LIPIDS

Lipids, better known as fats, are both good and bad for humans. Some amount of lipid must be present in the diet; however, we sometime goes overboard. Lipids are a very diverse group of compounds. There are six major categories of lipids.

Lipid types:

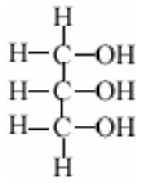
1. triglycerides
2. phospholipids
3. sterols (steroids)
4. vitamins
5. waxes
6. prostaglandins.

Triglycerides

Triglycerides are significant because they serve as the basis for forming all the other lipid types: phospholipids, sterols, vitamins, waxes, and prostaglandins. Just as polysaccharides have building blocks called monosaccharides, triglycerides have building blocks: glycerol and 3 fatty acids.

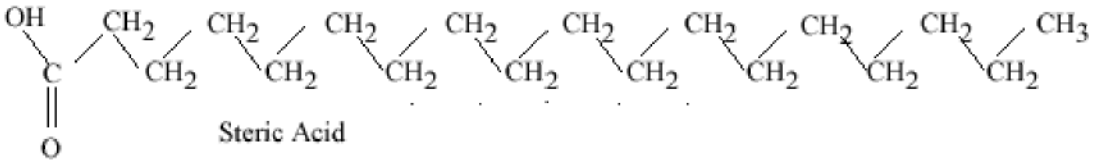
Glycerol

Glycerol, also commonly called glycerin, is a 3-carbon compound with hydroxyl groups (OH) on the same side of each carbon and hydrogens at all the other places. The formula could be written as $C_3H_5(OH)_3$. Glycerol is important as an industrial lubricant, found in soaps, and also onions (think how both soap and onions make your eyes water).



Fatty Acids

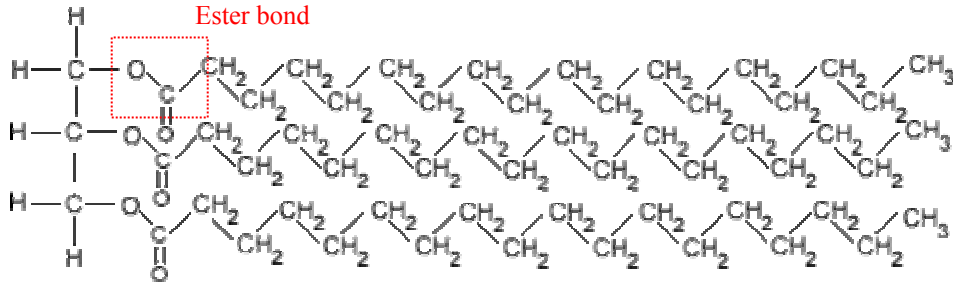
Fatty acids are long chains of carbons with a carboxyl component (the acid part) and hydrogens filling the other areas around the carbons. They are typically an even number of carbons. An example is stearic acid with 18 carbons. A shortened formula for stearic acid may be written as $C_{17}H_{35}COOH$ where the COOH is the carboxyl group.



Steric Acid

Triglyceride Formation

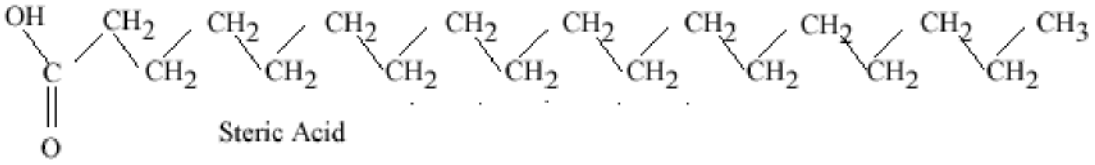
Triglycerides are formed when 1 glycerol and 3 fatty acids are joined by the hydroxyl groups of the glycerol and the carboxyl groups of the fatty acids. The fatty acids bond to glycerol when water is removed through a process known as condensation synthesis (dehydration synthesis). The result is an ester bond. Remember, esters tend to have pleasing aromas (and many fats have pleasing aromas – that's why steaks smell so good on the grill). There are therefore, 3 ester bonds between glycerol and the 3 fatty acids to form the triglyceride.



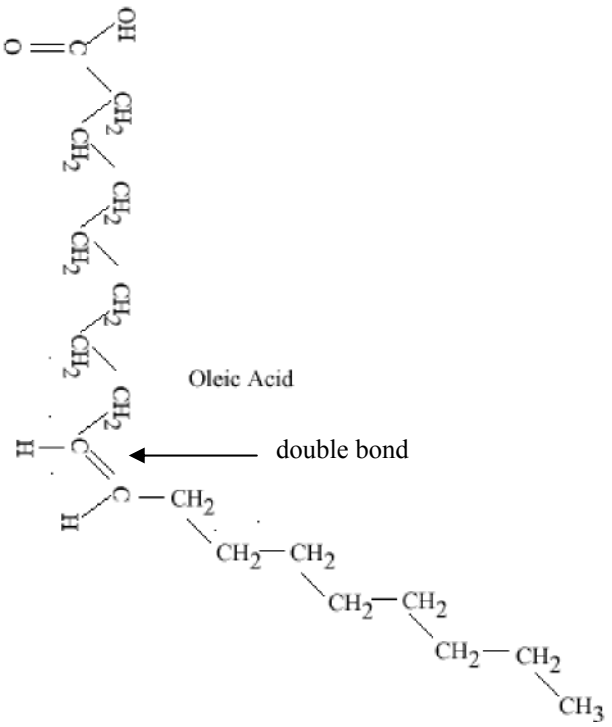
Triglycerides may be modified to form phospholipids, sterols, vitamins, waxes, and prostaglandins.

Saturated versus Unsaturated

Stearic acid is a saturated fatty acid. That means that every possible place, there is a hydrogen atom, thus it is "saturated" with hydrogen. Another way to put it is all the carbons are singly bonded to each other. Saturated fatty acids tend to form fats which are solids at room temperature, such as butter, margarine, shortening, lard, etc.

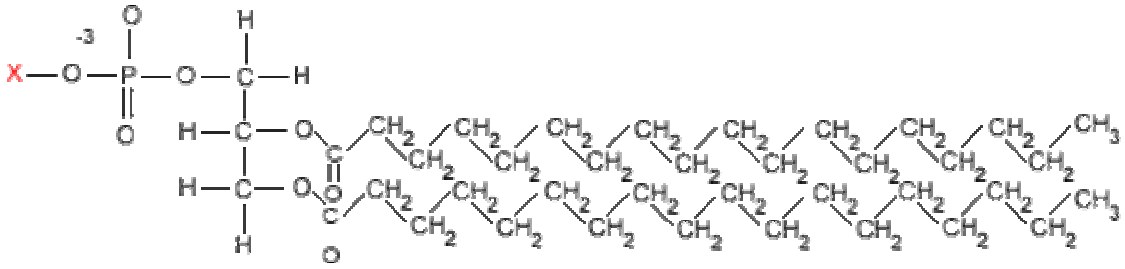


Oleic acid is unsaturated. There is a double bond between carbons 9 and 10 in the fatty acid. This means there are two less hydrogens than theoretically possible. The formula may be written as $C_{17}H_{32}COOH$. Unsaturated fatty acids tend to form liquids at room temperature, such as olive oil, safflower oil, peanut oil, etc.



Phospholipids

Phospholipids have their beginning as a triglyceride. One of the fatty acids (on an end) is removed and a phosphate group $(PO_4)^{-3}$ is attached to the opposite side of the glycerol unit. Other functional groups may be added to the phosphate group, but the overall structure of all phospholipids is the same. Phospholipids are the major components of membranes in cells and in neurons.

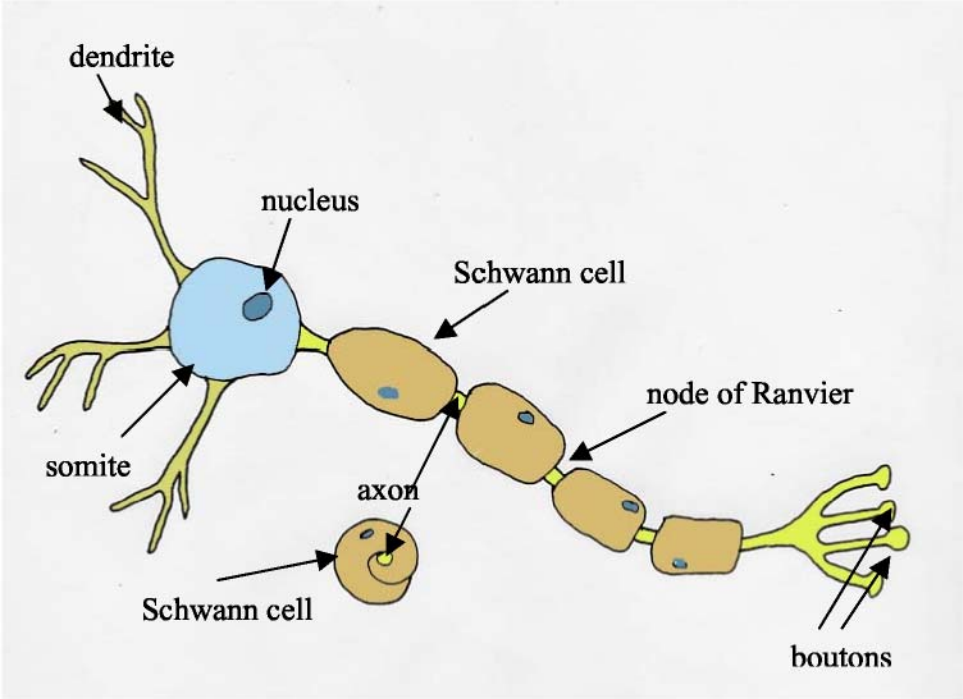


Neurons

Many people refer to neurons as nerve cells. Technically that is correct, but realize there are many types of nerve cells in the body, such as: glial cells, astrocytes, Purkinje cells, and others. Neurons are just one type.

Neurons have three basic parts: (1) the cell body, or somite (2) branch-like projections from the somite called dendrites and (3) leading away from the somite is the axon. The end of the axon may be branched with tiny swellings called boutons (French for button). The method neurons transmit nerve impulses is: dendrites receive the stimulus, the stimulus is passed down the dendrites to the somite. The somite passes the nerve impulse to the axon and the boutons of the axon undergo a chemical reaction that releases chemicals that diffuse across to either (1) other nerve cells (2) dendrites or (3) effectors such as muscles. The problem, however, is inside the neuron. It is the consistency of Jello. Nerve impulses would travel too slow because each would have to "wade" through the Jello like consistency of the cell.

In some cases, nerve impulses need to be slow. These are sometimes referred to as slow reflexes. However, what if you need a fast reflex, like when you put your hand on a hot stove? You better react quickly or you could get burned. Fast acting neurons are different from slow acting neurons. Fast acting neurons have cells which wrap around the axon, much like wrapping dough around small hot dogs to make "pigs-in-a-blanket". The cells which wrap around the axon are called Schwann cells. These Schwann cells coat the axon along its length with the exceptions of gaps between the Schwann cells. These gaps are called nodes of Ranvier. Why the gaps?

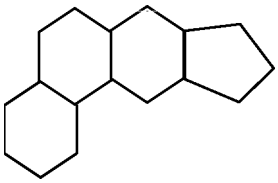


The nodes of Ranvier act very much like electrical wires without insulation. Think of how you slide across a car seat in cold weather and get "shocked" by static electricity. Once the nerve impulse gets to the axon, instead of wading through the "Jello" of the axon, it arcs between the nodes of Ranvier (like a bare wire) thus speeding up the nerve impulse. The Schwann cells are padded with a material called myelin. Myelin is simply the phospholipids we previously discussed.

Sometimes Schwann cells may become damaged and form "scars" along the length of the cell. This damage is thought to be caused by an autoimmune response where your immune system attacks the brain and spinal cord myelinated sheaths. This, unfortunately uncovers another part of the axon and, in effect, acts like another node of Ranvier. The result is the nerve impulse jumps the gap at the new node and the effect is similar to stuttering. This "stuttering" of the transmission along the axon is called Multiple Sclerosis.

Sterols

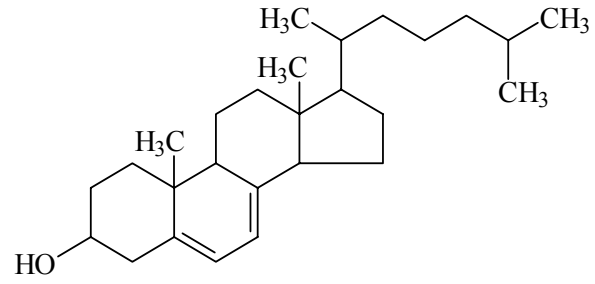
Sterols (also known as steroids) are derived from triglycerides. The triglyceride is modified into a ring structure. All sterols have a basic ring structure of three six membered rings (hexagons) and one five membered ring (pentagon). The first hexagons are staggered one above the other, the next hexagon lies next to the last hexagon, and the pentagon is attached to that.



What determines the nature of the sterol is what is attached to the rings. Some sterols form double bonds within the rings and almost all have a "tail" just off the pentagon. Some examples of sterols are cholesterol, testosterone, and progesterone.

Cholesterol

Is cholesterol good or bad? Like most things in life, there's no easy answer. Even if you never ate food with cholesterol in it, you would actually manufacture it in your system. Cholesterol provides protection in cell membranes from freezing temperatures and is also an important precursor in the formation of many steroid hormones and bile salts.



cholesterol

On the other hand, excess cholesterol can be a problem. It is often deposited

in the walls of arteries and veins in the form of plaque. Plaque formations cause the normally smooth walls of arteries to become rough. Platelets (thrombocytes), when pushed against those walls under pressure, release clotting factor, which causes blood clots. If this occurs in the heart, it is called a myocardial infarction (or heart attack). If it occurs in the brain, it is called a cerebral accident (or stroke). Most scientists suggest the level of cholesterol in the blood stream should not exceed 200 mg/dL.

HDL and LDL

An important aspect in determining if you are susceptible to cholesterol deposition in your arteries is the ratio of HDL to LDL. HDL stands for high density lipoprotein (sometimes erroneously called "good" cholesterol). It simply is a fat with a protein attached. LDL stands for low density lipoprotein (also erroneously called "bad" cholesterol). Individuals should try to reach a LDL of less than 100mg/dL. The HDL concentration should be less than 40mg/dL. HDL has the ability to remove excess levels of cholesterol from the blood and break it down in the liver. LDL, on the other hand, is a vasoconstrictor and a stimulant for the production of platelets.

Chart from www.reducetriglycerides.com

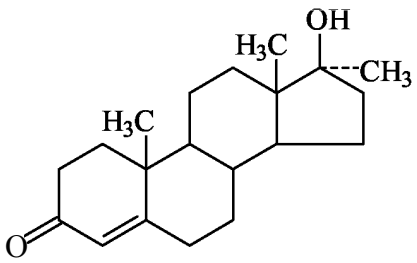
LIPID				**SHOULD BE**
Total Cholesterol (TC)	**Desirable** < 200mg/dL	**Borderline high** (depending on your HDL) 200 mg/dL -239 mg/dL	**HIGH** 240 mg/dL and above	Less than 200 mg/dL, depending on your HDL Not more than 4 times HDL is desired 4 X 40 mg/dL HDL = 160 mg/dL total cholesterol(TC) 4 X 50 mg/dL HDL = 200 mg/dL total cholesterol (TC)
HDL Cholesterol High Density Lipoprotein "Good" Cholesterol	**DESIRABLE** Men - 65 mg/dL Women - 75 mg/dL or Higher	**ACCEPTABLE** Men - 55 mg/dL Women - 65 mg/dL	**LOW** Men - <45 mg/dL Women - <55 mg/dL	A minimum of 55 mg/dL - 60 mg/dL The lower your HDL, the lower your total cholesterol (TC) should be!
HDL/TC Ratio HDL divided by Total Cholesterol (TC)	**IDEAL** 0.30 or Higher	**LOW** Under 0.24	**VERY DANGEROUS** Less than 0.10	Above 0.24 Example: 80 HD:190 TC = 0.42 The higher the number (your HDL:TC ratio), the better (the lower your risk of heart attack)
Triglycerides (TRG)	**BORDERLINE HIGH** 150 mg/dL - 199 mg/dL	**HIGH** 200 mg/dL - 499 mg/dL	**VERY HIGH** Over 500 mg/dL	Less than 150 mg/dL When triglycerides are "severely high" (greater than 1000 mg/dL), there is a risk of developing pancreatitis
TRG/HDL Ratio Triglycerides divided by HDL	**IDEAL** 2 or Less	**HIGH** 4	**MUCH TOO HIGH** 6	Less than 2 Example: 110 TRG:60 HDL<2 The lower your TRG:HDL ratio, the lower your risk of heart attack
LDL Cholesterol Low Density Lipoprotein "Bad" Cholesterol	**NEAR OPTIMAL OR ABOVE OPTIMAL** 100 mg/dL - 129 mg/dL	**BORDERLINE HIGH** 130 mg/dL - 159 mg/dL	**HIGH** 160 mg/dL - 189 mg/dL	Less than 100 mg/dL (OPTIMAL) 190 mg/dL and above is considered VERY HIGH

These numbers are based on a fasting lipid profile: 12 to 14 hours before the test (alcohol should not be consumed for the 24 hours). IF YOU DO NOT FAST, your Triglycerides, and LDL will be higher.

Testosterone

Testosterone is a male sex hormone. Females also produce testosterone, just not as much. This is the hormone that most people think of when they think of steroids. Hormones are chemical messengers produced in one location of the body (in the case of testosterone – the testis) but exert their influence in a different location of the body. Testosterone is responsible for the secondary sexual characteristics of males. These characteristics are most often viewed as changes that result from puberty. The secondary sexual characteristics of males are

- Rapid muscle and bone growth
- Voice change Pimples
- Facial hair
- Axillary hair
- Pubic Hair
- Enlargement of penis
- Testicles produce sperm
- Aggression?

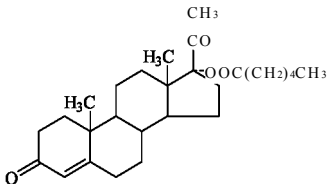


Aggression has a question mark next to it because scientists have recently re-evaluated the original study that indicated testosterone causes aggression in males and that concept is under review.

Does testosterone do what athletes say? Yes. It will very rapidly add bone and muscle growth. However, there are side effects. All males have a personal base-line level of testosterone. When testosterone is added in excess of the base-line, there are significant effects. For example, males will go bald. They will re-develop pimples. These are minor. There are also problems with heart disease and possible liver cancer.

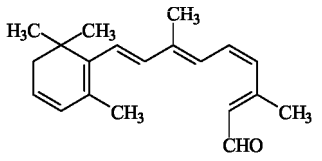
Progesterone

One female sex hormone is progesterone. Again, this is misleading since males also produce progesterone, however not at the levels of females. Progesterone is not responsible for the secondary sexual characteristics in females; instead, it has a role in getting the uterus ready for implantation by the developing fetus.



Vitamins

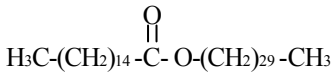
Again, you begin with triglycerides to form vitamins. Vitamins are nutrients essential for your well-being, but you cannot manufacture them. You must obtain them from some other source, usually through your diet. There are two classes of vitamins: fat soluble and fat insoluble. Since "like dissolves like", fat soluble vitamins are lipid derived.



Vitamin A

Fat Soluble Vitamins
The fat soluble vitamins are A, E, D, and K. All the others are fat insoluble. Many vitamins serve as coenzymes in biological systems.

Waxes
Waxes are exceptionally long-chain fatty acids and typically nonpolar. Waxes have the benefit of being soft and pliable when warm and hard when cold. Waxes are for protection. They are found naturally on fruits, leaves, and other plant parts as protection against bacteria, fungi, viruses, etc. They are also used as waterproofing. Humans produce waxes, not only ear wax, but hair is covered with a wax, and so is our skin.



Myricyl palmitate – a wax

Prostaglandins
These are oxygenated derivatives of polyunsaturated fatty acids. They often form ring structures or open ended rings. The first prostaglandin was found in the male prostate gland, hence their name, but since then we have found numerous others in different locations of the body. They have many different functions. Some prostaglandins cause vasoconstriction in one dosage and vasodilation at another dosage. They are used to induce labor in pregnant women, have a role in pain reception and fever.