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WHAT ARE STEROIDS?

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Abstract: Steroids belonging to the class of unsaponifiable lipids are steranines and are derivatives. Currently, more than 20,000 steroids are known and more than 100 of them are used in medicine. They perform various functions in the body.

The steroid molecules are based on the structure of the polycyclic saturated hydrocarbon estrane, built from four fused carbon rings. Many steroids contain hydrocarbon side chains, such as cholestane shown in the diagram, which is the basis of many sterols (steroid alcohols).

Key words: Steroids, estran, sterol, cholesterol, sitosterol, stigmasterol, progesterone, testosterone, androsterone, calceferol, aldosterone, cortisol, hydrophobic.

ЧТО ТАКОЕ СТЕРОИДЫ?

Аннотация: Стероиды, относящиеся к классу неомыляемых липидов, представляют собой стеранины являются производными. В настоящее время известно более 20 000 стероидов и из них в медицине используется более 100. Они выполняют различные функции в организме.В основе молекул стероидов лежит структура полициклического насыщенного углеводорода *эстрана*, построенного из четырех конденсированных углеродных колец. Многие стероиды содержат боковые углеводородные цепи, как, например, приведенный на схеме *холестан*, являющийся основой многих стеринов (стероидных спиртов).

Ключевые слова: Стероиды, эстран, стерин, холестерин, ситостерин, стигмастерин, прогестерон, тестостерон, андростерон, кальцеферол, альдостерон, кортизол, гидрофобный.

Classification of steroids.

The three most important groups of steroids are sterols, bile acids and steroid hormones. In addition, steroids include compounds of plant origin that have valuable pharmacological properties: steroid alkaloids, digitalis glycosides (cardiac glycosides) and steroid saponins.

Sterols

Steroid alcohols are called sterols. All sterols contain a β-hydroxyl group at C-3 and one or more double bonds in the B ring and side chain. Sterol molecules lack carboxyl and carbonyl groups.

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In animals, the most important sterol is cholesterol. Plants and microorganisms contain many related compounds, such as ergosterol, β-sitosterol, stigmasterol.

Cholesterol is present in all animal tissues, especially nerve tissues. It is an essential component of cell membranes, where it regulates their fluidity. The storage and transport forms of cholesterol are its esters with fatty acids. Along with other lipids, cholesterol and its esters are present in the lipoprotein complexes of blood plasma. Cholesterol is a component of bile and many gallstones.

Impaired cholesterol metabolism plays an important role in the development of atherosclerosis, a disease associated with the deposition of cholesterol (plaques) on the walls of blood vessels (calcification) due to elevated cholesterol levels in the blood. To prevent atherosclerosis, it is important that the diet is dominated by products of plant origin, which are characterized by low cholesterol content. On the contrary, food products of animal origin contain a lot of cholesterol, especially egg yolk, meat, liver, and brains.

Bile acids

Bile acids are formed from cholesterol in the liver. The chemical structure of these compounds is close to cholesterol. Bile acids are characterized by the presence of a shortened branched side chain with a carboxyl group at the end. There is no double bond in ring B, and rings A and B are articulated in the cis position. The steroid core contains from one to three β-hydroxyl groups at positions 3, 7 and 12.

Bile acids ensure the solubility of cholesterol in bile and promote the digestion of lipids. In the liver, primary bile acids are first formed — cholic and henodeoxycholic (anthropodeoxycholic). Dehydroxylation of these compounds by C-7 by the intestinal microflora leads to the formation of secondary bile acids — lithocholic and deoxycholic.

Steroid hormones

The biosynthesis of steroid hormones, a process that is not so noticeable in quantitative terms, is at the same time of great physiological importance. Steroids form a group of lipophilic signaling substances that regulate metabolism, growth and reproductive functions of the body.

There are six steroid hormones in the human body: progesterone, cortisol, aldosterone, testosterone, estradiol and calcitriol (obsolete name calciferol). With the exception of calcitriol, these compounds have a very short side chain of two carbon atoms or none at all. Most compounds of this group are characterized by the presence of an oxogroup at C-3 and a conjugated C-4/C-5 double bond in ring A. Differences are observed in the structure of rings C and D. In estradiol, the A ring is aromatic and, therefore, the hydroxyl group has the properties of a phenolic OH group. Calcitriol differs from vertebrate hormones, but it is also based on cholesterol. Due to the light-dependent ring-opening reaction, calcitriol forms a so-called "secosteroid" (an open-ring steroid).

Ecdysone— an insect steroid hormone, is an evolutionarily earlier form of steroids. Steroid hormones that perform a signaling function are also found in plants.

The spatial structure of steroids

According to the accepted nomenclature, the four rings in the steroid molecule are indicated by capital letters of the Latin alphabet A, B, C, D. Due to the tetrahedral orientation of the valences of the carbon atom, the structure of the membrane as a whole is not flat, but folded. Three possible conformations of cyclohexane are called "armchair", "bathtub" and "twisted bathtub" (twist conformation, not shown in the diagram). The most common conformations are chairs and bathtubs. Five-membered rings often adopt an "envelope" conformation. Individual aliphatic rings easily change from one conformation to another, even at room temperature. Such transitions are impossible in steroid molecules.

Substituents in the steroid cortex can be located in the plane of the ring (e — equatorially) or almost perpendicular to the plane (a — axially). If the substituents in the spatial model are directed toto the observer (in a two-dimensional image above the plane), then such connections are indicated by a solid line (β-position).If the substituents are oriented away from the observer (in a two—dimensional image - under the plane), then such connections are represented by a dotted line (α-position). The so-called angular methyl groups at C-10 and C-13 are always in the β-position.

Adjacent rings A and B can be located in the same plane (trans-articulation; 2) or located at an angle to each other (cis-articulation; 1). The shape of the joint depends on the position of the substituent (H) at the common carbon atom (C-5), which can occupy a cis or trans position with respect to the angular methyl group at C-10. The substituents at the intersections of the individual rings are usually in the trans position. The shape of the steroid core resembles a flat disk. The exception is the molecules of ecdysteroids and bile acids, as well as cardiac glycosides and toad toxins, bent at an angle due to the cis-articulation of rings A and B.

The Vanderwaals model of cholesterol gives a real idea of the spatial structure of steroid molecules. The four rings form a rigid frame to which a relatively flexible side chain is attached.

Steroids are relatively nonpolar (hydrophobic) compounds. Due to separate polar groupings, hydroxy or oxo groups, they can exhibit amphiphilic properties. These properties are most pronounced in bile acid salts.

Thin layer chromatography

Thin-layer chromatography (TCX) is an effective, predominantly analytical, method for the rapid separation of lipids and other low-molecular substances (amino acids, nucleotides, vitamins, drugs). The test sample is applied to a thin layer of silica gel mounted on a plate of glass, foil or plastic (1). The plate is replaced in a chromatography chamber with a small amount of solvent. Under the action of capillary forces, the solvent front moves along the plate, entraining substances present in the sample (2). The rate of movement of the substances being separated depends on the distribution between the stationary and mobile phases, i.e. between hydrophilic silica gel and a non-polar solvent. The chromatographic process is completed at the moment when the solvent reaches the upper edge of the plate. The silica gel layer is dried, and the analyzed substances are developed on a plate using suitable dyes or under UV light (3). The mobility of a substance in a given system is expressed as the Rf value. By comparing the obtained Rf values with the mobility of control substances (witnesses), the compounds present in the sample are identified.

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