

## Retrosynthetic Analysis

Retrosynthetic analysis is the term used to describe a problem-solving approach that “works backward”. An organic synthesis typically involves a series of steps to transform “starting materials” – the molecules that you begin with – into the “target” molecule – the molecule you want to make. Because usually there are many compounds available that could be used as starting materials, checking out the possibility of starting with any particular ones likely won’t lead to a solution. And as you consider all the molecules you could make from each starting molecule, and then all the molecules you could make from each of those, it becomes obvious that the synthetic routes you might consider grow exponentially. For example, if you have a pool of ten molecules that could be used as starting materials, and each one of them – and the molecules you make along the way – can be transformed into three different products, a short synthesis involving only three steps still offers 90 synthetic routes to consider, a four-step synthesis offers 270 routes to consider, and a five-step synthesis offers 810 routes to consider! And, almost all of them won’t lead to the target molecule.

Alternatively, planning the synthesis “backwards” (hence the term “retro”) is dramatically more efficient: You are *certain* that each step you plan will lead to a synthesis of the target molecule. You’re still likely to consider some “dead-end” routes (that don’t let you start with the available starting materials), but if you keep in mind what you have to start with, you can minimize planning that goes the wrong way.

Once you’ve mastered this approach to problem-solving, you’ll find applications in fields as different as medicine, science, and engineering. When you know where you need to end up, the most efficient way to plan how to get there may be to work backward!