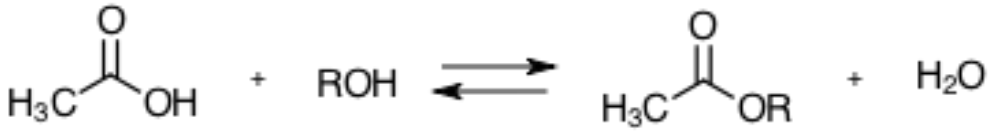
Esterification

Summary:

This lab represents a traditional acid-catalyzed esterification to create a range of esters that represent the diversity of odors used in the flavoring and perfume industry. The esterification reaction proceeds through the reaction of a carboxylic acid and an alcohol with concentrated sulfuric acid.



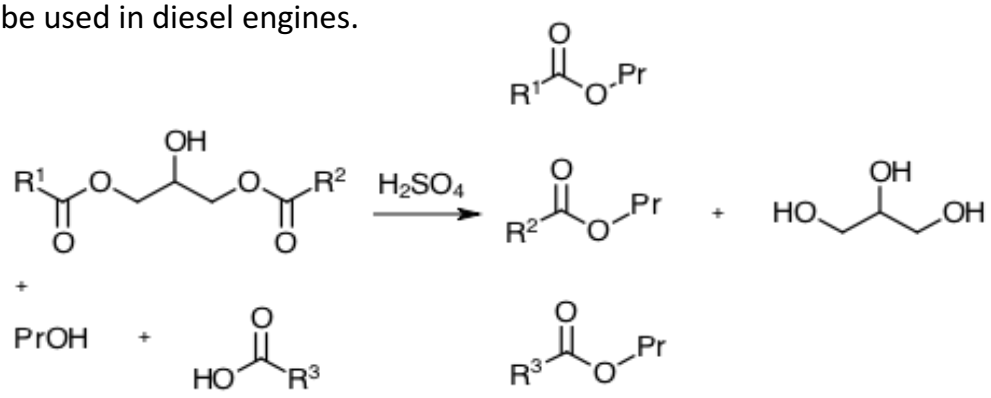
Reference: Fischer Esterification, Organic Chemistry Laboratory Manual, A. B. Padfas, Hayden-McNeil, 2013

Chemical Name Aldrich Catalog #	Amount per 100 students (g or mL)	EH&S	Purchasing cost per 100 students ($)
1-pentanol 398268	15 mL		$3.23
2-pentanol P8017	15 mL		$1.63
Isopentyl alcohol W205702	15 mL		$0.91
Hexyl alcohol W256706	15 mL		$0.49
4-methyl-2-pentanol 109916	15 mL		$0.51
Glacial acetic acid 695092	150 mL		$10.30
Sodium bicarbonate (5%) S6014	300 mL		$1.02
Sulfuric acid, conc 258105	5 mL		$1.02
Sodium sulfate, anhyd. 258105	25 g		$1.75

Esterification: Greener Approach

Summary:

This preparation of biodiesel from vegetable oil is an acid-catalyzed transesterification reaction with 1-propanol, a greener alternative than methanol. This procedure has also been adapted to fit within a typical 3-hour lab period. Waste vegetable oil can be used as the raw material and the product, introducing students to the concept of biobased, renewable feedstocks. The product from this experiment can be used in diesel engines.



Reference: Acid-Catalyzed Preparation of Biodiesel from Waste Vegetable Oil: An Experiment for the Undergraduate Organic Chemistry Laboratory, J. Chem. Educ. 2011, 88, 201–203

Chemical Name Aldrich Catalog #	Amount per 100 students (g or mL)	EH&S	Purchasing cost per 100 students ($)
Vegetable Oil n/a	1000 mL		n/a
1-propanol 402893	400 mL		$28.59
Sulfuric acid, conc. 258105	7.5 mL		$0.24
Sodium chloride, 1M sol 746398	2.25 L		$8.37
Magnesium sulfate, anhydrous 793612	100g		$3.64

Comparison: Esterification Reaction

Comparison of greener and traditional lab:

- Greener method introduces the concepts of biobased resources and renewable raw materials
- Greener method produces the product, which can be used in diesel engines, along with aqueous waste
- Traditional esterification reaction uses various alcohols which all have moderate EH&S profiles

	Purchasing costs	Waste (per 100 students)	"Greener" benefits
Greener method	$48.25	1.4 L biodiesel product 2.3 aq. waste 100 g solid waste	
Traditional method	$19.84	525 mL aq. waste 25 g solid waste	

Other greener lab options to explore:

- Replacing Mineral Acids in the Laboratory: Nafion-Catalyzed Dehydration and Esterification, J. Chem. Educ. 1993, 70, 493-495.
- Methyl benzoate by Fischer Esterification, Macroscale and Microscale Organic Experiments, Williamson, K.L., Masters, K.M., 6th Edition, 2011, pp. 524-525.