



## Solving Multistep Carboxylic Acid Syntheses

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### Transcript

00:00:00:00 - 00:00:17:00

**Dr. Jessie Key:** Hello again, Dr. Jessie Key here to talk to you about synthetic strategies with carboxylic acids and derivatives by going through a few examples. In our first example, we're going to propose a multistep synthesis of benzaldehyde from the starting material, benzonitrile.

00:00:17:00 - 00:00:35:68

**Dr. Jessie Key:** Feel free to pause and try this problem on your own. Come on back when you're ready and we'll go through this together. To approach this problem, you should first determine what kind of changes have occurred between the starting material and the product.

00:00:35:68 - 00:00:47:02

**Dr. Jessie Key:** Has there been a change to the carbon skeleton? No, there are 7 total carbons in both structures. Has there been a change in functional groups?

00:00:47:02 - 00:01:16:76

**Dr. Jessie Key:** Yes, the starting material has a nitrile while the product has an aldehyde. Utilizing the strategy described earlier in the unit, you can focus your answer on getting to a more versatile carboxylic acid derivative to allow for the formation of the aldehyde. You can return to the carboxylic acid by hydrolysis under acidic aqueous conditions with heat.

00:01:16:76 - 00:01:41:83

**Dr. Jessie Key:** From this carboxylic acid, you can access the more versatile acid chloride by using thionyl chloride. The acid chloride can be reduced directly to an aldehyde using a more selective reducing agent like lithium tri (t-butoxy) aluminum hydride. This was one approach to solve this multi step synthesis problem.

00:01:41:83 - 00:01:54:25

**Dr. Jessie Key:** There are additional correct methods. Pause the video now and generate an alternative approach for this problem if you haven't done so already. Hint: You could proceed through an ester!

00:01:57:13 - 00:02:23:53

**Dr.Jessie Key:** In our second example, we're going to propose a multi-step synthesis of methyl hexanoate from the starting material 1-bromopentane. Again, feel free to pause and work on this on your own first and come back to finish the solution with me later. Welcome back! To approach this problem,

00:02:23:53 - 00:02:44:75

**Dr.Jessie Key:** you should first determine what changes have occurred between the starting material and the product. Has there been a change to the carbon skeleton? Yes, the parent chain is going from five carbons in 1-bromopentane to six carbons in methyl hexanoate, an increase of one carbon.

00:02:45:15 - 00:03:06:71

**Dr.Jessie Key:** Has there been a change in the functional groups? Yes, the starting material has a bromo group and the final product has a methyl ester. Seeing that there is a one carbon change to the carbon skeleton, you should consider what reactions accomplish this.

00:03:06:71 - 00:03:29:55

**Dr.Jessie Key:** Let's try out a strategy using a Grignard with carbon dioxide. First, use magnesium to convert the one bromopentane starting material into a magnesium halide Grignard reagent. Next, you can react the Grignard reagent with CO<sub>2</sub> followed by acidic aqueous workup to generate hexanoic acid.

00:03:32:52 - 00:03:56:88

**Dr.Jessie Key:** You can convert acids directly into esters by a few different methods, one of my favorite methods is the Fischer esterification. Using methanol with an acid catalyst, methyl hexanoate can be formed by Fischer esterification. This was one approach to solve this multistep synthesis problem, there are additional correct methods.

00:03:56:88 - 00:04:04:28

**Dr.Jessie Key:** Can you think of another approach to solve this problem using the other common reaction that adds one carbon unit to the skeleton?