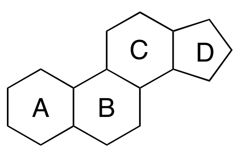
Examples of Alcohols in Natire:

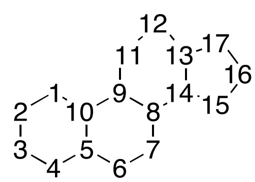
Steroids

Steroids are triterpenoids, a group of compounds produced in plants and animals. They are very widespread in nature and have many important biological functions including regulating sexual characteristics of males and females.

Steroids are characterized by a tetracyclic structure. A typical steroid ring structure consists of three six-membered rings and one 5-membered ring fused together. Depending on the biological function of the steroid, they have a variety of functional groups substituted on the skeleton.

The rings in a steroid skeleton are designated as the A, B, C and D rings. Positions are numbered by the pattern shown below:





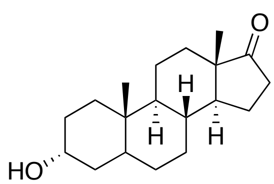
If groups attached to any of these four rings as drawn are pointing down, they are in the α position; if the groups are pointing up, they are in β position.

Many of the male and female steroidal hormones differ primarily by a methyl group at C-10 on the steroid skeleton.

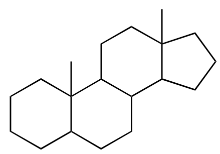
Androgens

Male steroidal hormones have the androstane skeleton.

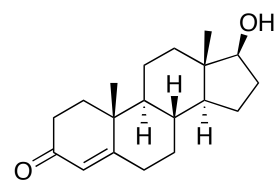
Androsterone was first isolated in 1931 by Adolf Butenandt from the extraction of 15,000 liters of urine. Approximately 15 milligrams of material was isolated and characterized as the below structure. The structure has two methyl groups at the 10 and 13 positions, a ketone functionality at the 17 position and an alpha (α) hydroxyl group at the 3 position. This type of structure is characteristic of an androstane skeleton, which has two beta (β) methyl groups at the 10 and 13 positions. Another example of this type of skeleton is testosterone. Testosterone differs from androsterone by a double bond between positions 4 and 5, a ketone at position 3 and an alcohol at position 17.



Androsterone



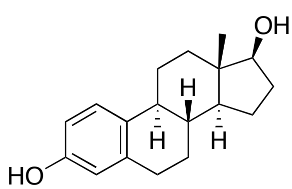
Androstane skeleton



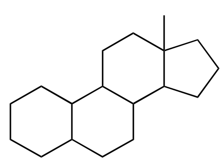
Testosterone

Estranes

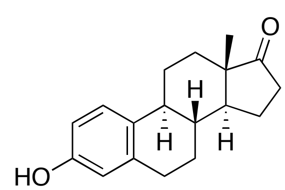
Estradiol was first isolated in 1929 from the extraction of 4 tons of hog ovaries. Approximately 12 milligrams of material was isolated and characterized as the below structure. The structure consists of an aromatized A ring, alcohol functionalities at positions 3 and 17 and a methyl group at position 13. This is characteristic of an estrane skeleton, which has a beta (β) methyl group at the 13 position. Female steroidal hormones have the estrane skeleton. Another example of this type of skeleton is estrone, in which the alcohol at position 17 is oxidized to a ketone.



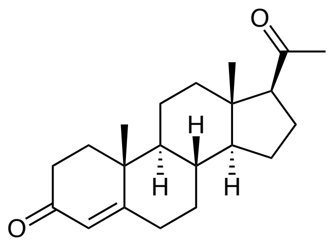
Estradiol



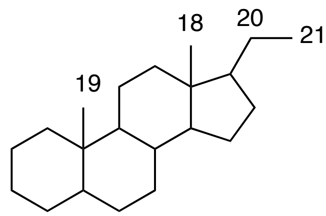
Estrane skeleton



Estrone

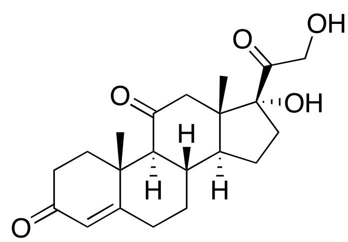


Progesterone



Pregnane skeleton

Cortisone is a hormone of the adrenal glands that is used medically to relieve inflammation. Cortisone is a highly oxidized steroid, containing a variety of functional groups including ketones, double bonds and alcohols.



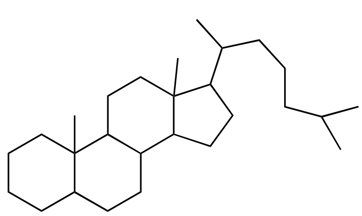
Cortisone

Pregnanes

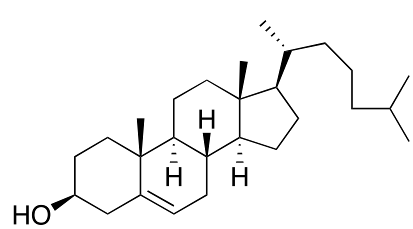
Progesterone is a hormone whose levels are elevated during pregnancy in females. Its structure has the pregnane skeleton, which has two methyl groups at positions 10 and 13 and a two carbon chain at position 17. Progesterone differs from testosterone by having the side chain at position 17.

Cholestanes

Cholesterol is a major steroid found in membranes of animals, and is a precursor to a variety of other steroid structures. Cholesterol has an alcohol at the 3 position and double bond between the 5 and 6 positions and a functionalized side chain as shown below.



Cholestane skeleton



Cholesterol

Physical Properties of Alcohols and Acidity

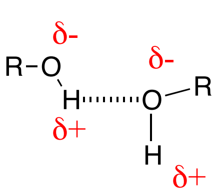
Look at the following comparisons:

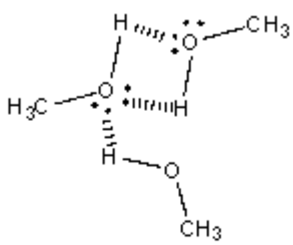
Name	Methanol	Ethane
Formula	CH_3OH	CH_3CH_3
Molecular Weight (g/mol)	32	30
Boiling Point (° C)	65	-89
State (at room temp)	liquid	gas

Ethane has almost the same molecular weight as methanol. However, the boiling point is much lower than methanol.

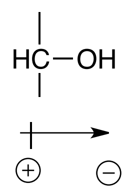
Why are the boiling points so different?
Answer: Alcohols are polar and able to form hydrogen bonds.

Hydrogen Bond





Dipole



Alcohols are strongly associated with each other both through dipole-dipole attraction (weaker intermolecular force) and hydrogen bonding (a stronger intermolecular force). The presence of the electronegative oxygen atom polarizes the bonds, and produces a dipole moment. The basic oxygen atoms also form partial bonds to the acidic hydroxyl hydrogens of another molecule (shown as dotted line in the figure above). Together, these factors raise the boiling points of alcohols far above their parent alkanes, with the hydrogen bonding being the most significant and powerful factor.

Physical Properties:

1. The polarity of alcohols make them quite soluble in (or miscible with) water if the number of carbons on the alcohol is less than 4. Butanol and higher alcohols are still soluble in water, but no longer infinitely miscible (completely soluble at all concentrations).
2. The melting point and boiling point for an alcohol is higher than its parent alkane (as seen from our comparison above).
3. The density of alcohol is less than 1 g/cm^3 (and hence less than water. If the given alcohol is not miscible with water (carbons >4), it will be floating on top of water)