of a Large and Versatile Family of Pyridoxal-Dependent Enzymes The mitochondrial enzyme aspartate aminotransferase provides an especially well studied example of PLP as a coenzyme for transamination reactions Figure The results of X-ray crystallographic studies provided detailed views of how PLP and substrates are bound and confirmed much of the proposed catalytic mechanism. Each of the identical kd subunits of this dimer consists of a large domain and a small one. PLP is bound to the large domain, in a pocket near the subunit interface. In the absence of substrate, the aldehyde group of PLP is in a Schiff-base linkage with lysine , as anticipated. The transamination reaction see Figure The lysine amino group that was initially in Schiff-base linkage with PLP appears to serve this role. The active site of this prototypical PLP-dependent enzyme includes pyridoxal phosphate attached to the enzyme by a Schiff-base linkage with lysine An arginine residue in the active site helps orient substrates by binding more Transamination is just one of a wide range of amino acid transformations that are catalyzed by PLP enzymes. Three common features of PLP catalysis underlie these diverse reactions. For example, bond a is labilized by aminotransferases, bond b by decarboxylases, and bond c by aldolases such more A Schiff base is formed by the amino acid substrate the amine component and PLP the carbonyl component. The protonated form of PLP acts as an electron sink to stabilize catalytic intermediates that are negatively charged. Electrons from these intermediates can be transferred into the pyridine ring to neutralize the positive charge on the pyridinium nitrogen. In other words, PLP is an electrophilic catalyst. The product Schiff base is cleaved at the completion of the reaction. Many of the enzymes that catalyze these reactions, such as serine hy- droxymethyltransferase, which converts serine into glycine, have the same fold as that of aspartate aminotransferase and are clearly related by divergent evolution. Others, such as tryptophan synthetase, have quite different overall structures.

Nonetheless, the active sites of these enzymes are remarkably similar to that of aspartate aminotransferase, revealing the effects of convergent evolution. This means of choosing one of several possible catalytic outcomes is called stereoelectronic control.

AMINO ACIDS AND NITROGEN COMPOUNDS pdf

6: The First Step in Amino Acid Degradation Is the Removal of Nitrogen - Biochemistry - NCBI Bookshelf

In this article we will discuss about the metabolism of sulphur-containing amino acids. There are 3 sulphur-containing amino acids, methionine, cysteine and cystine, but since the last two are very easily interconvertible by oxidation-reduction, they may be ta.

In this article we will discuss about the two main types of general reactions in amino acids, i. The fact that the reactions catalyzed are very different, while the coenzyme is identical, shows the decisive influence of the apoenzyme the protein part on the evolution of the reaction. During the formation of the intermediate Schiff base, the a-carbon and nitrogen of the amino acid are placed in the plane of the coenzyme. It must be noted that pyridoxal phosphate cannot be synthesized in our organism, which explains the vitamin B6 activity shown by pyridoxal, pyridoxine the corresponding primary alcohol and pyridoxamine the corresponding primary amine which is formed intermediately during the transamination process. We have already studied the mechanism of this reaction fig. Some of these, amines have an important physiological or pharmacological role and are therefore sometimes called biogenic amines. The table below indicates â€" for some amino acids â€" the corresponding amine and its localization or role. Decarboxylations are catalyzed by decarboxylases, pyridoxal phosphate-containing enzymes, present in microorganisms and animal tissues. Bacterial decarboxylases have an extremely narrow specificity, with the result that a purified decarboxylase can permit the quantitative titration â€" by measuring the CO2 liberated â€" of the corresponding amino acid in a complex mixture. It releases glycine and acetaldehyde which is transferred to the coenzyme thiamine-pyrophosphate see oxidative decarboxylation of pyruvic acid. The reactive mechanism is illustrated at the bottom of figure ; in fact, there are two steps, of which one is the reverse of the other; they can be summarized as follows: As we will note in the following, transamination is a very important reaction, for the formation of amino acids as well as the transformations they undergo. Transaminases are universally distributed: There is a large number of transaminases specific of various amino acids, but two of them are particularly abundant in animal tissues and were studied in detail; they catalyze the following 2 reactions: This process cannot therefore apply to proline whose nitrogen group is a secondary amine. On the contrary, transamination can take place on a primary amino group situated at the end of a side chain of amino acid. These reactions are found in alcohol and sulphur-containing amino acids. We will illustrate these reactions by two simple examples: Similar mechanisms and enzymes exist for threonine dehydration and methionine removal of CH3â€"SH group as well as for homoserine and homocysteine. We will find them especially in connection with reactions called transulphuration reactions see metabolism of sulphur-containing amino acids. It is noted that in these examples the actual enzymatic reaction is an elimination of water or of a sulphur-containing compound, deamination being a non-enzymatic consequence of this elimination. As shown by figure , this essentially irreversible process takes place in two steps. Deamination is therefore a non-enzymatic consequence of the enzymatic process of dehydrogenation. As regards the flavin coenzyme, it is reoxidized, generally by molecular oxygen; this leads to the formation of hydrogen peroxide which can then be decomposed by a catalase; but other electron acceptors can also permit the reoxidation of FADH2. Amino acid oxidases are stereospecific enzymes: One has also characterized a D-amino acid oxidase liver and kidney very abundant and very active on most D-amino acids and on glycine; this abundance is paradoxical at first sight considering the absence of corresponding substrates D-amino acids in higher animals. Glutamic acid is deaminated by a particular enzyme, L-glutamate- dehydrogenase, an enzyme which contains NAD or NADP depending on the organisms, and catalyzes the reaction represented in figure It concerns only a small number of amino acids. We will cite the deamination of L-aspartic acid into fumaric acid fig. This reaction is catalyzed by aspartate-ammonium lyase, an enzyme present in microorganisms and plants. In the same manner are deaminated histidine in animals and phenylalanine in plants.

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7: Nitrogen Cycle - Definition, Steps, Examples and Quiz | Biology Dictionary

An amino acid is an organic molecule that is made up of a basic amino group (âˆ'NH 2), an acidic carboxyl group (âˆ'COOH), and an organic R group (or side chain) that is unique to each amino acid.

The two key components of this complex are dinitrogenase reductase and dinitrogenase. Dinitrogenase reductase M r 60, is a dimer of two identical subunits shown at right. It contains a single Fe 4 -S 4 redox center see Fig. It also has two binding sites for ATP. Dinitrogenase is a tetramer with two copies of two different subunits combined Mr , Dinitrogenase contains both iron and molybdenum, and its redox centers have a total of 2 Mo, 32 Fe, and 30 S per tetramer. About half of the Fe and S is present as four Fe 4 -S 4 centers. The remainder is present as part of a novel iron-molybdenum cofactor of unknown structure. A form of nitrogenase that contains vanadium rather than molybdenum has been detected, and both types of nitrogenase systems can be produced by some bacterial species. The vanadium enzyme may be the primary nitrogen fixation system under some environmental conditions, but it has not been well characterized. Figure Nitrogen fixation by the nitrogenase complex. Electrons are transferred from pyruvate to dinitrogenase via ferredoxin or flavodoxin and dinitrogenase reductase. Dinitrogenase is reduced one electron at a time by dinitrogenase reductase, and must be reduced by at least six electrons to fix one molecule of Nz. The subunit structures and metal cofactors of the dinitrogenase reductase and dinitrogenase proteins are described in the text. Nitrogen fixation is carried out by a highly reduced form of dinitrogenase, and it requires eight electrons: Dinitrogenase is reduced by the transfer of electrons from dinitrogenase reductase Fig. Dinitrogenase has two binding sites for the reductase, and the required eight electrons are transferred to dinitrogenase one at a time, with the reduced reductase binding and the oxidized reductase dissociating from dinitrogenase in a cycle. This cycle requires the hydrolysis of ATP by the reductase. The immediate source of electrons to reduce dinitrogenase reductase varies, with reduced ferredoxin p. In at least one instance, the ultimate source of electrons is pyruvate Fig. Ribbon diagram of the structure of dinitrogenase reductase. The two subunits are shown in gray and light blue. A bound ADP is shown in dark blue. Iron and sulfur atoms in the Fe 4 4 complex are shown in red and yellow, respectively. The role of ATP in this process is interesting in that it appears to be catalytic rather than thermodynamic. Remember that ATP can contribute not only chemical energy, through the hydrolysis of one or more of its phosphodiester bonds, but also binding energy pp. In the reaction carried out by dinitrogenase reductase, both ATP binding and ATP hydrolysis bring about protein conformational changes that evidently help overcome the high activation energy of nitrogen fixation. Two ATP molecules are then hydrolyzed during the actual transfer of each electron from dinitrogenase reductase to dinitrogenase. Another important characteristic of the nitrogenase complex is an extreme lability when oxygen is present. The reductase is inactivated in air, with a half life of 30 s. The dinitrogenase has a half life of 10 min in air. Free-living bacteria that fix nitrogen avoid or solve this problem in a variety of ways. Some exist only anaerobically or repress nitrogenase synthesis when oxygen is present. Some aerobic bacteria, such as Azotobacter Uinelandii, partially uncouple electron transport from ATP synthesis so that oxygen is burned off as rapidly as it enters the cell Chapter When fixing nitrogen, cultures of these bacteria actually warm up as a result of their efforts to remove oxygen. The nitrogen-fixing cyanobacteria use still another approach. One of every nine cells differentiates into a heterocyst, a cell specialized for nitrogen fixation, with thick walls to prevent oxygen from entering. The symbiotic relationship between leguminous plants and the nitrogen-fixing bacteria in their root nodules Fig. The energy required for nitrogen fixation was probably the evolutionary driving force for this association of plants with bacteria. The bacteria in root nodules have access to a large reservoir of energy in the form of the abundant carbohydrate made available by the plant. Because of this energy source, the bacteria in root nodules may fix hundreds of times more nitrogen than their free-living cousins under conditions generally encountered in soils. To solve the oxygen-toxicity problem, the bacteria in root nodules are bathed in a solution of an oxygen-binding protein called leghemoglobin. This protein is produced by the plant although the heme may be contributed by the bacteria. The efficiency of the symbiosis between plants and bacteria is evident in the enrichment of soil nitrogen brought about by leguminous plants.

This enrichment is the basis of the crop rotation methods used by many farmers, in which plantings of nonleguminous plants such as corn that extract fixed nitrogen from the soil are alternated every few years with planting of legumes such as alfalfa, peas, or clover. Symbiotic nitrogen-fixing bacteria bacteroids, shown in red live inside the nodule cells, surrounded by the peribacteroid membrane blue. Bacteroids produce the enzyme nitrogenase, which converts atmospheric nitrogen N 2.

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8: Amino Acid | www.enganchecubano.com

It is found in amino acids that make up proteins, in nucleic acids, that comprise the hereditary material and life's blueprint for all cells, and in many other organic and inorganic compounds. In addition, nitrogen comprises about 80% of the Earth's atmosphere.

Contributors There is a tremendous variety of organic compounds which can be derived from carbon, hydrogen, and oxygen which is evident from the numerous previous sections discussing these compounds. If we include nitrogen as a possible constituent of these molecular structures, many more possibilities arise. Most of the nitrogen-containing compounds are less important commercially, however, and we will only discuss a few of them here. Amines may be derived from ammonia by replacing one, two, or all three hydrogens with alkyl groups. Some examples are The terms primary one , secondary two , and tertiary three refer to the number of hydrogens that have been replaced. Both primary and secondary amines are capable of hydrogen bonding with themselves, but tertiary amines have no hydrogens on the electronegative nitrogen atom. The three methylamines listed above can all be isolated from herring brine. Amines, as well as ammonia, are produced by decomposition of nitrogen-containing compounds when a living organism dies. The methylamines are obtained commercially by condensation of methanol with ammonia over an aluminum oxide catalyst: Dimethylamine is the most important, being used in the preparation of herbicides, in rubber vulcanization, and to synthesize dimethylformamide, an important solvent. Amides are another important nitrogen containing organic compound. The key feature of an amine is a nitrogen atom bonded to a carbonyl carbon atom. Like esters , amides are formed in a condensation reaction. While esters are formed from the condensation reaction of an alcohol and a carboxylic acid, amides are formed from the condensation of an amine and a carboxylic acid: This general reaction is usually unfavorable, because the hydroxyl group acts as a bad leaving group. Organic chemists have devised methods to work around this by using certain chemicals to activate the carboxylic acid and allow for the addition of the amine. As amides are formed by condensation reactions, many important condensation polymers involve amide linkages. Nylon, for instance, is formed from the amide condensation of hexamethylenediamine and adipic acid. A second set of condensation polymers formed from amide linkages are the proteins and peptides found in your body and in all organisms. These polymers are formed from another organic nitrogen compound, the amino acid. These molecules contain both an amine group and a carboxyl group. Examples of such amino acids are glycine and lysine: Amino acids are the constituents from which proteins are made. Some, like glycine, can be synthesized in the human body, but others cannot. Lysine is an example of an essential amino acidâ€”one which must be present in the human diet because it cannot be synthesized within the body. As mentioned, the condensation of amino acids into peptides forms amide linkages. For this reason, scientists sometimes refer to the amide backbone of a protein or peptide. A protein has a long series of amide bonds, as can be seen in the following figure showing the synthesis of a tri-peptide from three amino acids: Amino acids and proteins further discussed in the sections on enzymes and in a set of sections devoted to proteins and their chemistry in living systems. The intermolecular forces and boiling points of nitrogen-containing organic compounds may be explained according to the same principles used for oxygen-containing substances. Boiling Points Rationalize the following boiling points: Solution All four molecules have very similar geometries and the same number of electrons 26 valence electrons plus 8 core electrons , and so their London forces should be about the same. Compound a is an alkane and is nonpolar. By contrast compound b is an ether and should be slightly polar. This slight polarity results in a slightly higher boiling point. Compound c is isomeric with compound b but is an alcohol. There is hydrogen bonding between molecules of c , and its boiling point is much higher. Molecule d has both an amino group and a hydroxyl group, each of which can participate in hydrogen bonding. Consequently it has the highest boiling point of all.

9: Chapter 21 : Biosynthesis of Amino Acids, Nucleotides, and Related Molecules

Isoelectric point is the point along the pH scale where the amino acid has a net zero charge. Consider glycine. Look at the equilibrium below; as we add hydroxide ionsâ€”in other words, raise the pHâ€”different charged forms of glycine exist.

The amino acids differ from each other in the particular chemical structure of the R group. Building blocks of proteins Proteins are of primary importance to the continuing functioning of life on Earth. Proteins catalyze the vast majority of chemical reactions that occur in the cell. They provide many of the structural elements of a cell, and they help to bind cells together into tissues. Some proteins act as contractile elements to make movement possible. Proteins, in the form of antibodies , protect animals from disease and, in the form of interferon , mount an intracellular attack against viruses that have eluded destruction by the antibodies and other immune system defenses. Many hormones are proteins. This plethora of vital tasks is reflected in the incredible spectrum of known proteins that vary markedly in their overall size, shape, and charge. By the end of the 19th century, scientists appreciated that, although there exist many different kinds of proteins in nature, all proteins upon their hydrolysis yield a class of simpler compounds , the building blocks of proteins, called amino acids. It was one of the first amino acids to be identified, having been isolated from the protein gelatin in In the mids scientists involved in elucidating the relationship between proteins and genes agreed that 20 amino acids called standard or common amino acids were to be considered the essential building blocks of all proteins. The last of these to be discovered, threonine , had been identified in Chirality All the amino acids but glycine are chiral molecules. That is, they exist in two optically active asymmetric forms called enantiomers that are the mirror images of each other. This property is conceptually similar to the spatial relationship of the left hand to the right hand. One enantiomer is designated d and the other l. It is important to note that the amino acids found in proteins almost always possess only the l-configuration. This reflects the fact that the enzymes responsible for protein synthesis have evolved to utilize only the l-enantiomers. Reflecting this near universality, the prefix l is usually omitted. Some d-amino acids are found in microorganisms, particularly in the cell walls of bacteria and in several of the antibiotics. However, these are not synthesized in the ribosome. Compounds such as amino acids that can act as either an acid or a base are called amphoteric. The pKa of a group is the pH value at which the concentration of the protonated group equals that of the unprotonated group. Thus, at physiological pH about 7â€”7. Any free amino acid and likewise any protein will, at some specific pH, exist in the form of a zwitterion. That is, all amino acids and all proteins, when subjected to changes in pH, pass through a state at which there is an equal number of positive and negative charges on the molecule. The pH at which this occurs is known as the isoelectric point or isoelectric pH and is denoted as pI. When dissolved in water , all amino acids and all proteins are present predominantly in their isoelectric form. Stated another way, there is a pH the isoelectric point at which the molecule has a net zero charge equal number of positive and negative charges , but there is no pH at which the molecule has an absolute zero charge complete absence of positive and negative charges. That is, amino acids and proteins are always in the form of ions; they always carry charged groups. This fact is vitally important in considering further the biochemistry of amino acids and proteins. Standard amino acids One of the most useful manners by which to classify the standard or common amino acids is based on the polarity that is, the distribution of electric charge of the R group e. Nonpolar amino acids Group I amino acids are glycine , alanine , valine , leucine , isoleucine , proline , phenylalanine , methionine , and tryptophan. The R groups of these amino acids have either aliphatic or aromatic groups. In aqueous solutions, globular proteins will fold into a three-dimensional shape to bury these hydrophobic side chains in the protein interior. The chemical structures of Group I amino acids are: Isoleucine is an isomer of leucine, and it contains two chiral carbon atoms. Instead, its side chain forms a cyclic structure as the nitrogen atom of proline is linked to two carbon atoms. Phenylalanine, as the name implies, consists of a phenyl group attached to alanine. Methionine is one of the two amino acids that possess a sulfur atom. Methionine plays a central role in protein biosynthesis translation as it is almost always the initiating amino acid. Methionine also provides methyl groups for metabolism. Tryptophan contains an indole ring attached to the alanyl side chain. Polar, uncharged amino acids Group II amino acids are serine , cysteine , threonine , tyrosine , asparagine , and glutamine. The side chains in this group possess a spectrum of functional groups. However, most have at least one atom nitrogen , oxygen , or sulfur with electron pairs available for hydrogen bonding to water and other molecules. The chemical structures of Group II amino acids are: Tyrosine possesses a hydroxyl group in the aromatic ring, making it a phenol derivative. The hydroxyl groups in these three amino acids are subject to an important type of posttranslational modification: Like methionine, cysteine contains a sulfur atom. Asparagine, first isolated from asparagus , and glutamine both contain amide R groups. The carbonyl group can function as a hydrogen bond acceptor, and the amino group NH2 can function as a hydrogen bond donor. Acidic amino acids The two amino acids in this group are aspartic acid and glutamic acid. Each has a carboxylic acid on its side chain that gives it acidic proton -donating properties. In the ionic forms, the amino acids are called aspartate and glutamate. Free glutamate and glutamine play a central role in amino acid metabolism. Glutamate is the most abundant excitatory neurotransmitter in the central nervous system. Basic amino acids The three amino acids in this group are arginine , histidine , and lysine. Each side chain is basic i. As mentioned above for aspartate and glutamate, the side chains of arginine and lysine also form ionic bonds. The chemical structures of Group IV amino acids are The imidazole side chain of histidine allows it to function in both acid and base catalysis near physiological pH values. None of the other standard amino acids possesses this important chemical property. Therefore, histidine is an amino acid that most often makes up the active sites of protein enzymes. As a result, they are often found clustered on the surface of globular proteins in aqueous solutions. Amino acid reactions Amino acids via their various chemical functionalities carboxyls, amino, and R groups can undergo numerous chemical reactions. However, two reactions peptide bond and cysteine oxidation are of particular importance because of their effect on protein structure. At the turn of the 20th century, German chemist Emil Fischer first proposed this linking together of amino acids. Note that when individual amino acids are combined to form proteins, their carboxyl and amino groups are no longer able to act as acids or bases , since they have reacted to form the peptide bond. Therefore, the acid-base properties of proteins are dependent upon the overall ionization characteristics of the individual R groups of the component amino acids. Amino acids joined by a series of peptide bonds are said to constitute a peptide. After they are incorporated into a peptide, the individual amino acids are referred to as amino acid residues. Small polymers of amino acids fewer than 50 are called oligopeptides, while larger ones more than 50 are referred to as polypeptides. Hence, a protein molecule is a polypeptide chain composed of many amino acid residues, with each residue joined to the next by a peptide bond. The lengths for different proteins range from a few dozen to thousands of amino acids, and each protein contains different relative proportions of the 20 standard amino acids. Condensation reaction in which three molecules of the amino acid glycine produce a tripeptide chain, with the elimination of two molecules of water H2O. Cysteine oxidation The thiol sulfur-containing group of cysteine is highly reactive. The most common reaction of this group is a reversible oxidation that forms a disulfide. Oxidation of two molecules of cysteine forms cystine , a molecule that contains a disulfide bond. When two cysteine residues in a protein form such a bond, it is referred to as a disulfide bridge. Disulfide bridges are a common mechanism used in nature to stabilize many proteins. Such disulfide bridges are often found among extracellular proteins that are secreted from cells. In eukaryotic organisms, formation of disulfide bridges occurs within the organelle called the endoplasmic reticulum. In extracellular fluids such as blood , the sulfhydryl groups of cysteine are rapidly oxidized to form cystine. In a genetic disorder known as cystinuria , there is a defect that results in excessive excretion of cystine into the urine. The stones may cause intense pain, infection, and blood in the urine. Medical intervention often involves the administration of d-penicillamine. Penicillamine works by forming a complex with cystine; this complex is 50 times more water -soluble than cystine alone. In summary, it is the sequence of amino acids that determines the shape and biological function of a protein as well as its physical and chemical properties. Thus, the functional diversity of proteins arises because proteins are polymers of 20 different kinds of amino acids. With 20 different amino acids to chose from at each of these 51 positions, a total of , or about , different proteins could theoretically be made. Other functions Amino acids are precursors of a variety of complex nitrogen -containing molecules. Furthermore, there are complex amino-acid derived cofactors such as heme and chlorophyll. Heme is the iron -containing organic group required for the biological activity of vitally important proteins such as the oxygen -carrying hemoglobin and the electron -transporting cytochrome c. Chlorophyll is a pigment required for photosynthesis. Portion of polynucleotide chain of deoxyribonucleic acid DNA. The inset shows the corresponding pentose sugar and pyrimidine base in ribonucleic acid RNA. Thyroxine a tyrosine derivative produced in the thyroid gland of animals and indole acetic acid a tryptophan derivative found in plants are two examples of hormones. Several standard and nonstandard amino acids often are vital metabolic intermediates. Important examples of this are the amino acids arginine , citrulline, and ornithine, which are all components of the urea cycle.

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