Fats and Lipids

-Saturated/fat (cis-Double bonds) vs **Unsaturated**/oil Fatty Acids.

-Unsaturated FA in food lipids:

Oleic Acid (C18:1), Linoleic Acid (c18:2), Linolenic Acid(C18:3), Arachidonic Acid (C20:4)

An increase in chain size increases the Melting Point; double bonds drastically lower the MP.

-Hydrogenation of Oils: saturates them and increases their stability and solidity.

Some double bonds shift in configuration (from cis to Trans-fat aggravates plasma triglycerides, total cholesterol specially LDL while decreasing HDL)

-Emulsions:

The formation of "oil bubbles" in water (continuous phase)- **Emulsion in Cream, Oil is discontinuous in Water, hydrophilic heads outwards.**

-Fats in food pose 9kcal/g and are important for being a huge source of energy, ADEK vitamin transport, they add flavor and satiety; they are practical for food preparation (efficient heat transfer medium/ 170-200 degrees of heat for oils vs. 100 degrees of boiling for water). Lipids are useful in emulsification of phospholipids and the stabilization of oil-water emulsions such as creams and butters.

"LECITIN" is the most commonly used emulsifier. Emulsifiers "sit" on the oil and orient the heads and tails to fix the oil droplets in their positions. It is also found in Eggs and assists in the production of Mayonnaise.

An Emulsion is described as **a discontinuous liquid phase in a continuous liquid phase**; the notation used to describe it is (Discontinuous phase/Continuous Phase) [ex. (O/W) is for oil in water emulsion in Cream]. The difference between the types of creams is dependent on the oil content, which is due to the fat in Milk (used in the making of Cream).

Milk is usually 4% Fat, the quantity of lipids is usually tampered to produce the different types of Creams (Cooking cream, sweet cream….); the milk contains indigenous emulsifiers that automatically react.

The formation of "water bubbles" in oil (continuous phase)- **Emulsion in Butter, water is discontinuous in Oil, hydrophobic tales outwards.**

Butter making involves "grouping the fats" via Churning of cream and letting out and filtering out the water. Ends up with 80-83% of fats (giving a yellow color and a solid structure).

Making Margarine: plant oil, water, and emulsifiers shaken into butter.

-Rancidity is the deterioration of oils with the production of "Off- flavors".

-Two forms of Rancidity:

1. Hydrolytic rancidity: Lipolysis

Ester Linkages of triglycerides hydrolyze and release fatty acids, most common in systems of fat and water.

-In the Dairy Industry, this is important for the process of **milk homogenization**. Triglyceride is hydrated in the presence of Lipase into Glycerol and **Short-Chain-Free Fatty Acids. On the Macro Level, homogenization means that fat globules become smaller and distribute along the aqueous phase. Milk naturally contains Lipase.** Homogenization prevents the creaming of Milk.

Once milk is homogenized, there's more surface area for the reactions to proceed, which is why Lipase is removed/denatured by heating/irradiating the protein lipase.

-In Frying and Cooking, Oils are extensively used (specially for being heat transfer mediums). In the process of lipolysis, Triglycerides are hydrolyzed (food naturally contains water) and heated producing Glycerol and **Long-Chain-Free-Fatty-Acids (long chains are odorless and tasteless).** The Produced Fatty Acids are problematic and increase with the concomitant use of the same oil; the Free Fatty Acids polymerize and produce high molecular weight residues that appear to be brown. The reuse of oil decreases the quality of the foods fried, they end up with a dark surface, which absorbs more oil per every cook. The effects are toxic and health threatening. When perceivable changes in color of the frying oil appear, the oil must be replaced.

High fat/low moisture foods, have low to no chances of developing Hydrolic Rancidity, they include Oils and Baklaava

Smoking Point of Oils: The temperature at which "Haze" is seen over the oil's surface due to high concentrations of Free Fatty Acids which have a lower boiling point of Triglycerides, with the repeated use of the same oil, foods tend to have a lower Smoking Point.

2. Oxidative Rancidity: Auto Rancidity:

Flavor: Oil/fat containing foods, are all susceptible to develop auto-oxidation, this process is self-sustaining.

Fats and oils react with Molecular Oxygen and the reaction rate increases as it proceeds. This process affects all fat containing foods and their overall quality

Heat, Light, radiation breaks the Hydrogen off the oils producing unstable free radicals that react with Oxygen (O2) and become peroxides and go back to their free radical form to react. This Chain Reaction implies a fast deterioration of the food

Linoleic acid with two double bonds that produce (4x4=16) hydroperoxides

4 hydro-peroxides are produced every time an oxidative/ free radical forming reaction occurs with triglycerides. Hydro-peroxides do not smell, they are neither volatile nor of high molecular weight, however they are unstable and eventually decompose into **Aldehydes, Ketones, and Alcohol depend on which bond breaks,** they do smell, specially aldehydes, given their low molecular weight while alcohols and ketones change the food's taste.

Auto-oxidation is primarily affected by factors such as:

-The degree of bond unsaturation (due to more hydroperoxides as there are more double bonds to react faster) is as: **Marine fats> Vegetable Fats> Animal Fats**.

-Temperature (Q_{10} if equal to 2, doubles the reaction)

-Light and Radiation

-Oxygen

-Catalysis: Ions of metals (Fe and Cu) are powerful oxidation catalysts

Antioxidants: donate their Oxygen interrupting Propagation and preventing the regeneration of Free Radicals via Hydrogen donation to free radicals.

Most have a benzene ring and –OH (as Benza-Phenoles)

BHA, BHT, α−Tocopherol, Sesanol, Thymol, p-cymene-2,3-diol

Synergism: Between Phenolic antioxidants (BHA & BHT)

BHT extends the life of specific oil by 42hrs and BHA extending the oil's life by 35hrs. The total amount of hours extended is added into 91 hours more than the control oil. The antioxidants enhanced each other's activity and prevented oxidation together better than each alone.

The activity of two combined antioxidants has a more pronounced activity than each with it's own. This synergism is due to the two antioxidants working together to regenerate each other. BHA gives its Hydrogen to regenerate BHT from its radical (BHA's primary oxygen is more labile). The secondary antioxidant regenerates the primary antioxidant (and the most effective one). This is why phenolic antioxidants are added together for the purpose of exploiting Synergism among them.