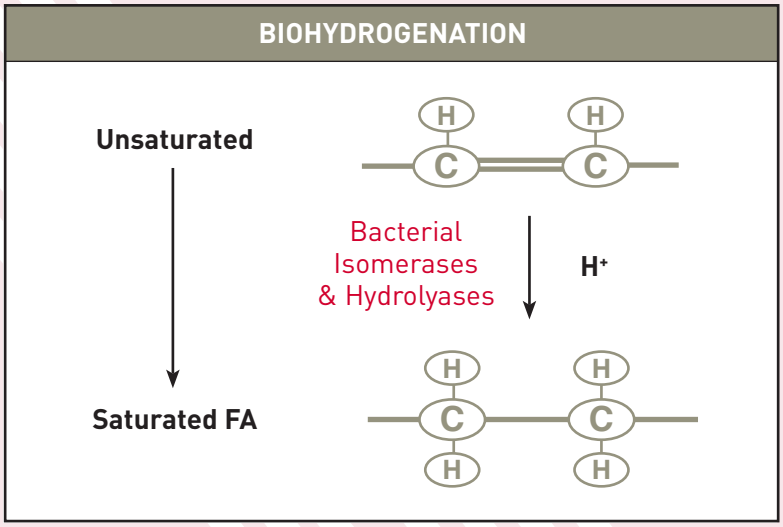
Unsaturated vs. Saturated Fatty Acids

Most fats in plant sources, such as grains and oil seeds, are not only in triglyceride form, but they are also highly unsaturated. Thus they have a lower melting point which is why they are liquid at room temperature. Unsaturated oils are also more unstable and can oxidize over time. The first thing that bacteria in the rumen will do when plant oil sources are eaten by the cow is to hydrolyze their triglycerides to free fatty acids and glycerol. But the unsaturated fatty acids released are toxic to rumen microbes. When some of them are taken up by bacteria into their cell walls, their walls become fragile; and the bacteria die when their cell walls break. Thus the bacteria need to saturate the unsaturated fatty acids to detoxify them. They can do this because they have enzymes for transforming unsaturated fatty acids to saturated fatty acids. This process, called biohydrogenation, occurs as illustrated in the figure below.



A. Lock, 2006

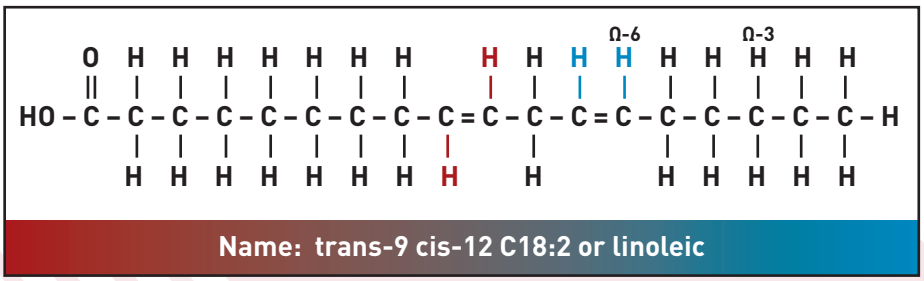
This process is highly efficient as about 85% of dietary unsaturated fatty acids from grains, oil seeds, and fat supplements such as calcium salts of fatty acids (CSFA) are converted to saturated fatty acids in the rumen. But that still leaves about 15% unsaturated fatty acids that escape the rumen and travel to the small intestine where they can be absorbed. But they also have another effect. Unsaturated fatty acids decrease dry matter intake (DMI). This will be examined in more detail in a later edition of Fat Feeding Facts. Also in the process of bacteria biohydrogenating unsaturated fatty acids, especially linoleic (C18:2), an intermediate step occurs which results in significant milk fat depression.

An example of an unsaturated fatty acid is linoleic as shown in the figure below. Describing individual unsaturated fatty acids is done by designating the location of double bonds and their configuration. Triglycerides present in plant oils have double bonds that are in the cis form. That means that both hydrogen (H) atoms on the carbons (C) of the double bond are on the same side. Bacteria must first change that cis to a trans (opposite side) configuration before they can biohydrogenate that double bond. The nomenclature for linoleic fatty acid which has two double bonds is trans-9 (the configuration and location of the first double bond at the 9th carbon atom), cis-11(configuration and location of the second double bond at the 11th carbon atom) C18:2—which means linoleic has 18 carbons with 2 double bonds. Omega designation of unsaturated fatty acids originates from the right side of the fatty acid and refers to the location of the first carbon atom on the double bond. Thus, linoleic shown below is an omega-6 fatty acid while linolenic (C18:3) would be an omega-3 fatty acid.

FAT FEEDING FACTS 3

Unsaturated vs. Saturated Fatty Acids

- **cis (same side)** and **trans (opposite side)** describe position of hydrogen atoms relative to each other
- Polyunsaturated fatty acids (PUFA) contain *more than one double bond*
- Monounsaturated fatty acids (MUFA) contain *only one double bond*



A synopsis of comparative differences between saturated and unsaturated fatty acids is shown below. Future Fat Feeding Facts will address further some aspects noted below but not explained now.

SATURATED VS. UNSATURATED FAT	
Saturated • Every carbon (C) atom is saturated with hydrogen (H) • Most stable • Does not negatively affect rumen microbial activity • Does not decrease dry matter intake • Does not contribute to milk fat depression • Fat flowing from rumen is 85 to 90% saturated free fatty acids • 65% of fatty acids in milk are saturated	**Unsaturated** • One or more double bonds (=) exists between two carbon atoms • More unstable and susceptible to oxidation • Toxic to rumen microbes so they "biohydrogenate" them—convert to saturated fatty acids • Metabolically decreases dry matter intake • Major contributor to milk fat depression