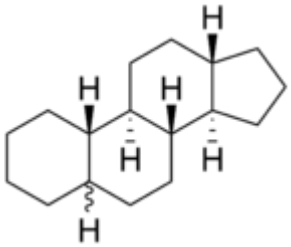
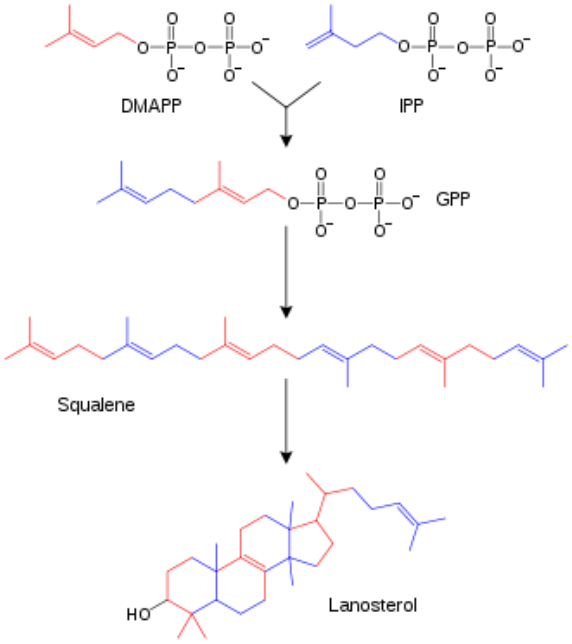
Steroids

Steroids comprise a group of cyclical organic compounds whose basis is a characteristic arrangement of seventeen carbon atoms in a four-ring structure linked together from three 6-carbon rings followed by a 5-carbon ring and an eight-carbon side chain on carbon 17.



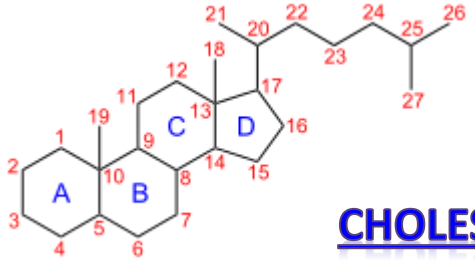
These rings are synthesized by biochemical processes from cyclization of a thirty-carbon chain, squalene, into lanosterol or cycloartenol. Hundreds of distinct steroids are found in animals, fungi, plants, and elsewhere and many steroids are necessary to life at all levels.



They include cholesterol, the sex hormones estradiol and testosterone, bile acids, and drugs such as the anti-inflammatory agent dexamethasone.

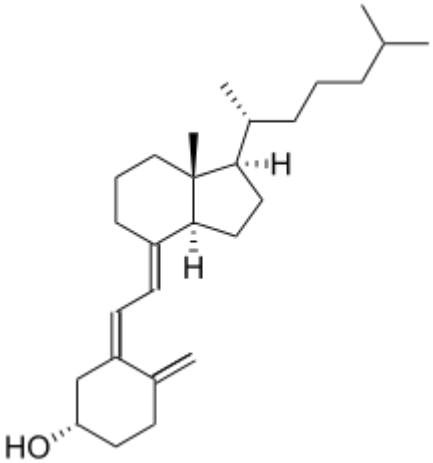
Steroids

The three cyclohexane rings are designated as rings A, B and C in the figure to the right and the one cyclopentane ring as ring D.



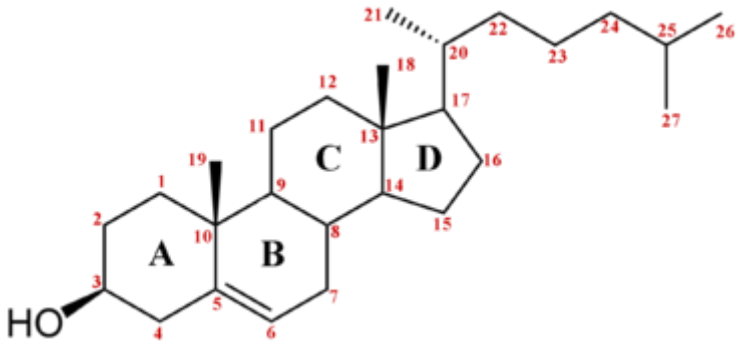
CHOLESTANE

Individual steroids vary, first and primarily, by the oxidation state of the carbon atoms in the rings and by the chains and functional groups attached to this four-ring system; second, steroids can vary more markedly via changes to the ring structure (e.g., via ring scissions that produce secosteroids like vitamin D3, see below). Sterols are a particularly important form of steroids, with sterols having a cholestane-derived framework and an hydroxyl group at the C-3 ring position being the most prominent



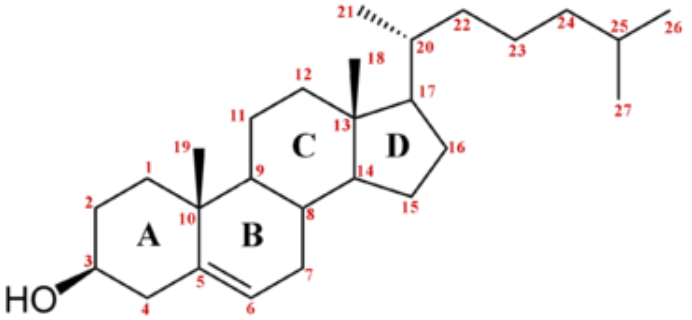
SECOSTEROIDS

Cholecalciferol (vitamin D_3), an example of a 9,10-secosteroid. The hydroxyl group (HO-) is in position C3 of the parent steroid A-ring. The triene substructure attached to the ring bearing the hydroxyl group is a result of the ring scission (cleavage) giving rise to this secosteroid.



Sterols, Cholesterol

Cholesterol



Cholesterol

- It is a sterol (or modified steroid), a lipid molecule and is biosynthesized by many animal cells because it is an essential structural component of animal cell membranes that is required to maintain both membrane structural integrity and fluidity.

- Cholesterol enables animal cells to (a) not need a cell wall (like plants & bacteria) to protect membrane integrity/cell-viability and thus be able to (b) change shape and (c) move about (unlike bacteria and plant cells which are restricted by their cell walls).

- In addition to its importance within cells, cholesterol also serves as a precursor for the biosynthesis of steroid hormones, bile acids, and vitamin D.

- Cholesterol is the principal sterol synthesized by animals. All kinds of cells in animals can produce it.

Steroid Hormones

The steroid hormones include:

(1) the **SEX HORMONES** that influence sex differences and support reproduction; these include androgens, estrogens, and progestagens.

(2) the **CORTICOSTEROIDS**, including the majority of synthetic steroid drugs, with natural products classes being the glucocorticoids that regulate many aspects of metabolism and immune function, and the mineralocorticoids that help maintain blood volume and control renal excretion of electrolytes.

(2) the **ANABOLIC STEROIDS**, natural and synthetic, that interact with androgen receptors to increase muscle and bone synthesis, where in popular expressions, use of the term "steroids" may refer to anabolic steroids.

Steroid Hormones

(1) SEX HORMONES

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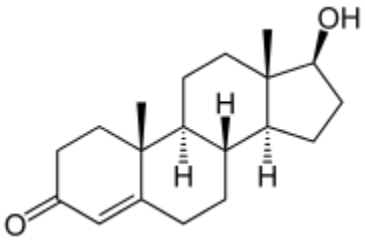
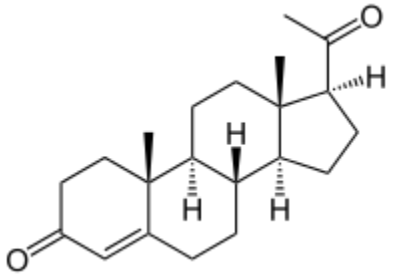


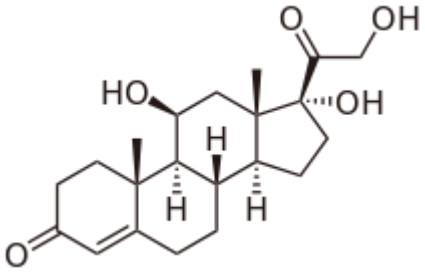
Testosterone, the principal male sex hormone



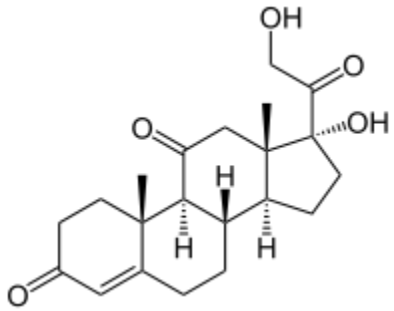
Progesterone, a steroid hormone involved in the female menstrual cycle and pregnancy

Steroid Hormones

(2) CORTICOSTEROIDS



Cortisol

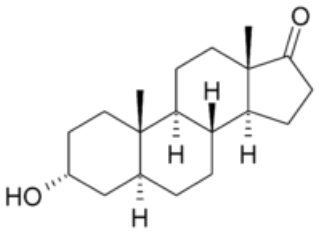


Cortisone

- **Effects and uses**
- **Cortisone, a glucocorticoid, and adrenaline are the main hormones released by the body as a reaction to stress. They elevate blood pressure and prepare the body for a fight response.**
- **A cortisone injection can also be used to give short-term pain relief and reduce the swelling from inflammation of a joint, tendon, or bursa in, for example, the joints of the knee, elbow, and shoulder.**
- **Cortisone may also be used to on purpose of suppress immune response in persons with auto immune diseases or following an organ transplant to prevent transplant rejection. The suppression of the immune system may also be important in the treatment of inflammatory conditions.**
- **Cortisone is a common treatment for a severe sore throat that occurs commonly with infectious mono nucleosis. Cortisone does not decrease the duration of the viral infection, but is used purely to increase the comfort of a patient with trouble speaking or swallowing as a result of the mononucleosis-induced swollen throat.**
- **Cortisone is also used by dermatologists to treat keloids, relieve the symptoms of eczema and atopic dermatitis, and stop the development of sarcoidosis**

Side Effects **Oral use of cortisone has a number of potential systemic side-effects: hyperglycemia, insulin resistance, diabetes mellitus, osteoporosis, anxiety, depression, amenorrhea, cataracts and glaucoma, among other problems. Local side effects are rare but can include: pain, infection, skin pigment changes, loss of fatty tissue, and tendon rupture.**

Steroid Hormones



(3) ANABOLIC STEROIDS

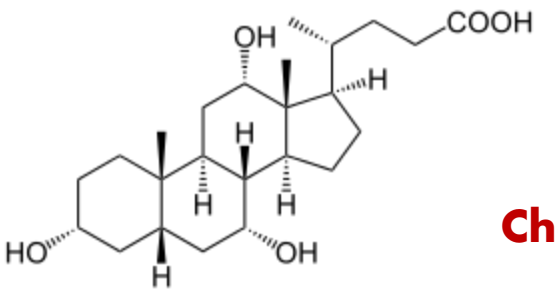
Androsterone

Anabolic steroids, technically known as anabolic-androgenic steroids (AAS), are drugs that are structurally related to the cyclic steroid ring system and have similar effects to testosterone in the body. They increase protein within cells, especially in skeletal muscles. Anabolic steroids also have androgenic properties, including the development and maintenance of masculine characteristics such as the growth of the vocal cords, testicles (primary sexual characteristics) and body hair (secondary sexual characteristics).

Anabolic steroids were first made in the 1930s, and are now used therapeutically in medicine to stimulate muscle growth and appetite, and treat chronic wasting conditions, such as cancer and AIDS. The American College of Sports Medicine acknowledges that AAS, in the presence of adequate diet, can contribute to increases in body weight, often as lean mass increases and that the gains in muscular strength achieved through high-intensity exercise and proper diet can be additionally increased by the use of AAS in some individuals.

Ergogenic (Ergogenic aids are any external influences that can be determined to enhance performance in high-intensity exercises) uses for anabolic steroids in sports, racing, and bodybuilding as performance-enhancing drugs are controversial because of their adverse effects and the potential to gain unfair advantage is considered cheating. Their use is referred to as doping and banned by all major sporting bodies. For many years, AAS have been by far the most detected doping substances in IOC-accredited laboratories. In countries where AAS are controlled substances, there is often a black market in which smuggled, clandestinely manufactured or even counterfeit drugs are sold to users.

Bile Acids



Cholic Acid

Bile acids are steroid acids found predominantly in the bile of mammals and other vertebrates. Different molecular forms of bile acids can be synthesized in the liverby different species. Bile acids are conjugated with taurine or glycine in the liver, forming bile salts.

Primary bile acids are those synthesized by the liver. **Secondary bile acids** result from bacterial actions in the colon.

Bile acids comprise about 80% of the organic compounds in bile (others are phospholipids and cholesterol). An increased secretion of bile acids produces an increase in bile flow.

The main function of bile acids is to facilitate the formation of micelles, which promotes digestion and absorption of dietary fat, but they are increasingly being shown to have hormonal actions throughout the body.

Bile Acids Functions

As amphipathic molecules with hydrophobic and hydrophilic regions, conjugated bile salts sit at the lipid/water interface and at the right concentration form micelles.

The added solubility of conjugated bile salts aids in their function by preventing passive re-absorption in the small intestine. As a result, the concentration of bile acids/salts in the small intestine is high enough to form micelles and solubilize lipids.

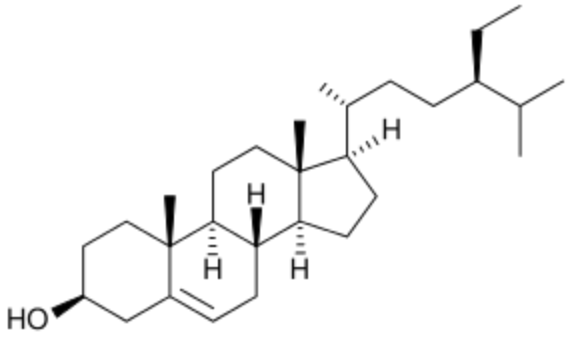
Bile acid-containing micelles aid lipases to digest lipids and bring them near the intestinal brush border membrane, which results in fat absorption.

Bile acids also serve other functions, including eliminating cholesterol from the body, driving the flow of bile to eliminate certain catabolites (including bilirubin), emulsifying fat-soluble vitamins to enable their absorption, and aiding in motility and the reduction of the bacteria flora found in the small intestine and biliary tract. Bile acids also have metabolic actions in the body resembling those of hormones acting through two receptors.

Synthesis of bile acids is a major route of cholesterol metabolism in most species other than humans.

The body produces about 800 mg of cholesterol per day and about half of that is used for bile acid synthesis producing 400–600 mg daily. Human adults secrete between 12-18 g of bile acids into the intestine each day, mostly after meals. The bile acid pool size is between 4–6 g, which means that bile acids are recycled several times each day.

Example of Plant Sterols



β-Sitosterol, a plant or phytosterol, with a fully branched hydrocarbon side chain at C-17, and an hydroxyl group at C-3.

STEROIDS