



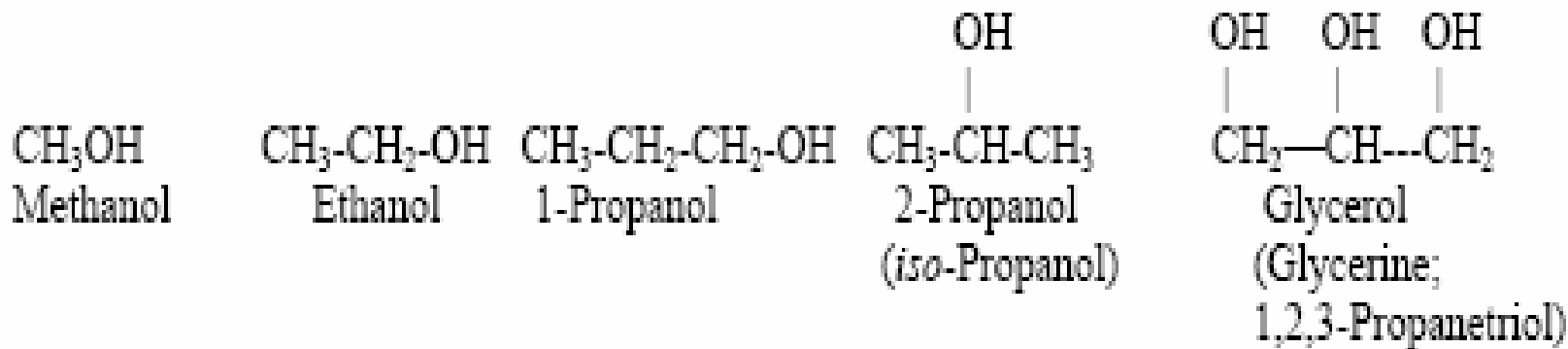
THE CHEMISTRY OF BIODIESEL

Important Families of Organic Compounds in Relation to Biodiesel

- Alcohols
 - Methanol
 - Ethanol
- Carboxylic acids
 - Free fatty acids
- Lipids
 - Triglycerols
 - Glycerophospholipids
 - Waxes
- Esters
 - Methyl esters
 - Ethyl esters

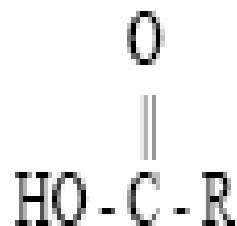
[Alcohols]

- There are many different types of alcohols
- The common feature present in all alcohols is an -OH, or hydroxyl, functional group
- This functional group often dictates the behavior and reactivity of the organic molecule

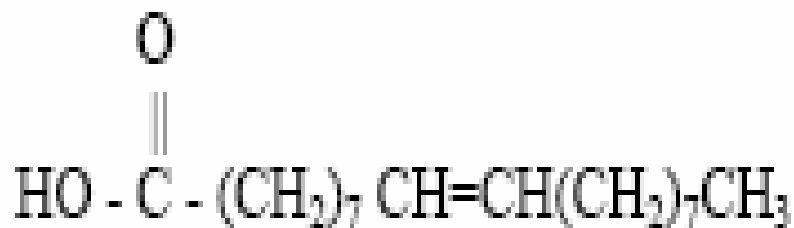


[Carboxylic acids]

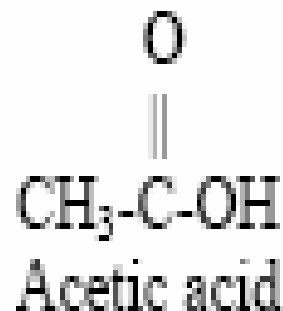
An organic compound containing the -COOH , or carboxyl functional group



Carboxylic Acid (R is a carbon chain)



Oleic Acid



[Lipids]

■ Historically, lipids are defined as components of living systems that are soluble in organic solvents and essentially **insoluble in water**.

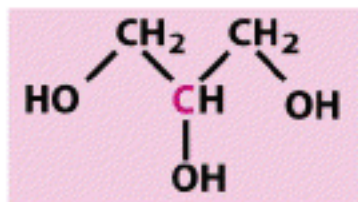
1. Lipids by this definition lack a common structural feature.
2. No more descriptive modern definitions exist

■ Lipids come in a variety of molecular structures:

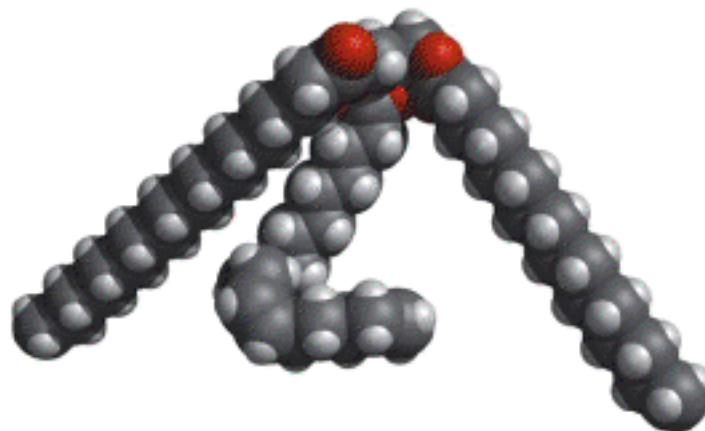
- Triacylglycerols – fats and oils
- Phospholipids
- Sphingolipids
- Steroid hormones
- Cholesterol

[Triacylglycerols (TAGs)]

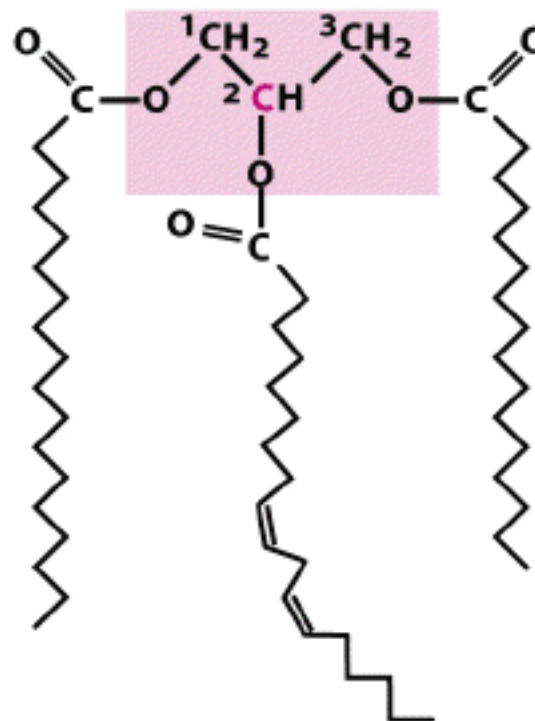
- Triacylglycerols are the most prevalent type of storage lipid in plants and animals.
- They are also the most common biodiesel **feedstock**
- There are several different types of triacylglycerols
 - Saturated – no C=C, double bonds
 - Unsaturated – one or more C=C, double bonds
 - Mono-unsaturated
 - poly-unsaturated
 - Hydrogenated (trans fats) –catalyzed, trans-saturated oils
 - Partially hydrogenated
 - Fully hydrogenated



Glycerol



Triacylglycerol



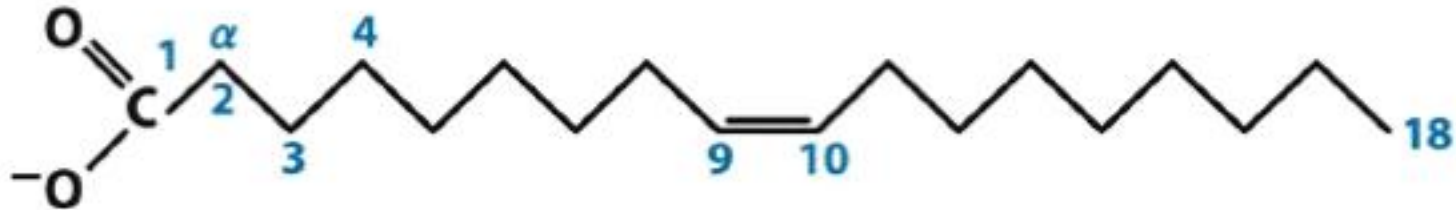
**1-Stearoyl, 2-linoleoyl, 3-palmitoyl glycerol,
a mixed triacylglycerol**

Figure 10-3

Lehninger Principles of Biochemistry, Fifth Edition

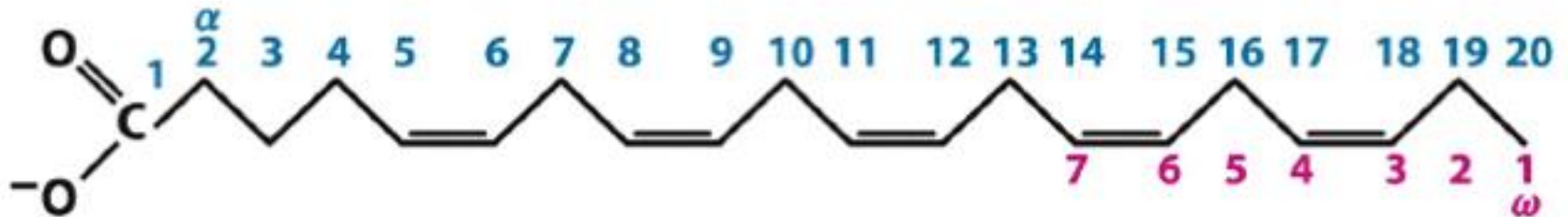
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FATTY ACIDS



(a) 18:1(Δ^9) *cis*-9-Octadecenoic acid

Oleic acid



(b) 20:5($\Delta^{5,8,11,14,17}$) Eicosapentaenoic acid (EPA),
an omega-3 fatty acid

Figure 10-1

Lehninger Principles of Biochemistry, Fifth Edition

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C4 to C36,

Saturated or unsaturated, occasionally 3-C rings, OH or CH₃ gps.

[Esters



Ester

- Esters are formed by the reaction of an acid with an alcohol
 - This is known as an **esterification** reaction
 - The hydrolysis of an ester with a strong base is known as **saponification**, the process of making soap

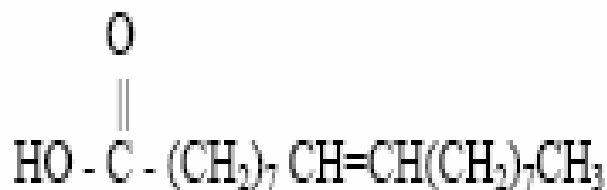


Figure 6. Oleic Acid



Methyl oleate (biodiesel)

TRANSESTERIFICATION

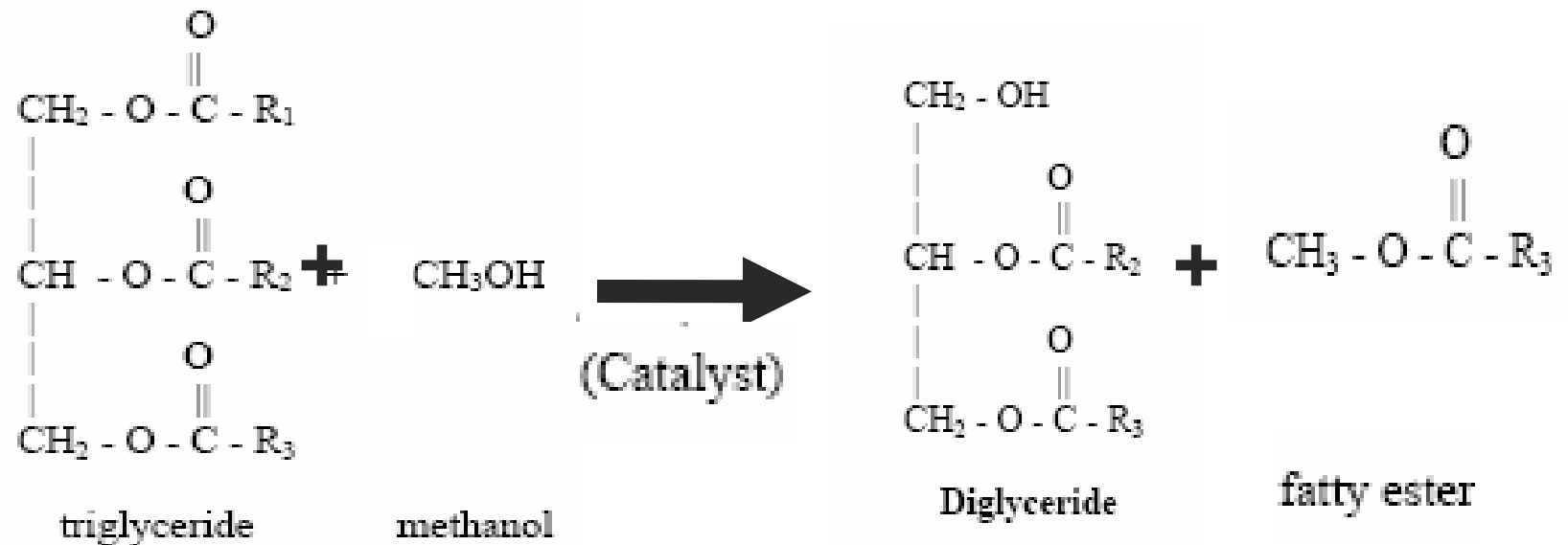
a step-by-step visual guide



Catalyst



[Step 1]



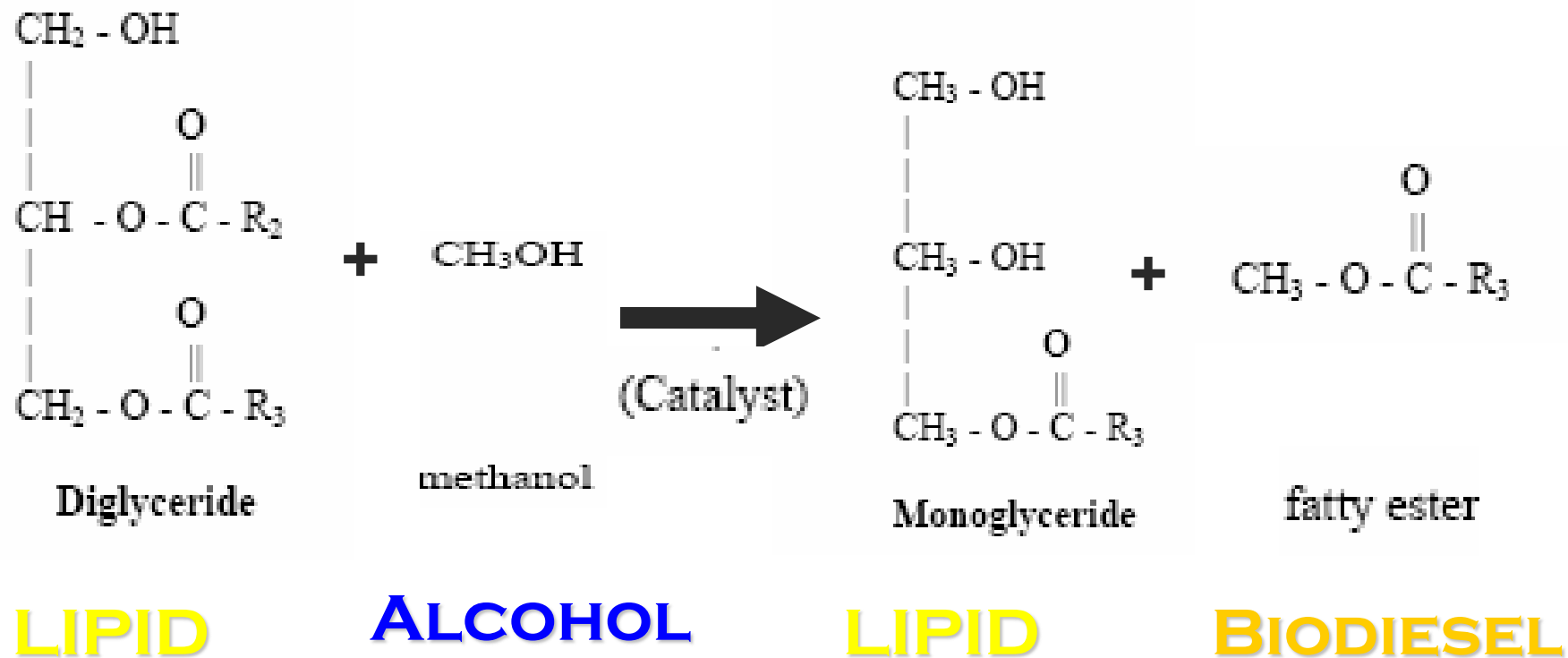
LIPID

ALCOHOL

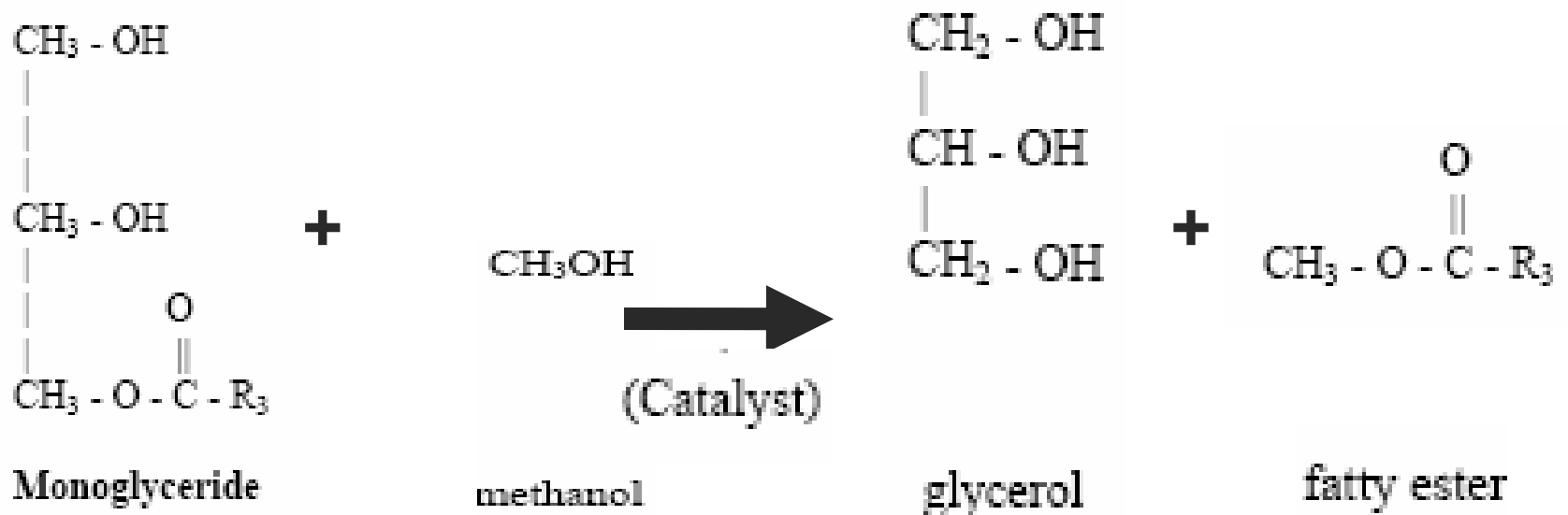
LIPID

BIODIESEL

[Step 2:



[Step 3]



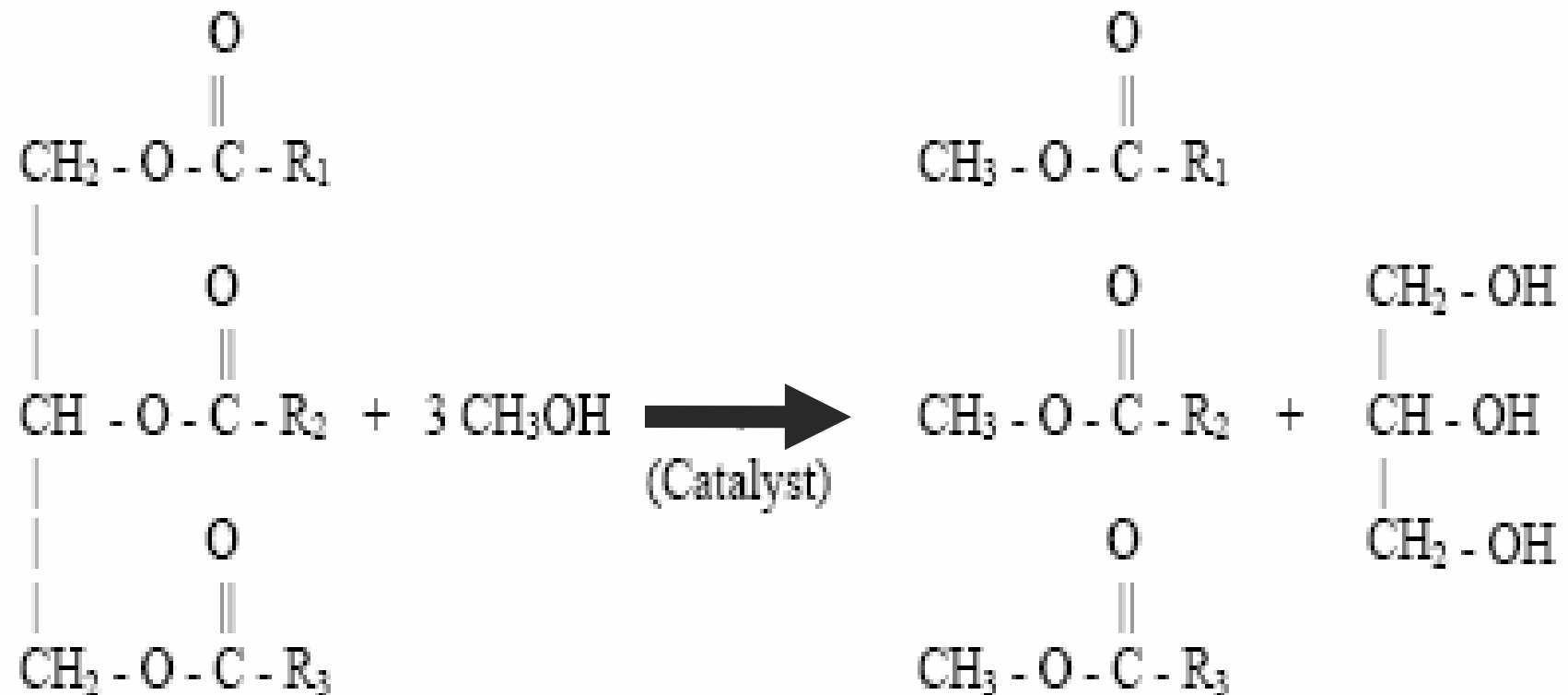
LIPID

ALCOHOL

GLYCEROL

BIODIESEL

Combined Reaction



triglyceride

methanol

mixture of fatty esters

glycerol

LIPID

ALCOHOL

BIODIESEL

GLYCEROL