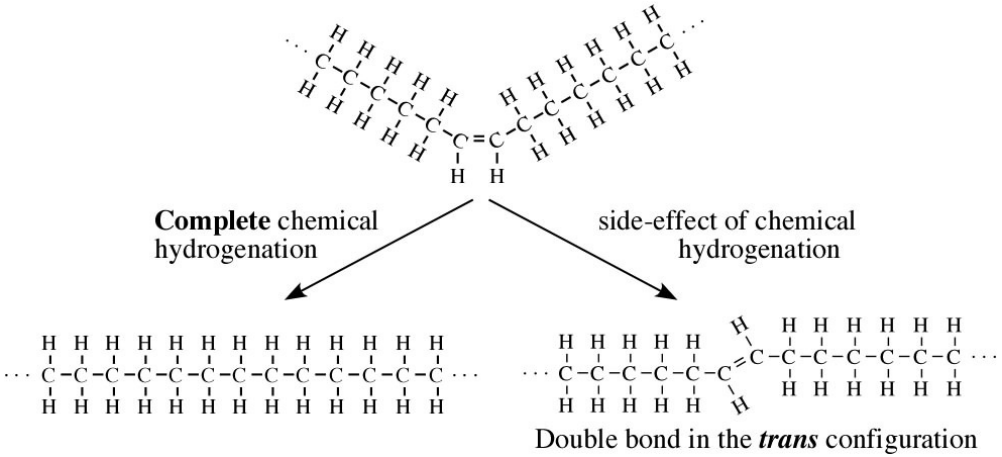
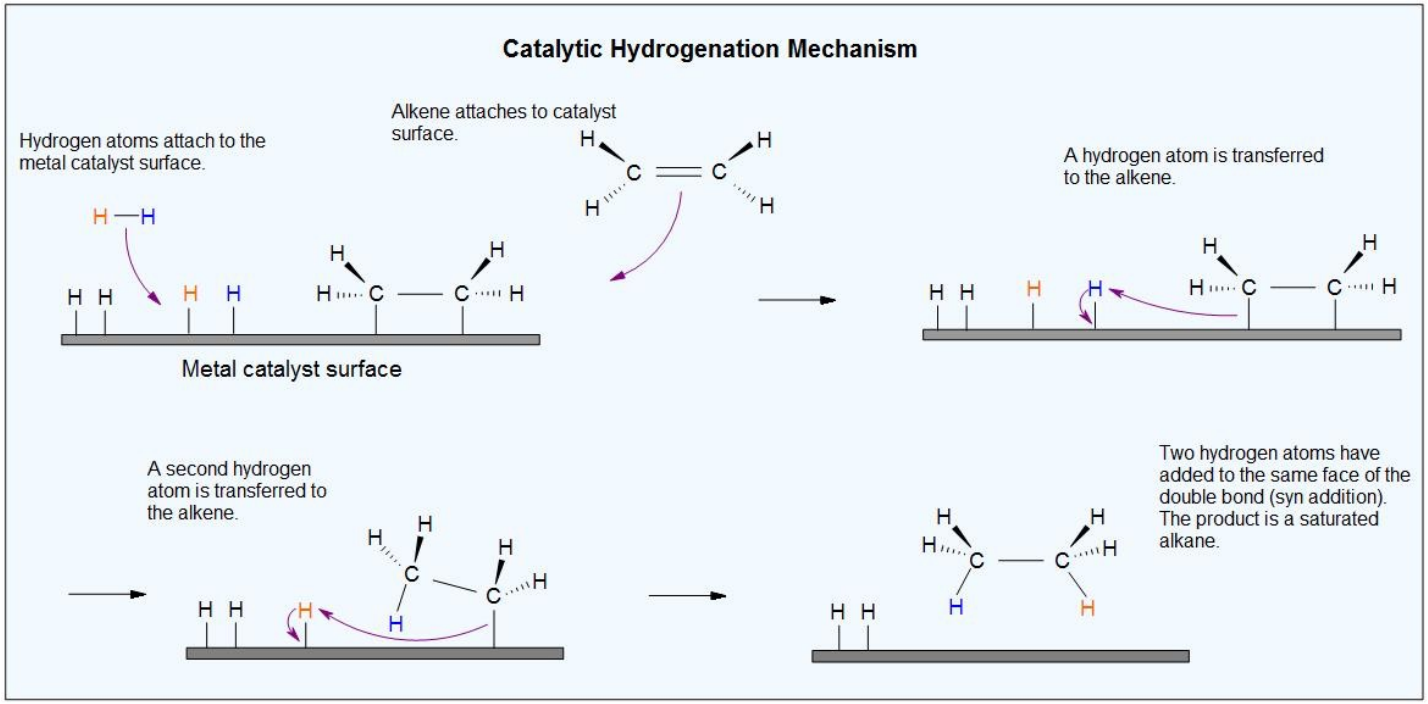
Lipid hydrogenation





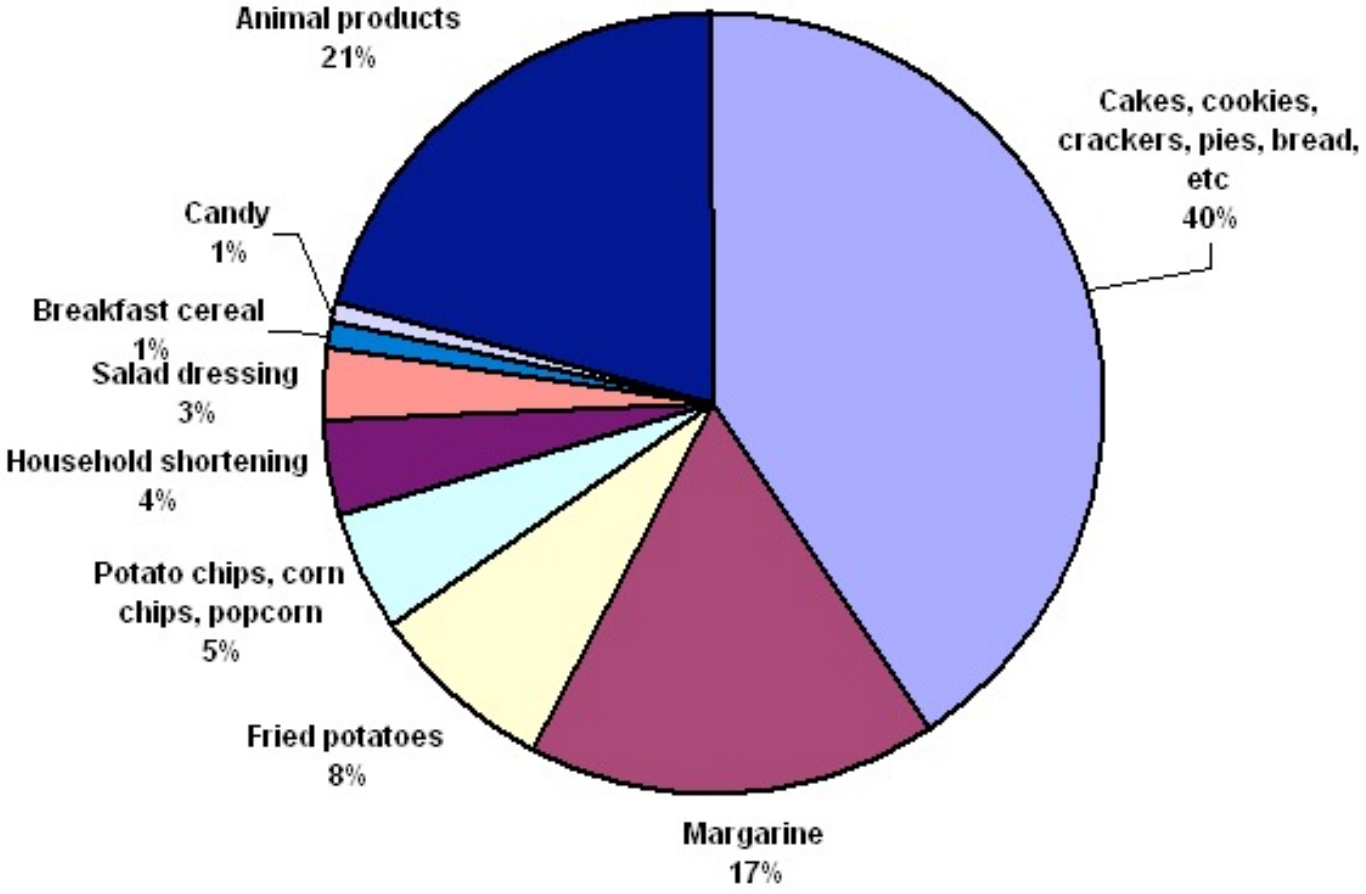
The partial hydrogenation of fats with industrial methods leads to the formation of unsaturated lipids in trans configuration.

Trans-fatty acids

Reaction with numerous applications, especially in the treatment of oils and fats in the food industry; through a partial hydrogenation the vegetable oils, normally liquid, are converted into solid or semi-solid fats (such as margarine).

Typically, the reagent used is gaseous hydrogen, H2, in the presence of metal catalysts such as Ni, Pd or Pt. The reaction is generally carried out under rather drastic conditions, at high temperatures and pressures.

Main dietary sources of trans fats for the adult American population. Average intake of trans fat equal to 5.8 g (2.6% of total calories).



As early as 1988 there were suggestions in the scientific literature that trans fats could be a cause of the large increase in coronary artery disease. In 1994, it was estimated that trans fats caused 20,000 deaths annually in the US from heart disease.

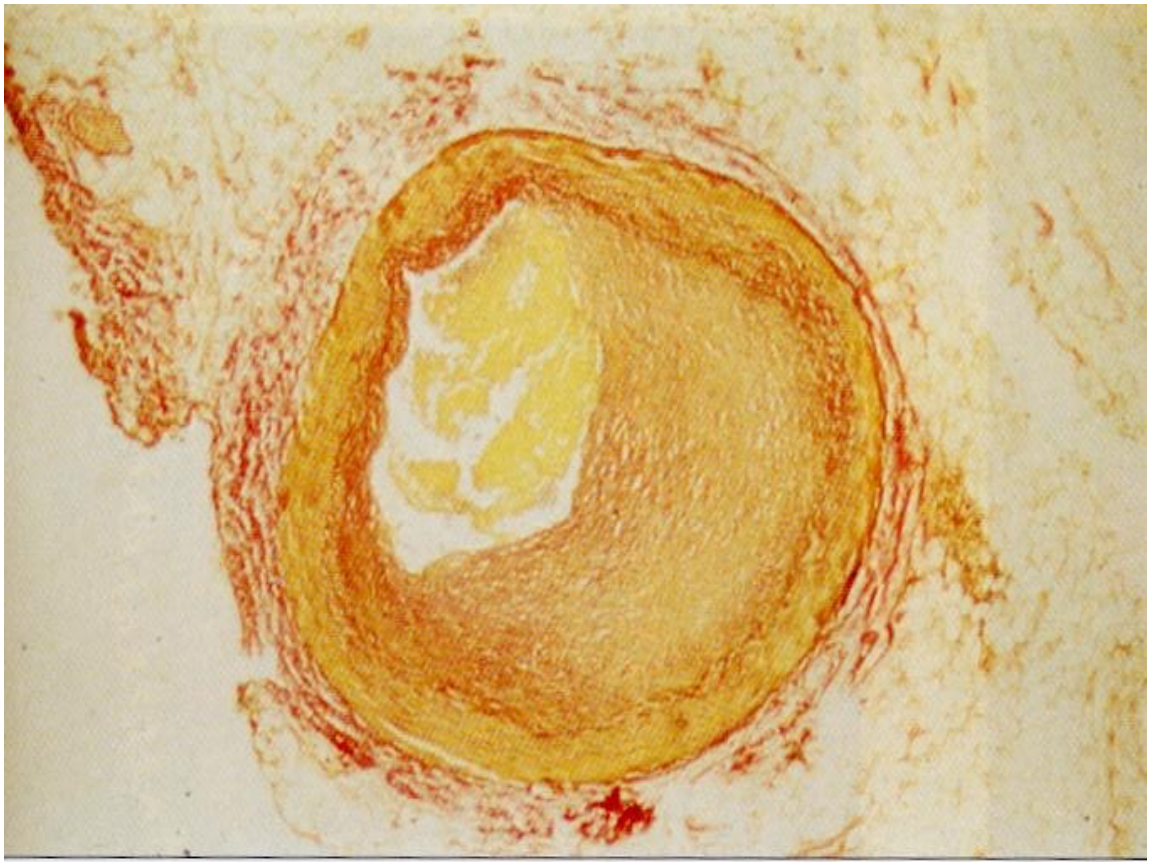
1. Food and nutrition board, institute of medicine of the national academies (2005). *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients)*. National Academies Press. p. 423.

2. Food and nutrition board, institute of medicine of the national academies (2005). *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients)*. National Academies Press. p. 504.

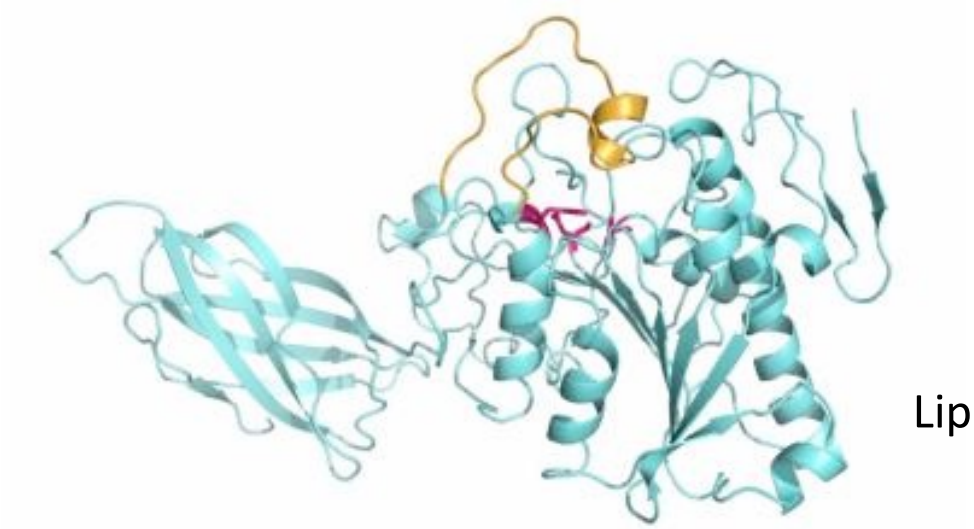
3. Mozaffarian D, Katan MB, Ascherio A, Stampfer MJ, Willett WC (April 13, 2006). "Trans Fatty Acids and Cardiovascular Disease". New England Journal of Medicine 354 (15): 1601–1613.

Trans unsaturated fats increase the risk of chronic cardiovascular disease by inducing an increase in LDL cholesterol and a decrease in HDL cholesterol.

Atherosclerotic deposit



The biochemical mechanism that leads to the increased risk of chronic cardiovascular disease related to the intake of trans fats is not clear. It is hypothesized that since they are not recognized by lipases, they remain in circulation for longer, increasing the formation of atherosclerotic plaques.



Lipasi pancreatica

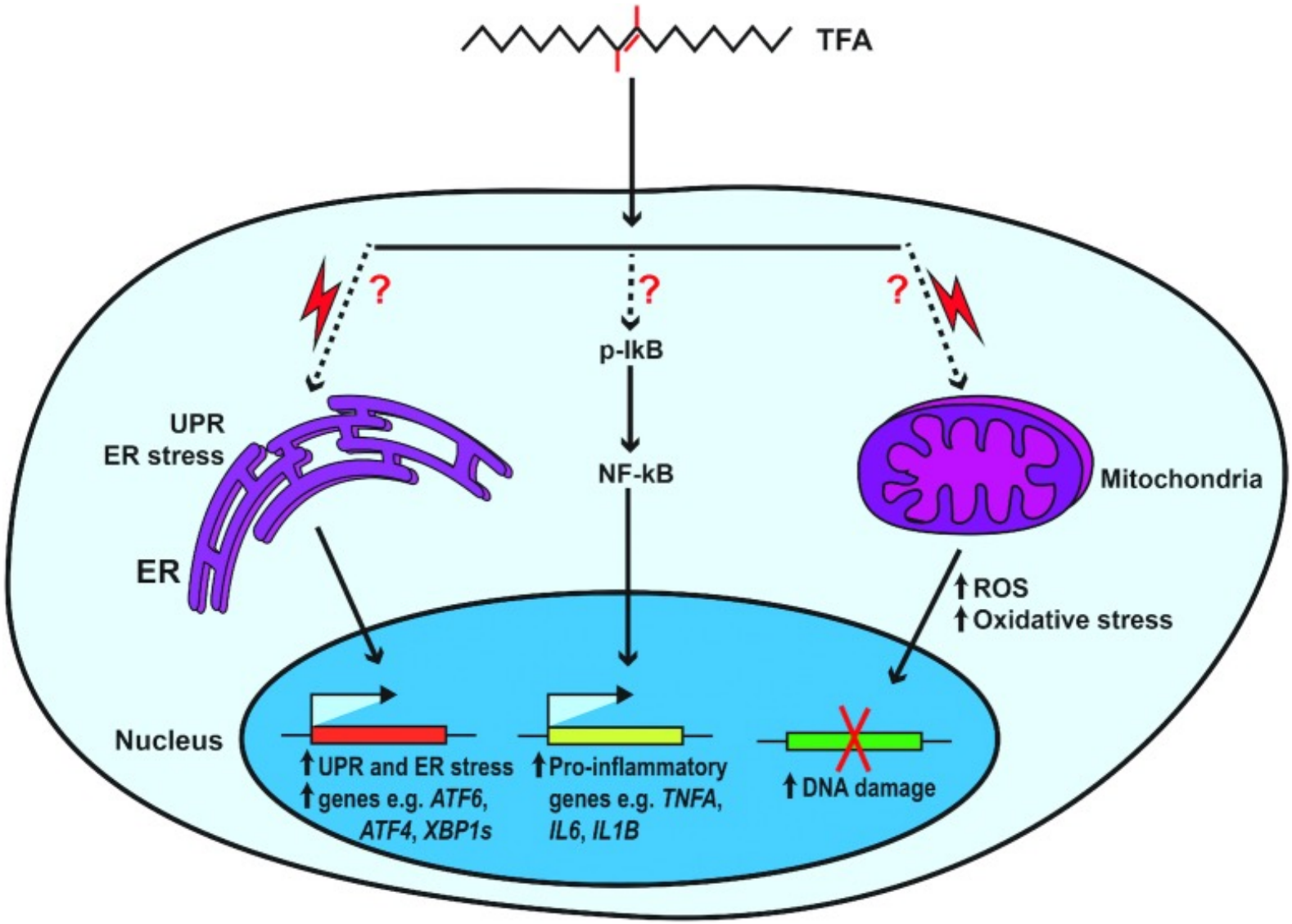
"On a per-calorie basis, trans fats appear to increase the risk of CHD more than any other macronutrient, conferring a substantially increased risk at low levels of consumption (1 to 3% of total energy intake)". The study (3) estimates that between 30,000 and 100,000 cardiac deaths per year in the United States are attributable to the consumption of trans fats.

- Denmark (since 2003) has regulated the trans fat content, it cannot exceed 2% in the single ingredient. A 50% reduction in chronic cardiovascular diseases is expected.
- Switzerland adopted the same limits in 2008.
- New York City and California imposed a declaration of hydrogenated fats contents in restaurants.

- https://www.mayoclinic.org/diseases-conditions/high-blood-cholesterol/in-depth/trans-fat/art-20046114

Oteng AB, Kersten S. Mechanisms of Action of trans Fatty Acids.
Adv Nutr. 2020 May 1;11(3):697-708.
doi: 10.1093/advances/nmz125.

“Overall, in vivo and in vitro studies demonstrate that industrial trans fatty acids promote inflammation and endoplasmic reticulum (ER) stress, although to a lesser degree than SFAs, whereas cis-unsaturated fatty acids are protective against ER stress and inflammation. Additionally, industrial trans fatty acids promote fat storage in the liver at the expense of adipose tissue compared with cis-unsaturated fatty acids and SFAs. In cultured hepatocytes and adipocytes, industrial trans fatty acids, but not cis-unsaturated fatty acids or SFAs, stimulate the cholesterol synthesis pathway by activating sterol regulatory element binding protein (SREBP) 2-mediated gene regulation. Interestingly, although industrial and ruminant trans fatty acids show similar effects on human plasma lipoproteins, in preclinical models, only industrial trans fatty acids promote inflammation, ER stress, and cholesterol synthesis. Overall, clearer insight into the molecular mechanisms of action of trans fatty acids may create new therapeutic windows for the treatment of diseases characterized by disrupted lipid metabolism.



Proposed molecular mechanisms of *trans* fatty acids. *ATF4*, activating transcription factor 4; *ATF6*, activating transcription factor 6; ER, endoplasmic reticulum; p-IκB, phosphorylated IκB; ROS, reactive oxygen species; TFA, *trans* fatty acid; UPR, unfolded protein response; *XBP1s*, X-box binding protein 1, spliced form; ?, represents unclarified mechanism.