

LIPIDS

**Water-insoluble compounds found in
animals and plants**

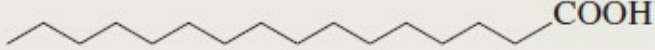


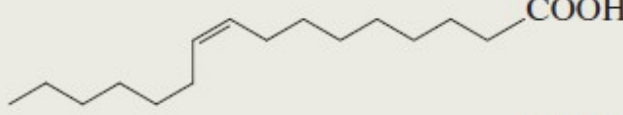
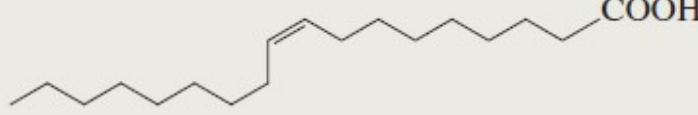
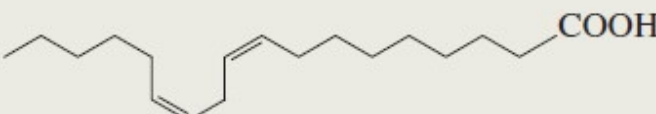
Lipids

- The solubility of lipids in nonpolar organic solvents results from their significant hydrocarbon component.
- Lipids have a variety of structures and functions
 - **Fatty Acids**
 - **Waxes**
 - **Fats and Oils**
 - **Membranes**
 - **Terpenes**
 - **Steroids**

Fatty Acids

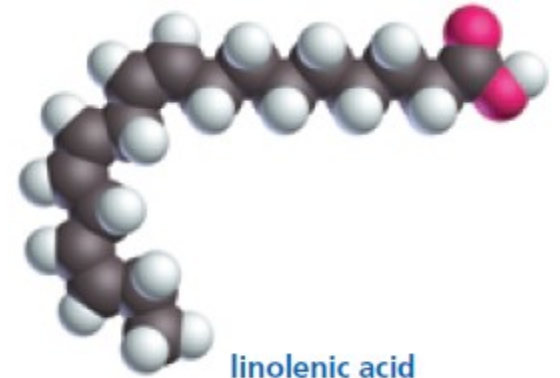
- carboxylic acids with long hydrocarbon chains.
- can be saturated or unsaturated
- The physical properties depend on
 - the length of the hydrocarbon chain and
 - the degree of unsaturation.
- the m.p. of saturated fatty acids increase with increasing molecular weight

Common Naturally Occurring Fatty Acids

16	palmitic acid	hexadecanoic acid		63
18	stearic acid	octadecanoic acid		69
20	arachidic acid	eicosanoic acid		77
16	palmitoleic acid	(9Z)-hexadecenoic acid		0
18	oleic acid	(9Z)-octadecenoic acid		13
18	linoleic acid	(9Z,12Z)-octadecadienoic acid		-5



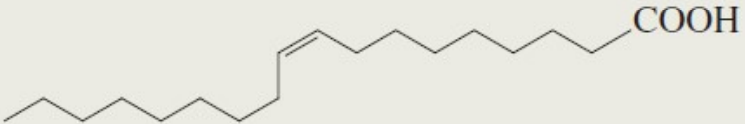
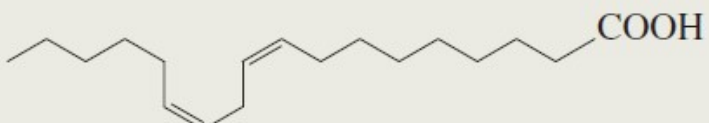
stearic acid



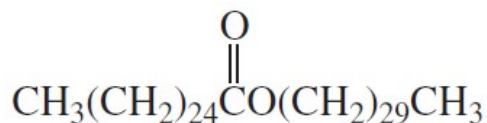
linolenic acid

- Why unsaturated fatty acids have lower melting points than saturated fatty acids?
- The double bonds in unsaturated fatty acids generally have the cis configuration. This configuration produces a bend in the molecules, which prevents them from packing together as tightly as fully saturated fatty acids.

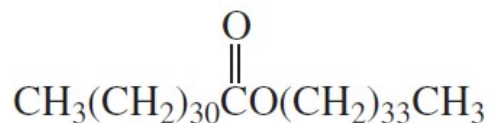
- The **melting points** of the unsaturated fatty acids **decrease** as the number of **double bonds** increases.

18	oleic acid	(9Z)-octadecenoic acid		13
18	linoleic acid	(9Z,12Z)-octadecadienoic acid		-5

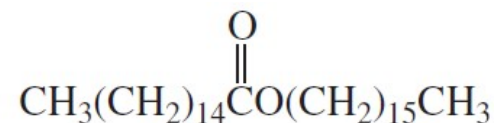
Waxes



a major component of
beeswax
structural material
of beehives



a major component of
carnauba wax
coating on the leaves
of a Brazilian palm

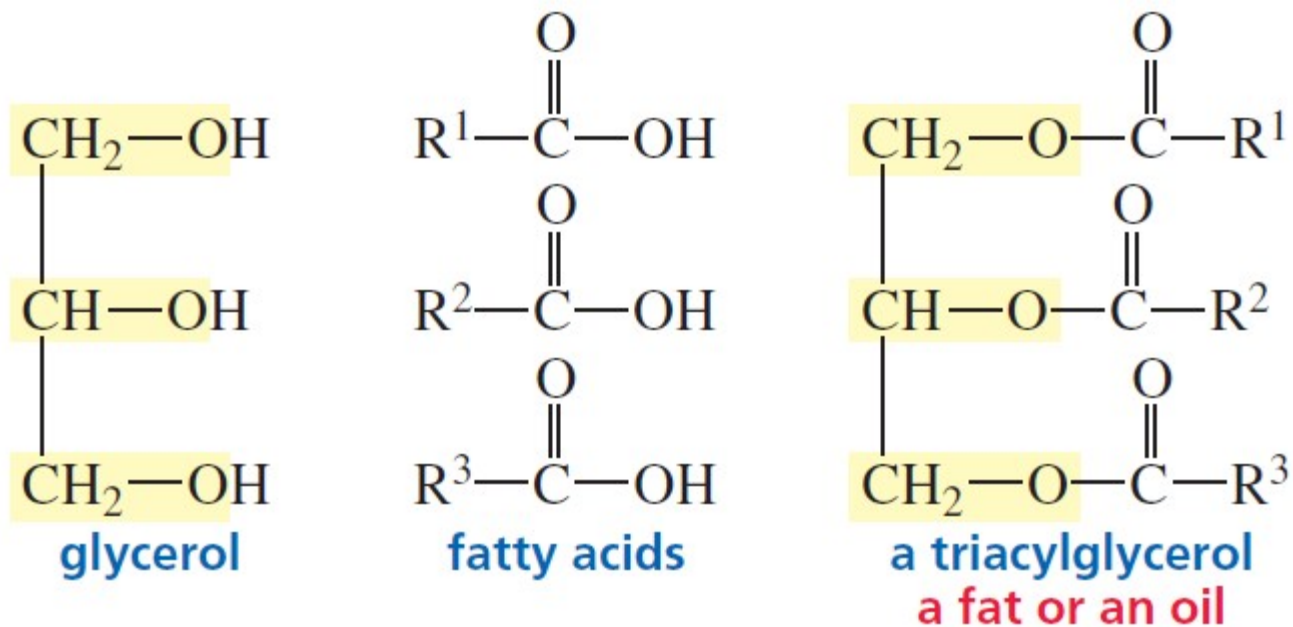


a major component of
spermaceti wax
from the heads of
sperm whales

- **esters** formed from long-chain carboxylic acids and long-chain alcohols.
- Waxes are common in living organisms.
- **feathers of birds, wax secretion to keep fur lubricated, to render exoskeletons waterproof, surfaces of certain leaves and fruits where it serves as a protectant against parasites and minimizes the evaporation of water.**

Fats and Oils

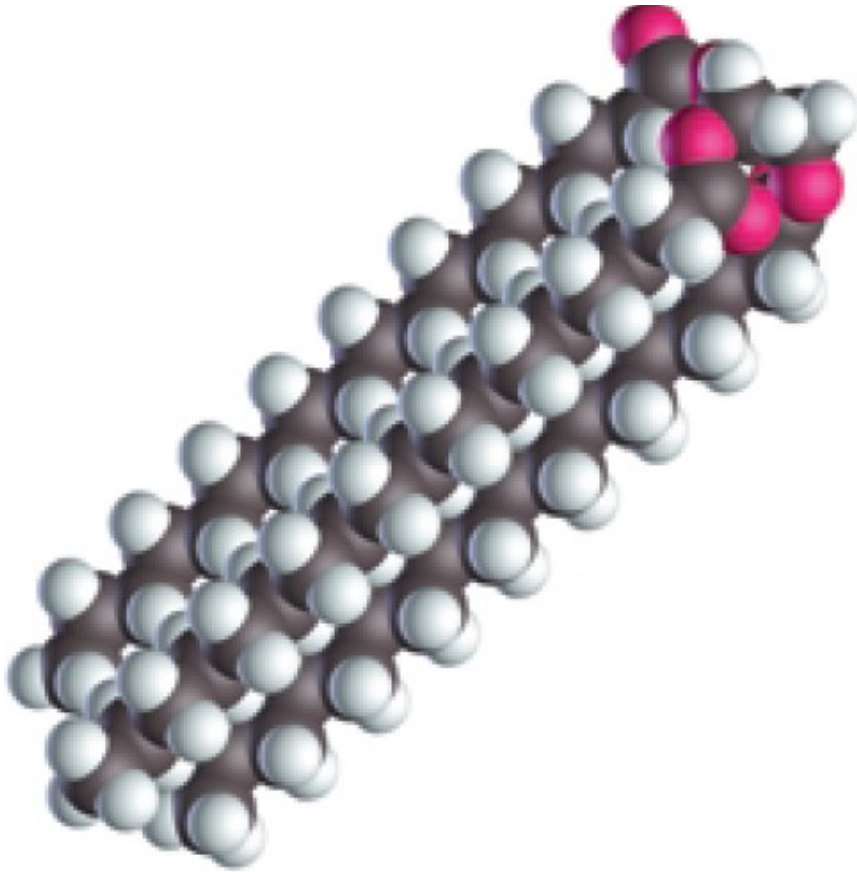
- **Triacylglycerols**
 - simple triacylglycerol.
 - Mixed triacylglycerols



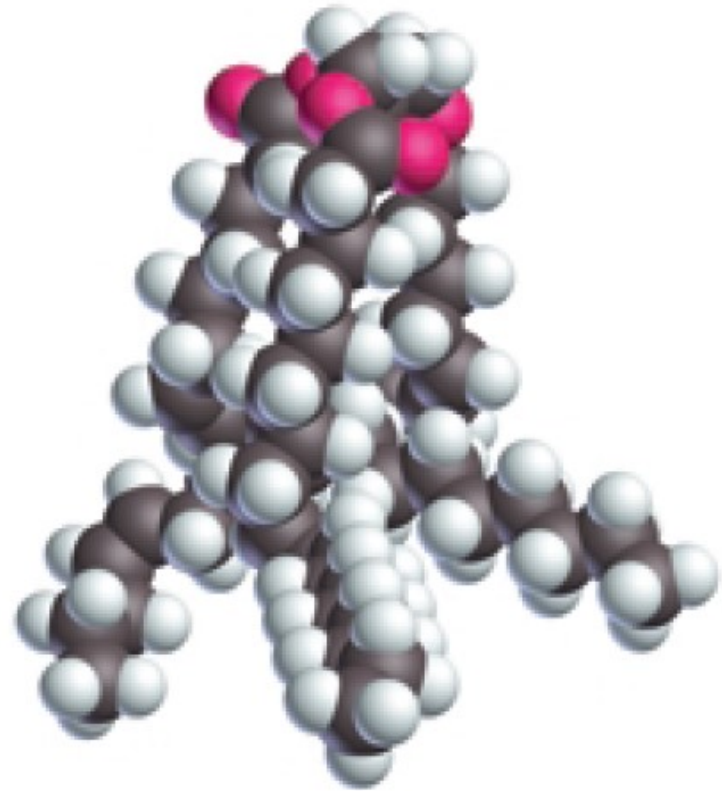
Fats and Oils

- **Fats:** Triacylglycerols that are solids or semisolids at room temperature
 - usually obtained from **animals** and are composed largely of triacylglycerols with either saturated fatty acids or fatty acids with only one double bond.
- **Oils:** Liquid triacylglycerols
 - typically come from **plant** products such as corn, soybeans, olives, and peanuts. They are composed primarily of triacylglycerols with unsaturated fatty acids that cannot pack tightly together.

Fats and Oils



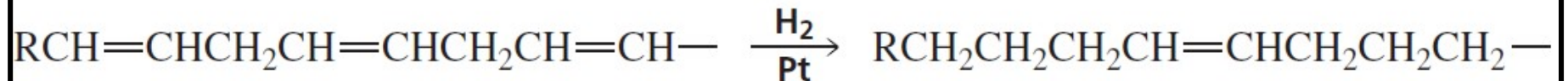
a fat



an oil

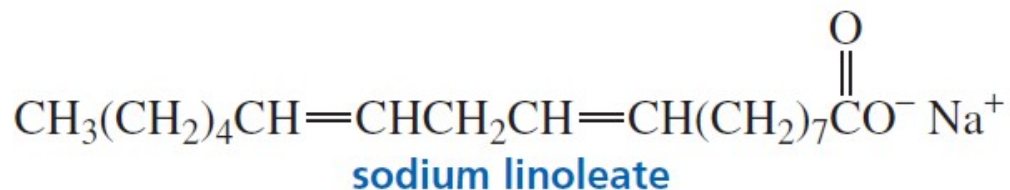
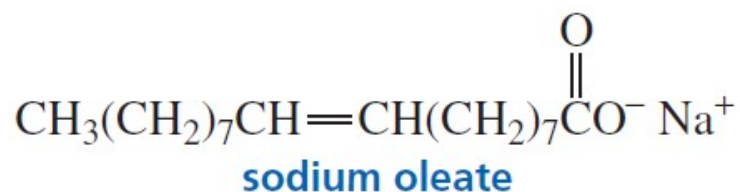
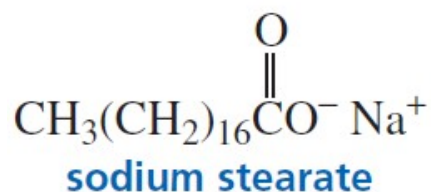
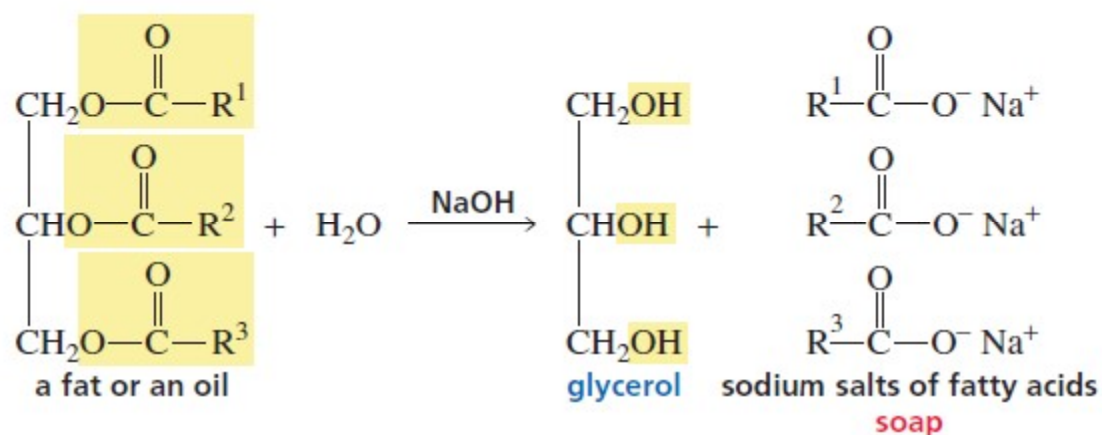
Hardening of Oils

- Catalytic hydrogenation of some or all of the double bonds of polyunsaturated oils.
 - Preparation of Margarine by hydrogenating vegetable oils such as soybean oil



Hydrolysis of Fats

- **Saponification** : Soaps are sodium or potassium salts of fatty acids

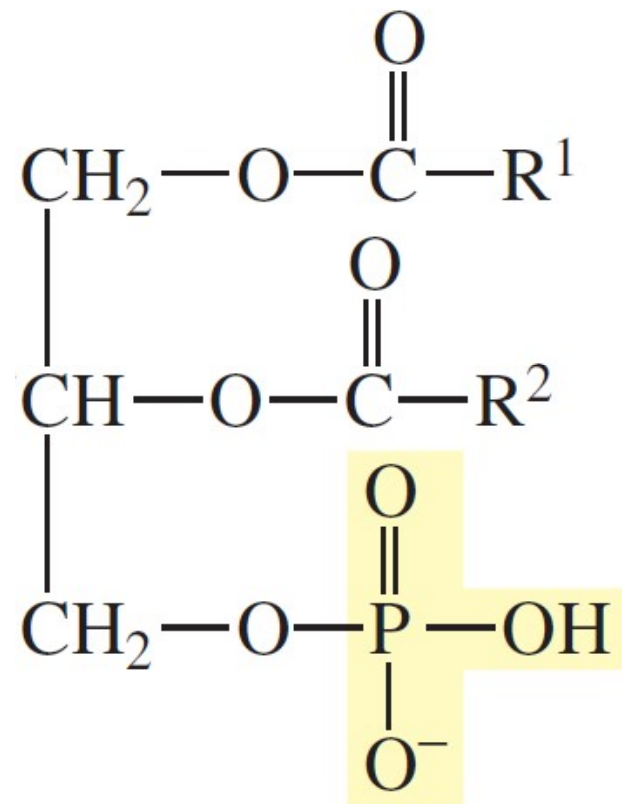


Membranes

- some parts of organisms must be separated from other parts (**biological system**)
- the outside of the cell must be separated from the inside (**On a cellular level**)
- “Greasy” lipid membranes serve as the barrier
- Example: **Phospholipids**

Phospholipids

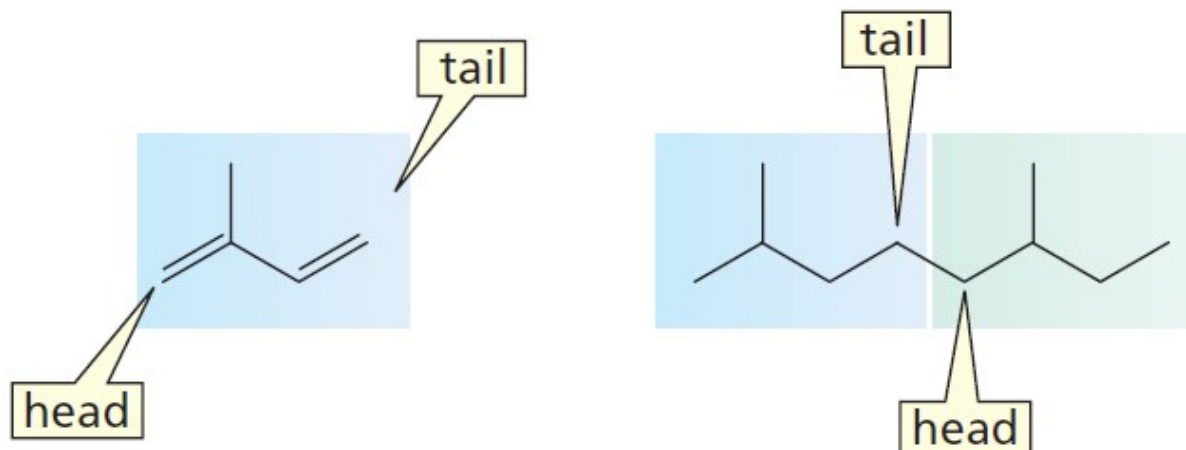
- **Phosphoacylglycerols** (*aka* phosphoglycerides)
- a terminal OH group of glycerol is esterified with phosphoric acid
- **C-2 carbon** of glycerol in phosphoacylglycerols has the **R configuration**



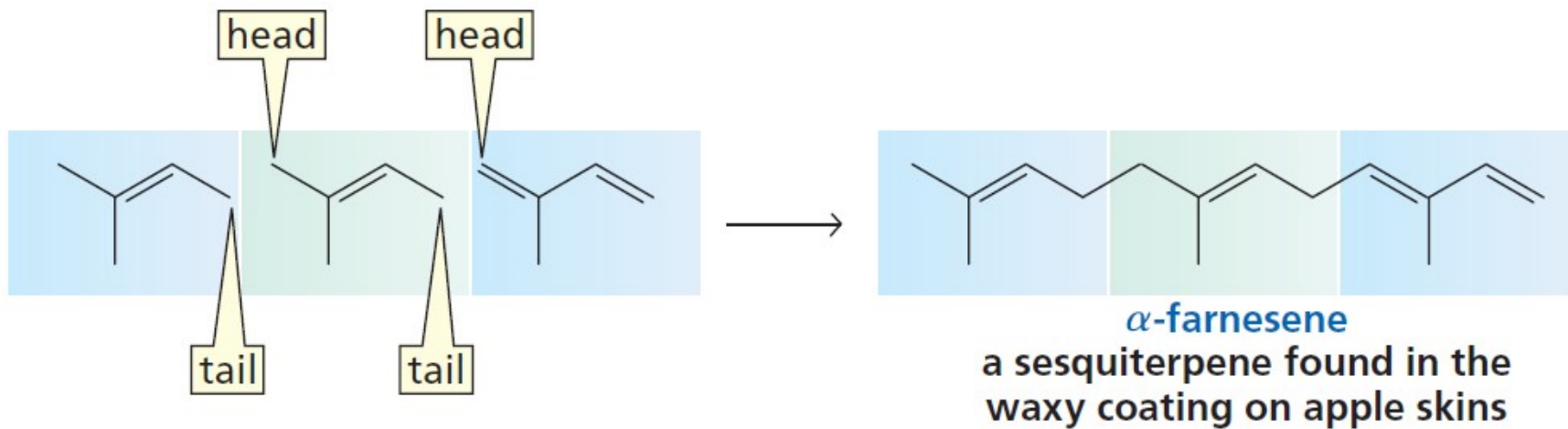
a phosphatidic acid

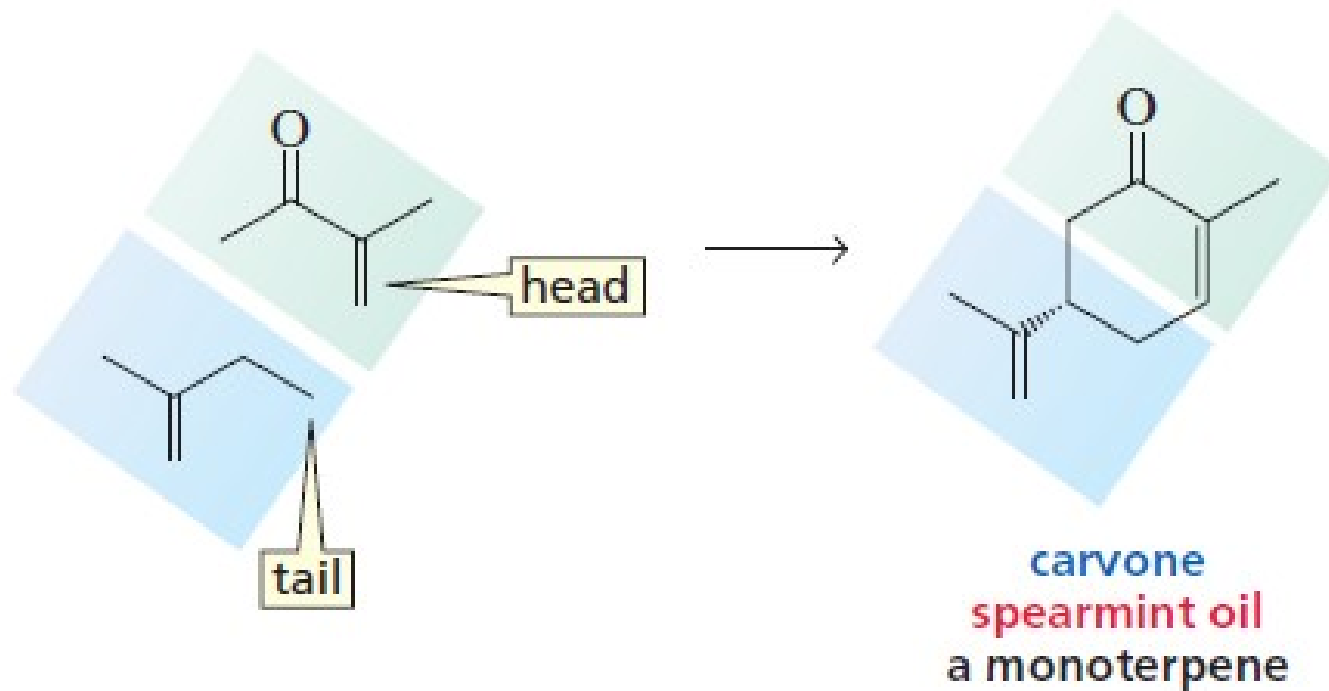
Terpenes

- can be hydrocarbons, or they can contain oxygen and be alcohols, ketones, or aldehydes.
- contain carbon atoms in multiples of 5
 - 10, 15, 20, 25, 30, and 40 carbon atoms
- Oxygen-containing terpenes are sometimes called **terpenoids**.
- **isoprene rule:** isoprene units are linked in a head-to-tail fashion



Isoprene Rule

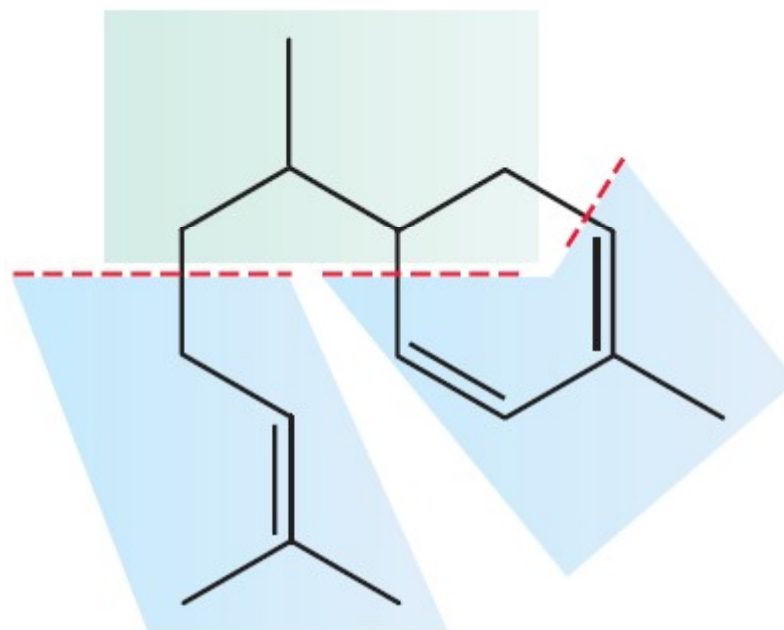
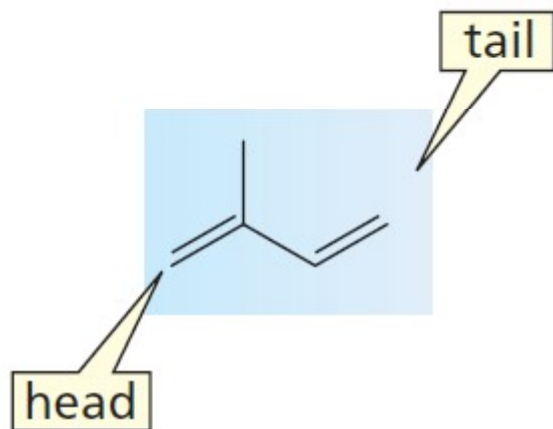




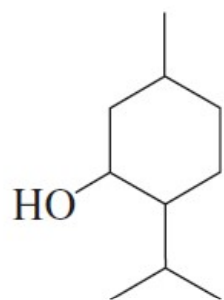
- In the case of cyclic compounds, the linkage of the head of one isoprene unit to the tail of another is followed by an additional linkage to form the ring.

Using the Isoprene Rule

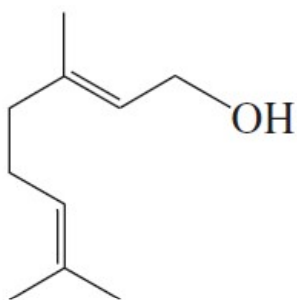
- Mark off the isoprene units in zingiberene



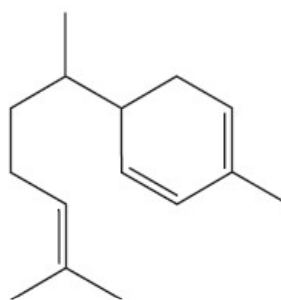
Terpenes



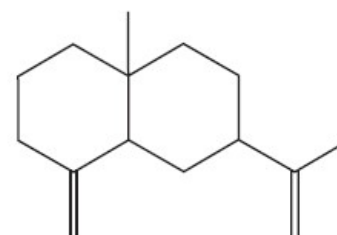
menthol
peppermint oil



geraniol
geranium oil



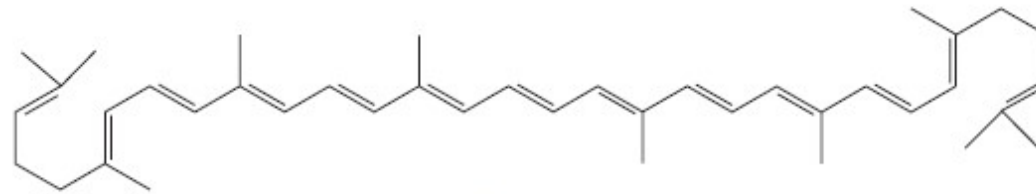
zingiberene
oil of ginger



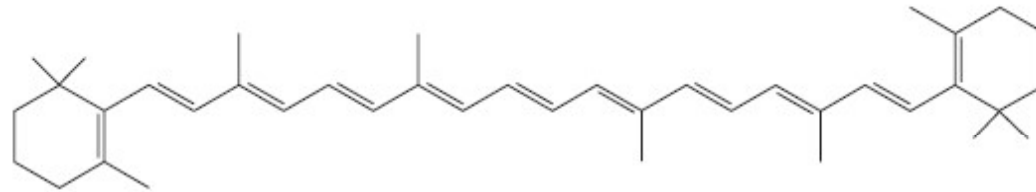
β -selinene
oil of celery

Carbon atoms	Classification	Carbon atoms	Classification
10	monoterpenes	25	sesterterpenes
15	sesquiterpenes	30	triterpenes
20	diterpenes	40	tetraterpenes

Carotenoids



lycopene

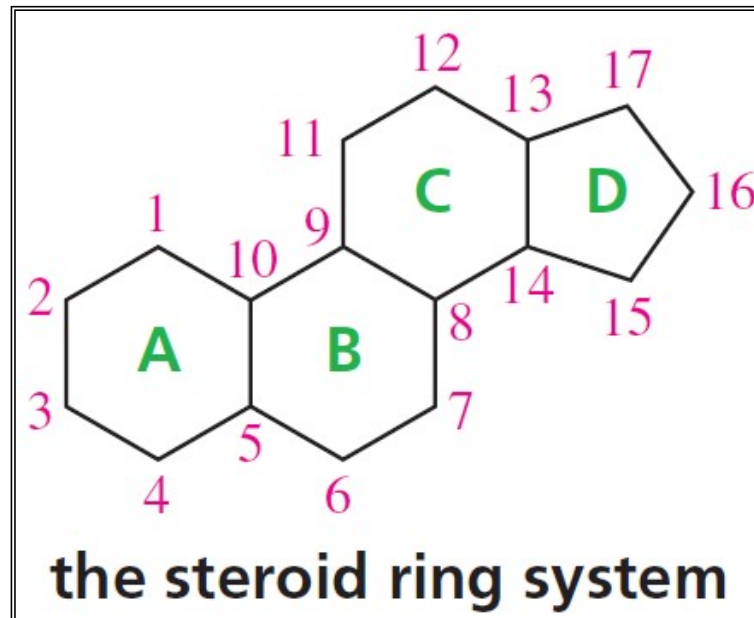


β -carotene

- tetraterpenes.
- Lycopene, the compound responsible for the red coloring of tomatoes and watermelon, and the compound that causes carrots and apricots to be orange, are examples of carotenoids.

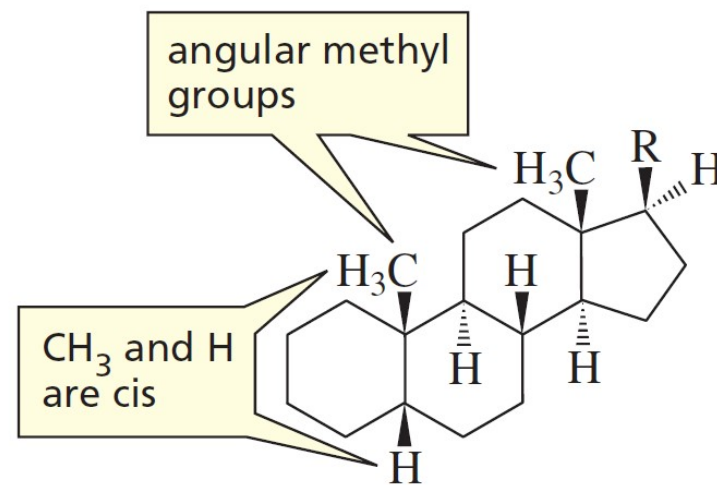
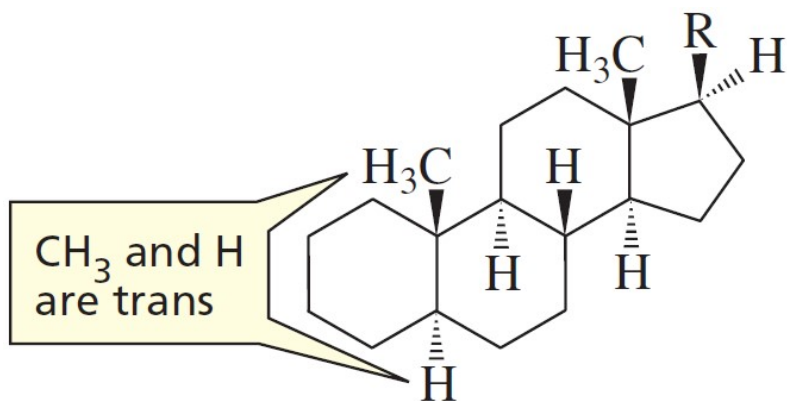
Steroids

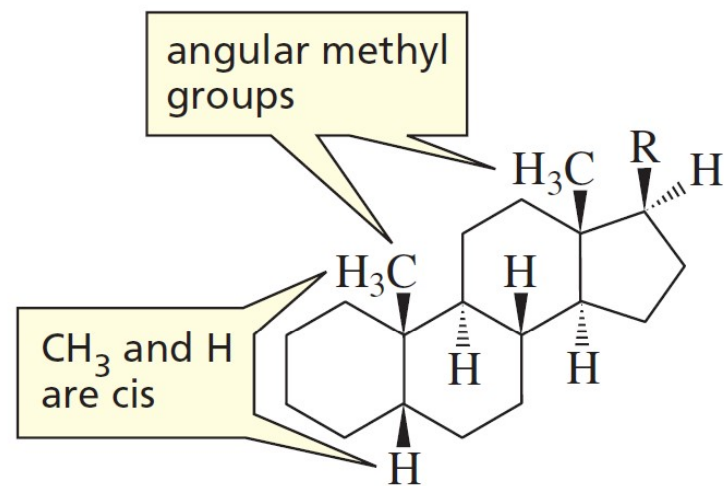
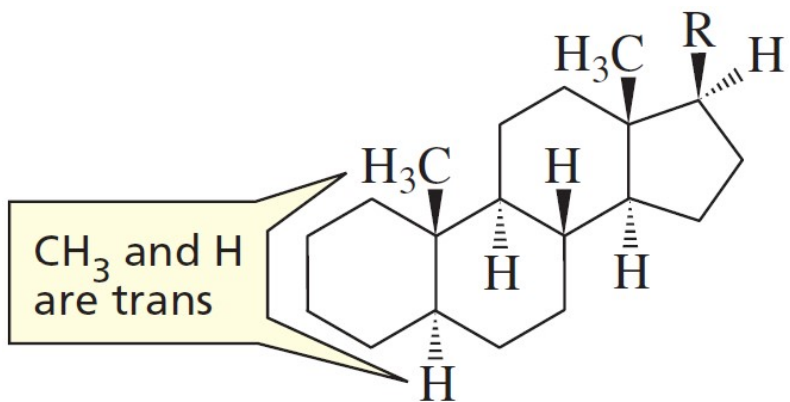
- All steroids contain a **tetracyclic ring system**. The four rings are designated A, B, C, and D.
- A, B, and C are six-membered rings and D is a five-membered ring.



Stereochemistry

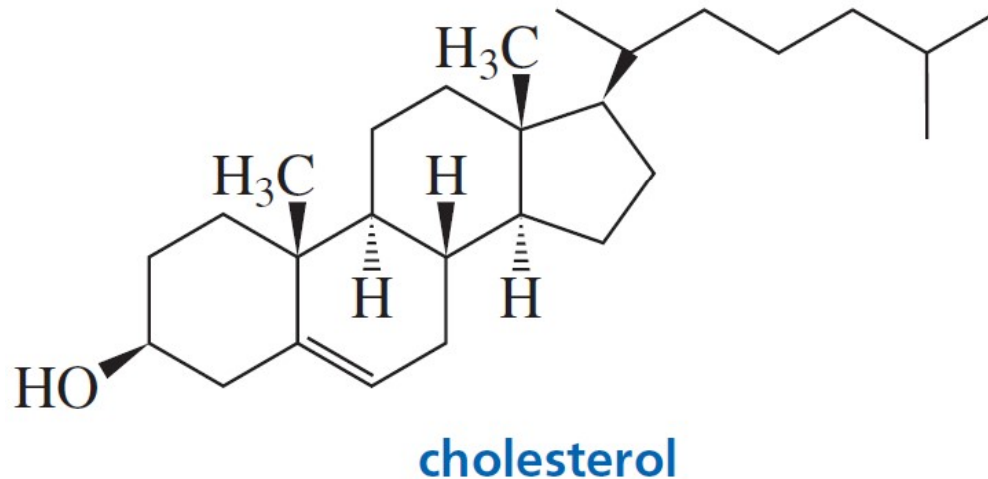
- In steroids, the B, C, and D rings are all trans fused. In most naturally occurring steroids, the A and B rings are also trans fused.
- Many steroids have methyl groups at the 10- and 13-positions. These are called **angular methyl groups**.
- When steroids are drawn, both angular methyl groups are shown to be above the plane of the steroid ring system





Cholesterol

- The most abundant member of the steroid family in animals and the precursor of all other steroids.
- important component of cell membranes



- Number of stereoisomers are possible?

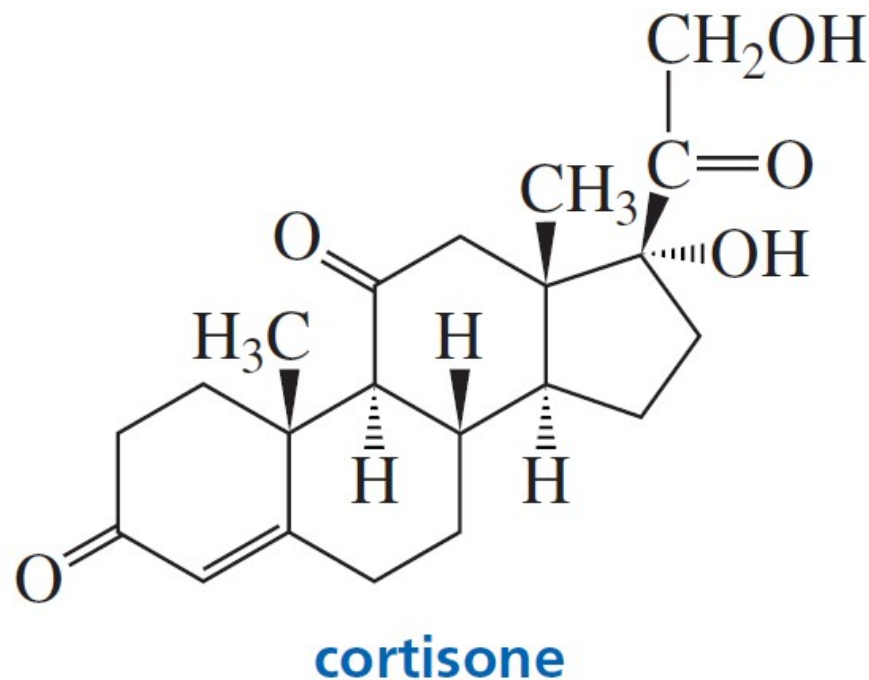
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Classification of Steroid Hormones

- Glucocorticoids
- Mineralocorticoids
- Androgens
- Estrogens

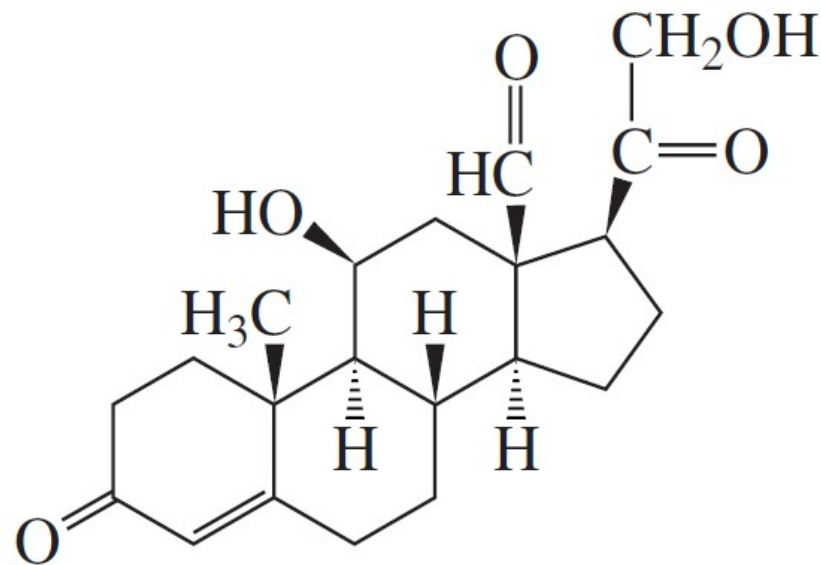
Glucocorticoids

- involved in glucose metabolism, as well as in the metabolism of proteins and fatty acids



Mineralocorticoids

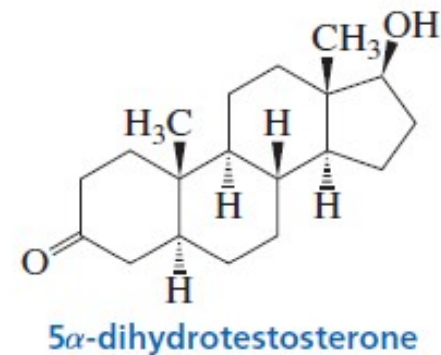
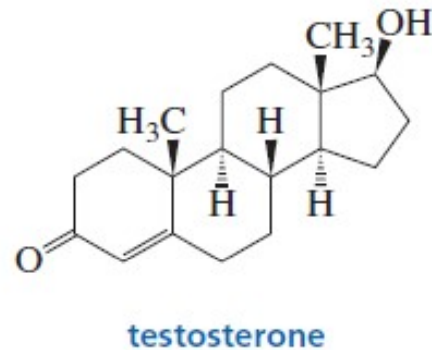
- Mineralocorticoids cause increased reabsorption of Na^+ , Cl^- , and HCO_3^- by the kidneys, leading to an increase in blood pressure.



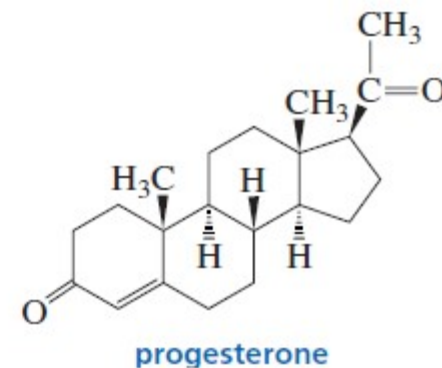
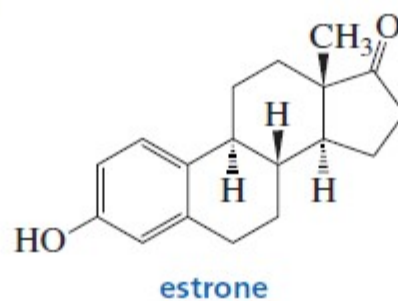
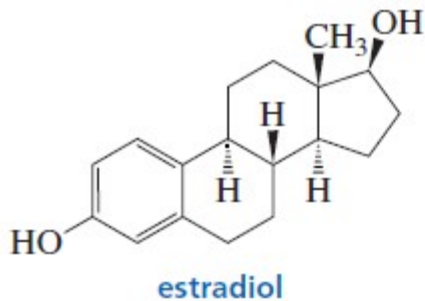
aldosterone

Androgens and Estrogens

- male sex hormones

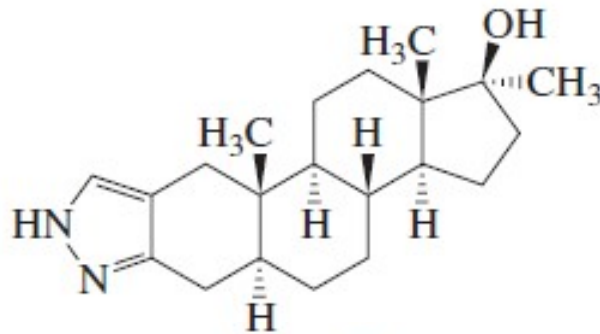


- Female sex hormones

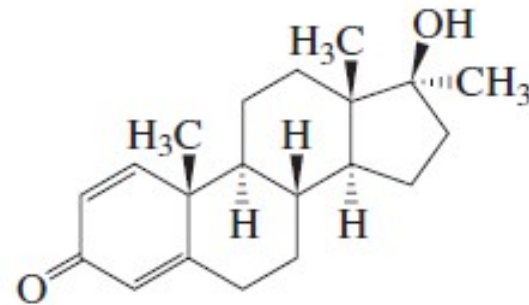


difference between testosterone and progesterone

Synthetic Steroids



stanozolol



Dianabol

- steroids that are not available in nature
- They have the same muscle-building effect as testosterone.
- Steroids that aid in the development of muscle are called **anabolic steroids**.

Curious case of shot put champ

Magdeburg (Germany): Having been crowned European shot put champion in 1986, Heidi Krieger was one of the stars of the former GDR. But having been subjected to a doping program like thousand of other former East German athletes, Krieger realised on her 1990 retirement that the effects of testosterone hormone abuse had left her with all the traits of a man.

She opted for a sex change operation and is today known as Andreas whose birth certificate has been altered and, sporting a moustache, he now owns an army clothes shop in Magdeburg.

The confident, strapping man of 1.87m shows a copy of his photo from his competition days as Heidi, and a timid girl stares out from the image with short brown hair and broad shoulders hidden in a tracksuit.

"I don't know if I would have remained as a woman, because my problems were already there, but they stole my story from me," the 44-year-old said.

"I never had the possibility of saying: I do not want to take hormones. I was barely 16 years old when my coach first gave me those blue pills."

During the 20-year period the GDR competed as a separate state, the tiny country of 16 million people won 519 medals at 11 Olympic games — 192 of which were gold.



Former German shot putter Andreas Krieger, who competed as a woman (Heidi Krieger) on the East German athletics team, poses with a picture of himself in 1987

To achieve this success, the East German state ensured their athletes had the best available facilities and equipment, coaching and medical back-up, psychological testing and dietary supplements.

But it was the scale of state-sponsored doping — known as State Plan 14.25 — that set East Germany apart and was only brought to an end after the collapse of communism when the Berlin wall came down 20 years ago.

It is estimated some 10,000 athletes were part of the doping program which even involved the Stasi, the state's se-

cret police service, to make sure athletes took Turinabol, an anabolic steroid which encourages muscle growth.

Each athlete was on an index of prescribed hormones and the small country from behind the iron curtain became a medal factory.

Krieger was "Athlete No 54" on that list.

The GDR finished second on the medals table of several Olympic Games including Montreal 1976, Moscow 1980 and Seoul 1988.

At the European Athletics Championships in 1986 held in Stuttgart, Heidi Krieger won gold in the shot put and Andreas still has the telegram of congratulations sent to him by GDR leader Erich Honecker addressed to "My dear friend of sport".

But the anger still burns. "At that time, I felt increasingly foreign in my own body," he says, having opted for a sex change operation 12 years ago. "I officially became a man and I obtained a new birth certificate."

As Heidi died, so Andreas took life and the man emptied a plastic bag full of medals onto the counter in his clothes shop which he won as a woman.

Only the gold medal from Stuttgart is missing — he donated it to the association of the GDR's doping victims. "That medal doesn't mean anything to me now," he said. AFP

AFP



Former German shot putter Andreas Krieger, who competed as a woman (Heidi Krieger) on the East German athletics team, poses with a picture of himself in 1987