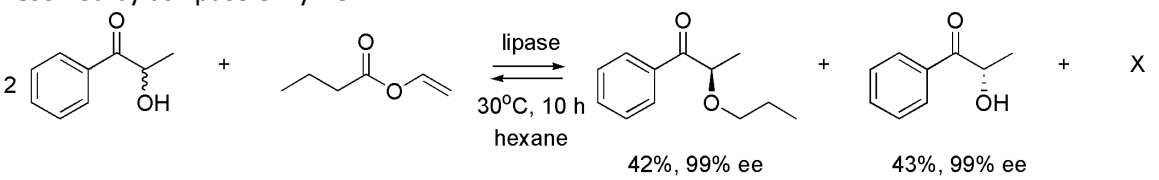
1. α-Hydroxyketones (acryloins) are important building blocks for many applications. To obtain them in enantiomerically pure form, the two enantiomers of a racemic acryloin can be kinetically resolved by as lipase enzyme:



a) Why does the enzyme convert only one of the two enantiomers?

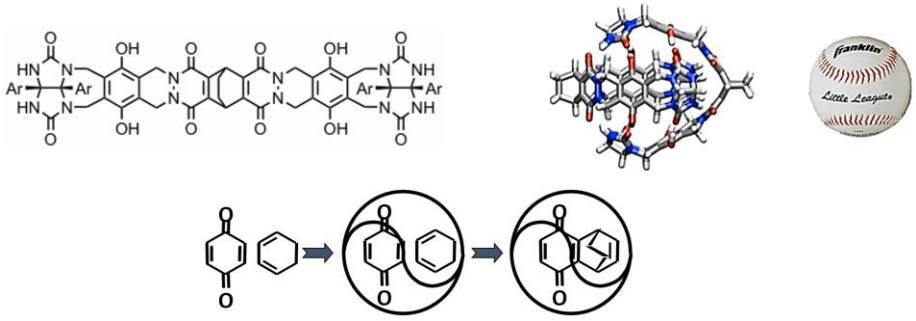
b) What is the structure of the missing compound X?

c) In principle, the esterification reaction shown above is fully reversible. What is the 'trick' that is applied here to shift the equilibrium fully to the right?

2. Lipases (see previous question) are known for their ability to work in some organic solvents, for example hexane. Most enzymes, however, are incompatible with such solvents. Describe two possible reasons for this incompatibility.

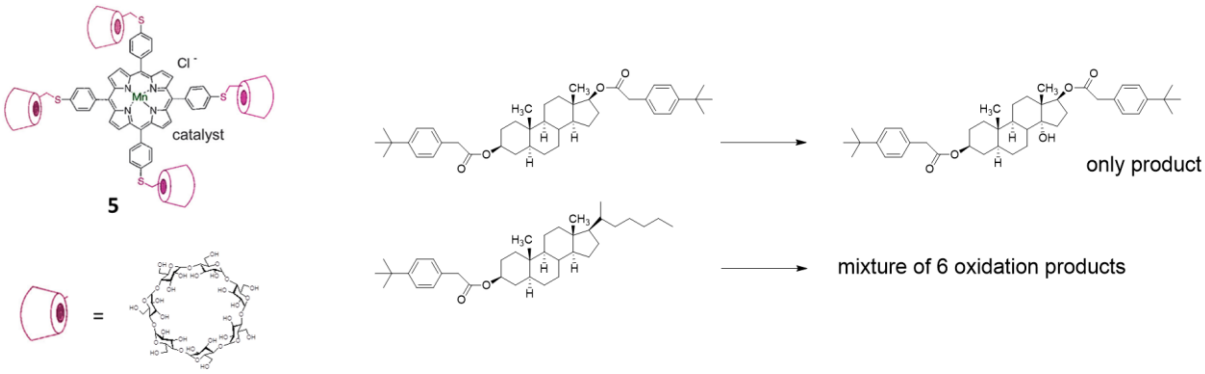
3. Folding of proteins and enzymes into a well-defined 3D tertiary structure is a main prerequisite for their function. This folding is often induced and stabilized by means of hydrogen bonds between amide groups of the amino acid residues in the polypeptide chain.
Explain why the hydrogen bonds between the amino acids can remain stable and strong, considering the fact that all proteins exist in water, a solvent which is very competitive for the formation of hydrogen bonds.

4. A self-assembled "molecular softball" , which is formed via 16 non-covalent hydrogen bonds between the two subunits, accelerates a Diels-Alder that occurs in its cavity spectacularly. The softball is however not a catalyst, since product inhibition occurs.



Propose a solution to make this "softball" act as a true catalyst.

5. One of the many cytochrome P450 enzyme mimics reported is an artificial system based on a catalytic manganese porphyrin to which four cyclodextrins are covalently connected (compound **5**, see below).



Manganese porphyrin catalyst **5** is capable of oxidizing steroid derivatives in water. The researchers made two observations when carrying out the two catalytic oxidation reactions on the right:

A) Both steroid derivatives are oxidized significantly faster by **5** compared to oxidation by a tetraphenyl manganese(III) porphyrin to which no cyclodextrins are connected.
B) After oxidation by **5**, the top steroid gives only a single, well-defined oxidation product, while the bottom steroid yields a mixture of 6 different oxidation products.

Give an explanation for both observations.