THE CHEMISTRY OF BIODIESEL

ORGANIC CHEMISTRY

- Organic chemistry is the chemistry of the element carbon.
- Carbon atoms have a great flexibility in bonding with themselves and other atoms
- Around 90% of all known compounds are organic compounds
- There are close to 10 million organic compounds

Common Elements in Organic Chemistry

Table 3. Some elements of importance to organic chemistry.

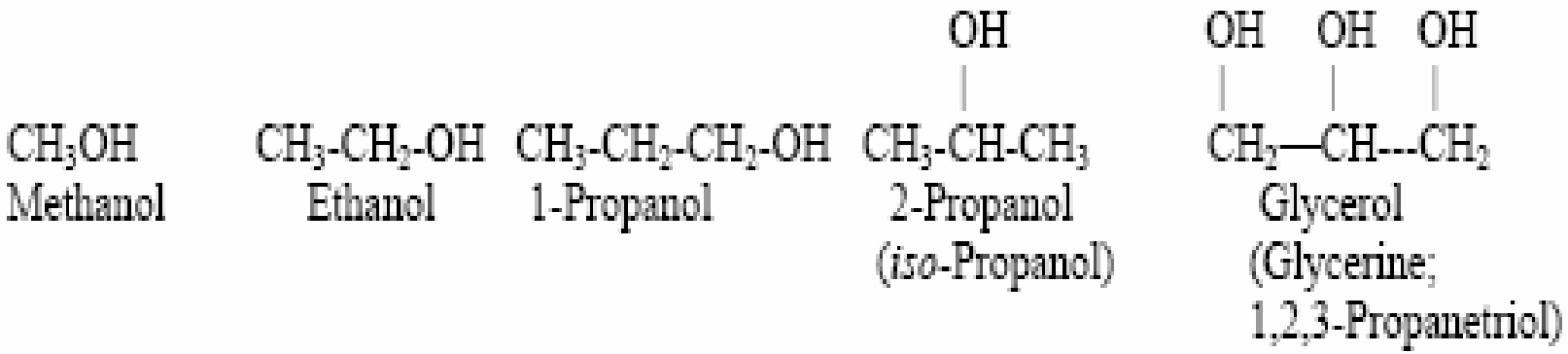
Name	Symbol	Atomic Number	Atomic Weight
Carbon	C	6	12.011
Hydrogen	H	1	1.008
Nitrogen	N	7	14.007
Oxygen	O	8	15.9994
Phosphorus	P	15	30.974
Sulfur	S	16	32.06

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

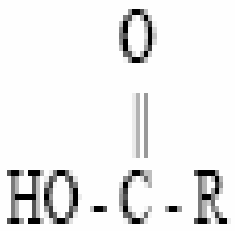
Alcohols

- 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

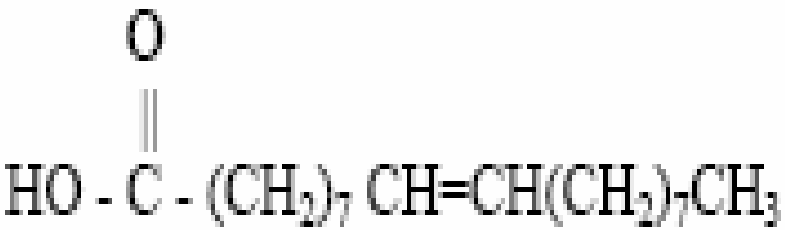


Carboxylic acids

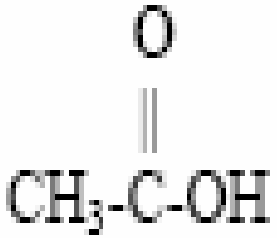
An organic compound containing the –COOH, or carboxyl functional group



Carboxylic Acid (R is a carbon chain)



Oleic Acid



Acetic acid

Lipids

- Lipids come in a variety of molecular structures:
  - Triacylglycerols – fats and oils
  - Phospholipids
  - Sphingolipids
  - Steroid hormones
  - Cholesterol

Triglycerols

- Triglycerols, or triglycerides, 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 triglycerols
  - Saturated – no C=C double bonds
  - Unsaturated – one or more C=C double bonds
  - Hydrogenated or Trans fats –catalyzed, trans-saturated oils

Triacylglycerols

- Saturated

Palmitic: R = $- (CH_2)_{14} - CH_3$ 16 carbons, (including the one that R is attached to.) (16:0)

- Unsaturated
  - Monounsaturated

Oleic: R = $- (CH_2)_7 CH=CH(CH_2)_7CH_3$ 18 carbons, 1 double bond (18:1)

  - Polyunsaturated

Linoleic: R = $- (CH_2)_7 CH=CH-CH_2-CH=CH(CH_2)_4CH_3$
18 carbons, 2 double bonds (18:2)

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

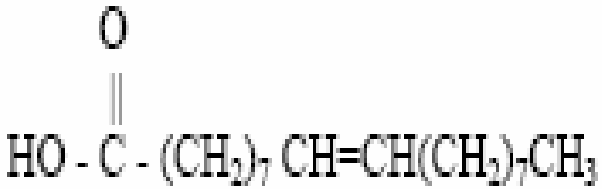


Figure 6. Oleic Acid

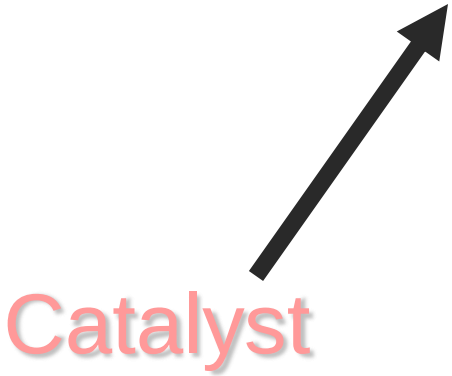
+ CH_3OH Methanol

Methyl oleate (biodiesel)

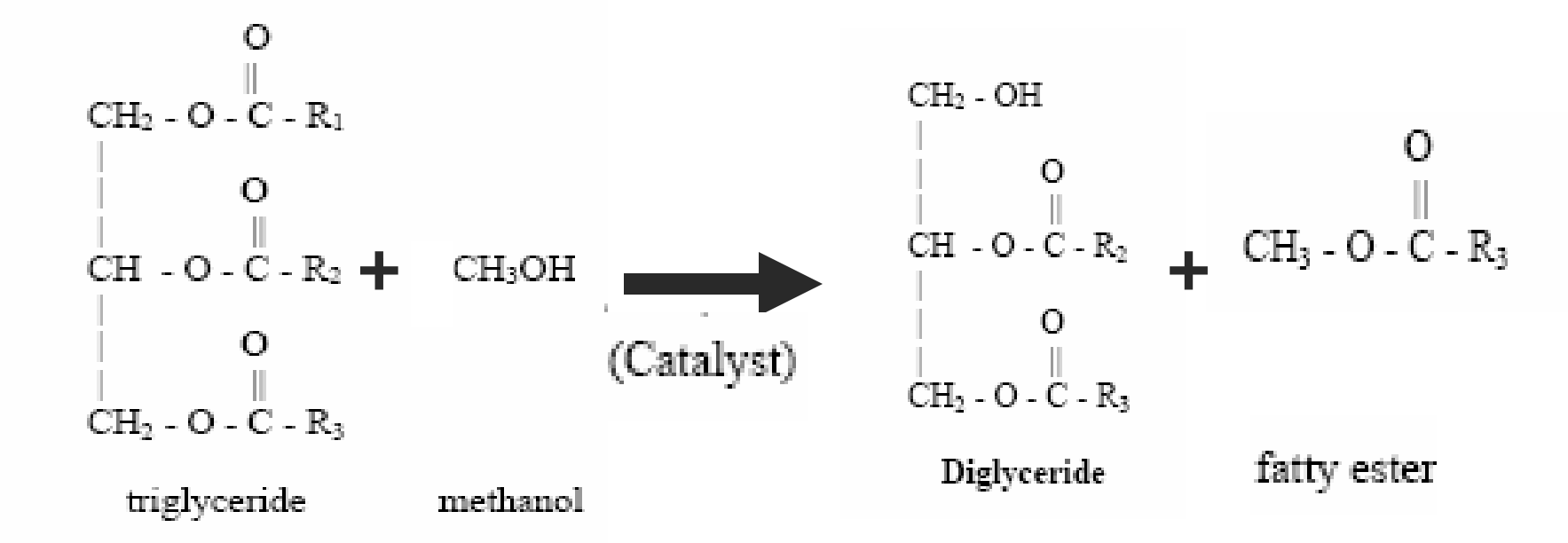
TRANSESTERIFICATION

a step-by-step visual guide

- OIL + ALCOHOL = GLYCEROL + BIODIESEL

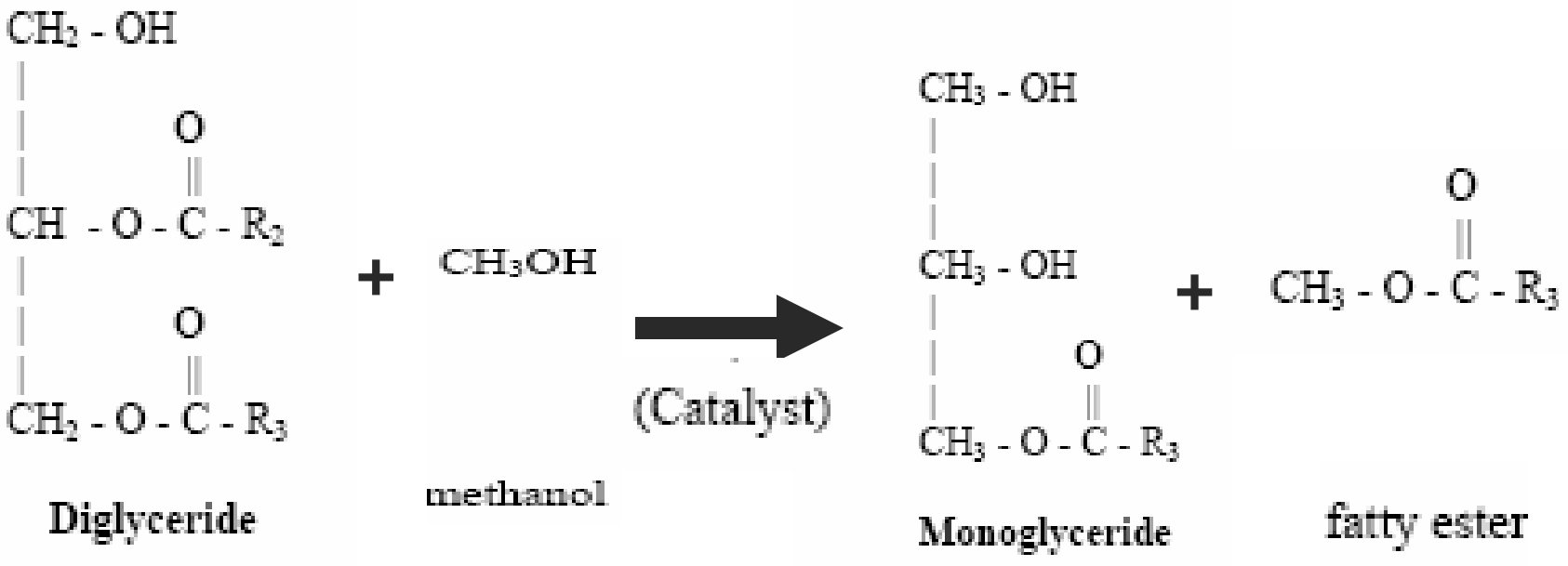


Step 1



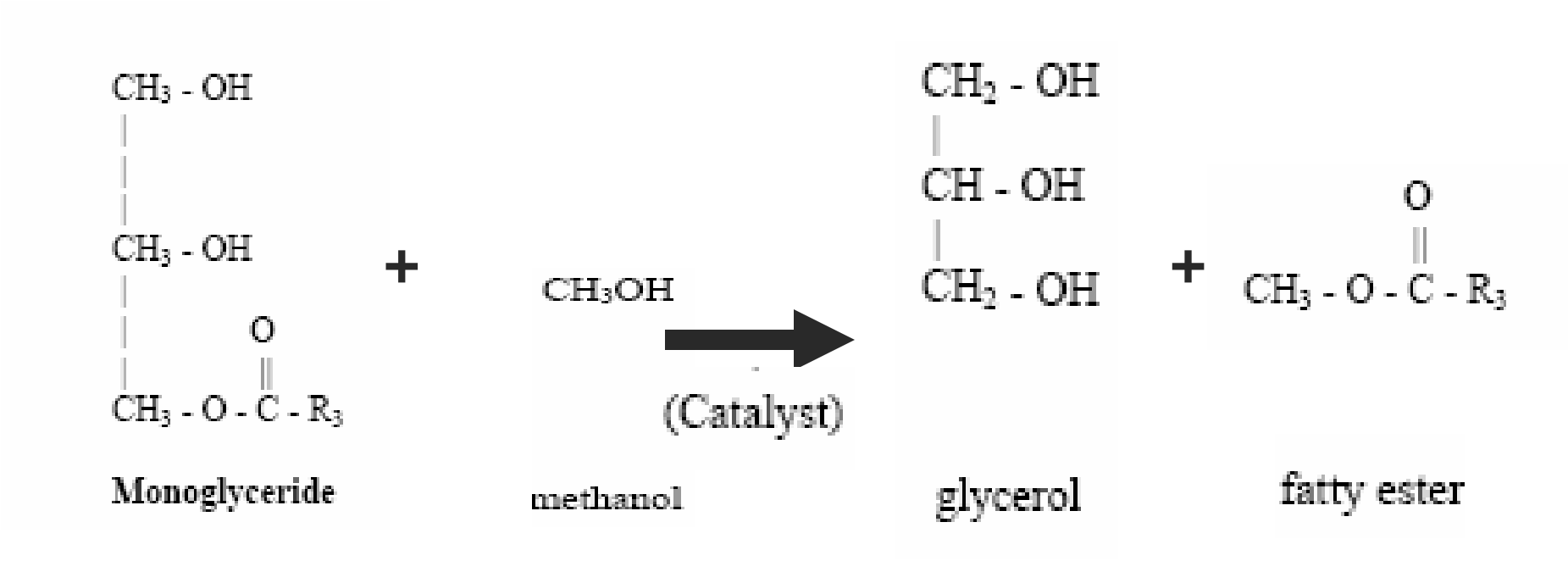
LIPID ALCOHOL LIPID BIODIESEL

Step 2:



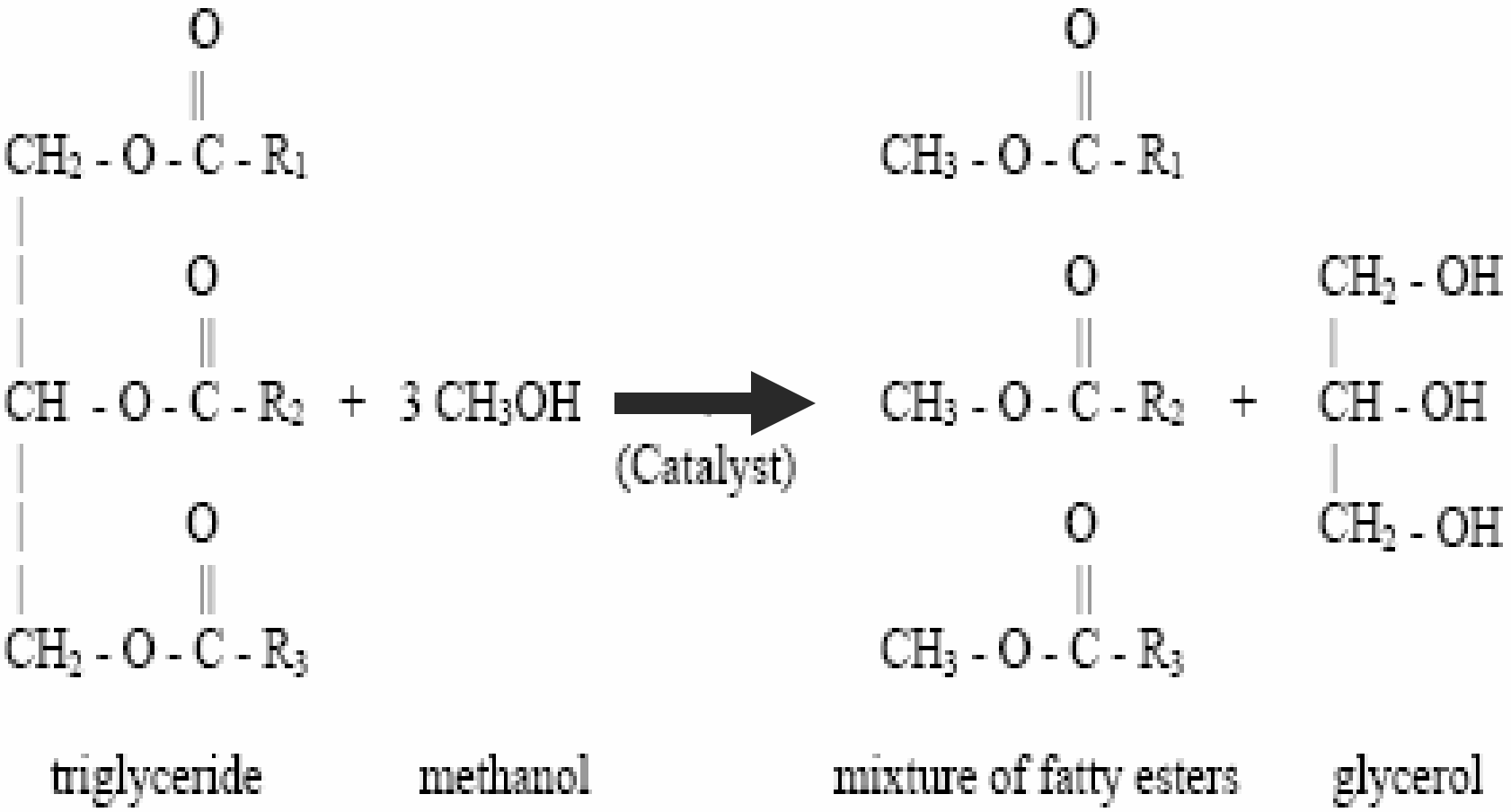
LIPID ALCOHOL LIPID BIODIESEL

Step 3



LIPID ALCOHOL GLYCEROL BIODIESEL

Overview



LIPID ALCOHOL BIODIESEL GLYCEROL