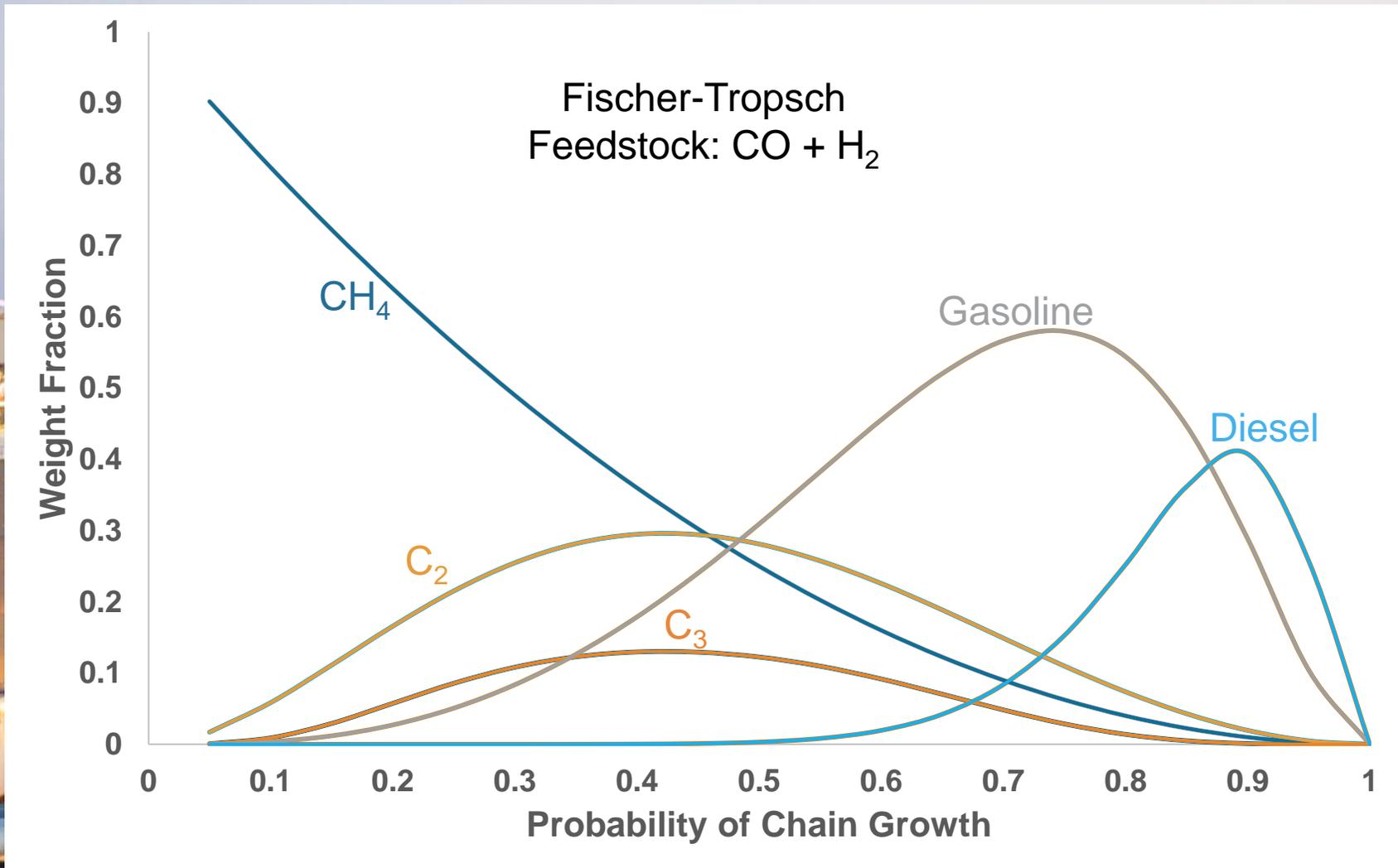




Taking a leaf out of Nature's book: Applying Insights from biology to industrial catalysts

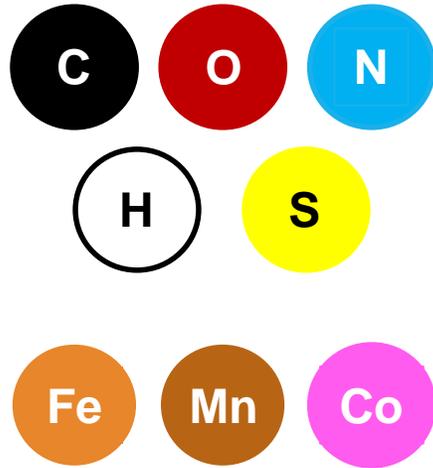
Dr. Fadi Saadi, Fellow

ARPA-E Summit
March 15, 2018



➤ Heterogeneous reactions often lead to a mixture of final products

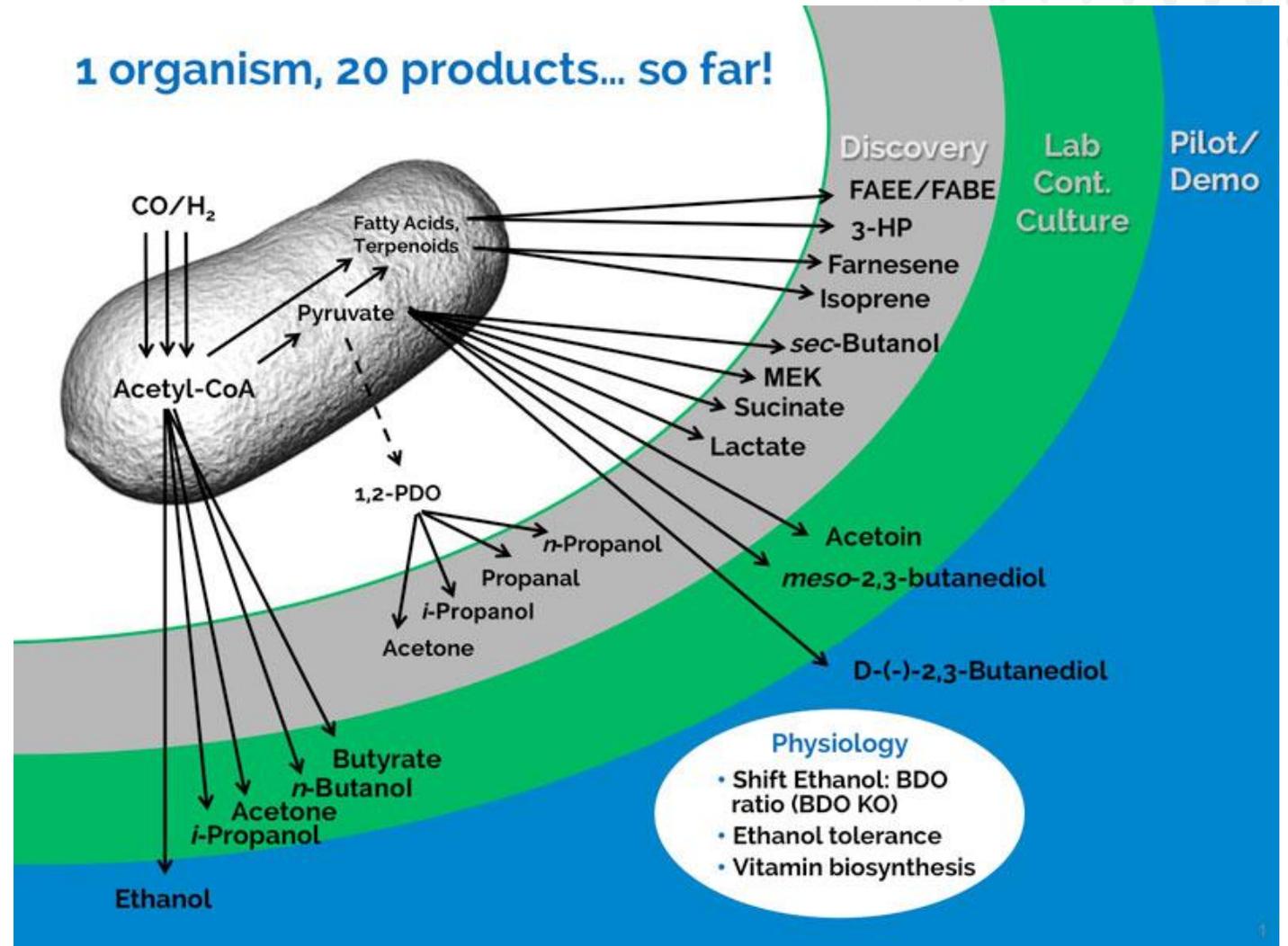
Biological System Capabilities



Biological systems:

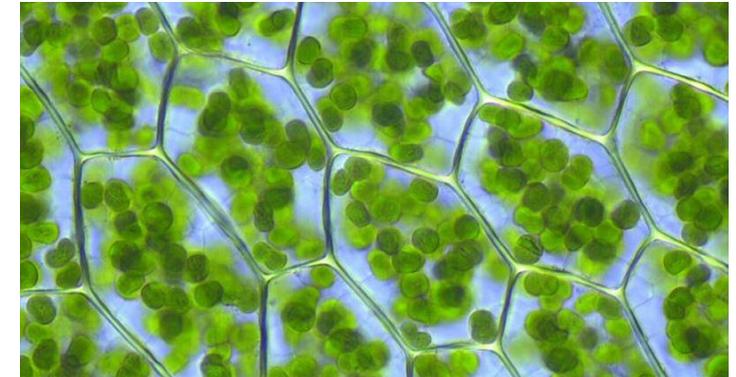
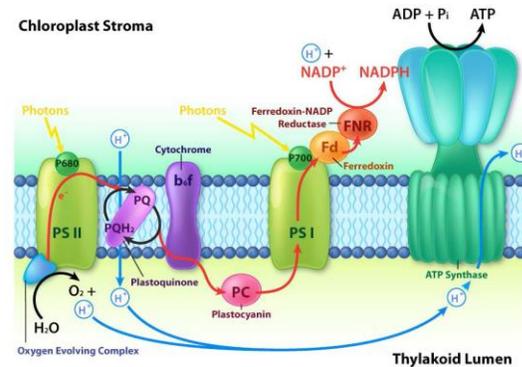
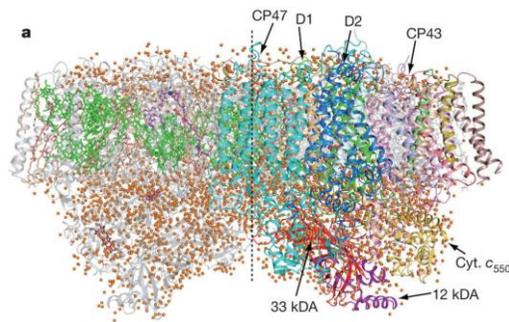
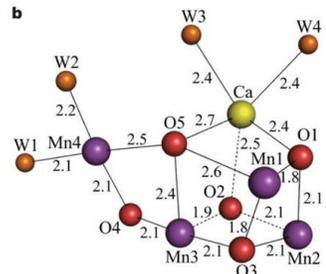
- Limited number of elements
- Wide range of selective products

1 organism, 20 products... so far!



Length Scales in Biochemical Reactions

➤ Biological reactions occur at many different length scales



1 nm

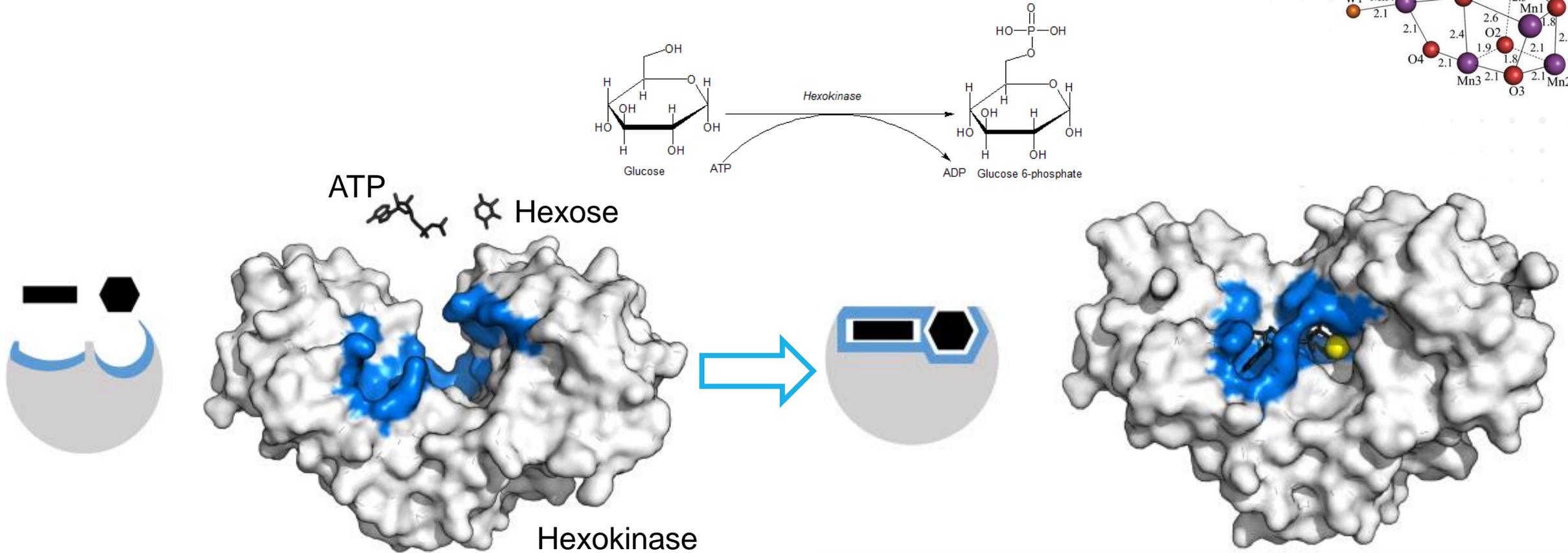
10 nm

100 nm

1 μm

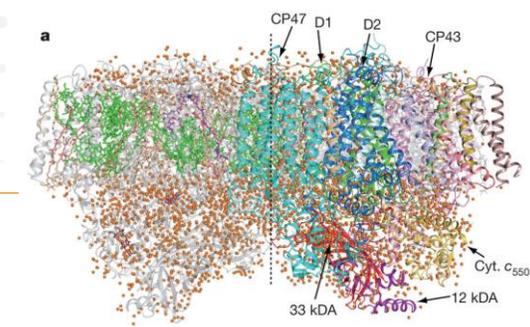
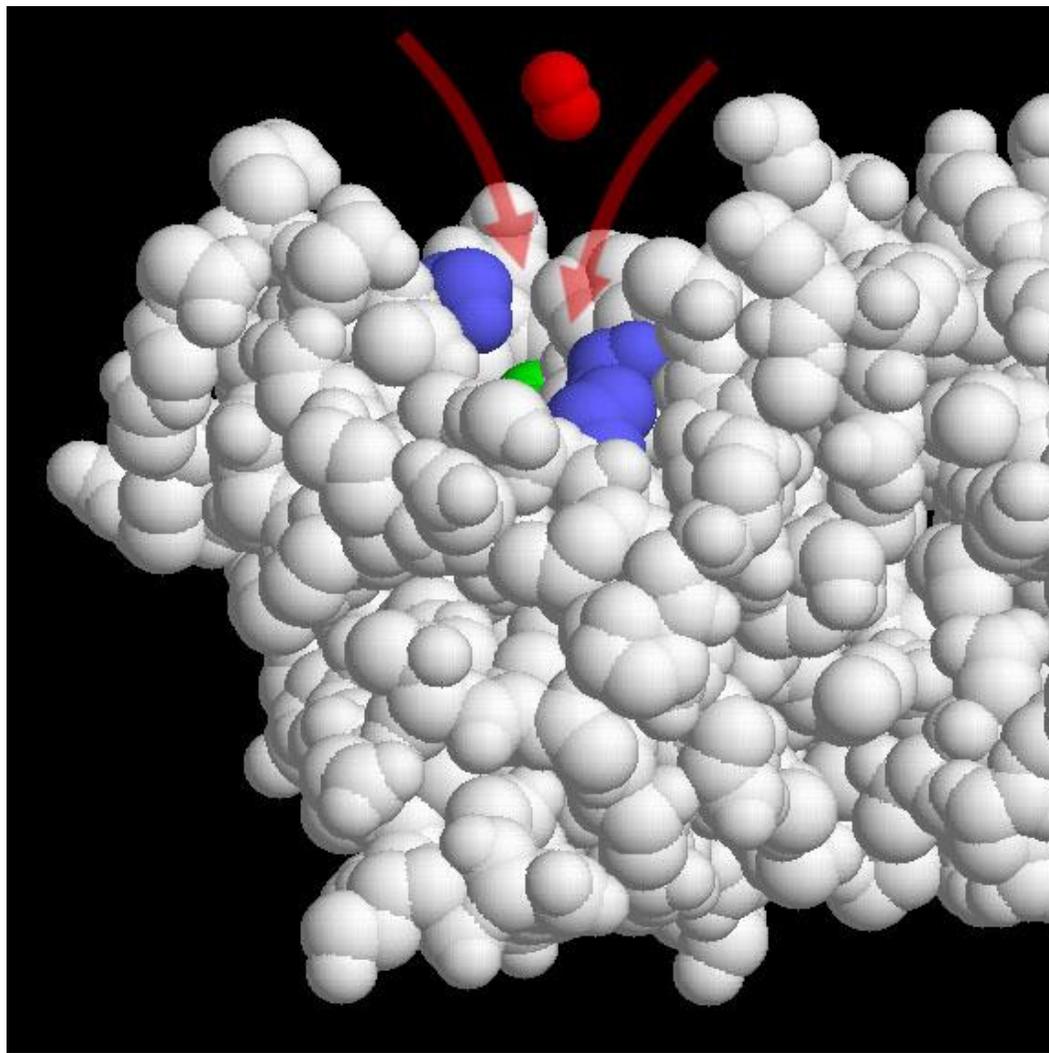
10 μm

Biological Interactions at the Active Site

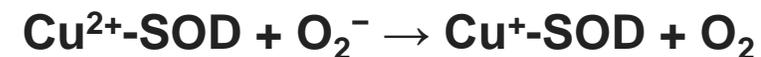


➤ Biological systems use inter- and intra- molecular interactions to guide the desired reaction

What does the Protein Environment Enable?

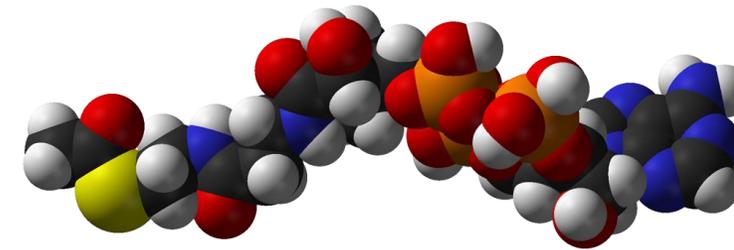
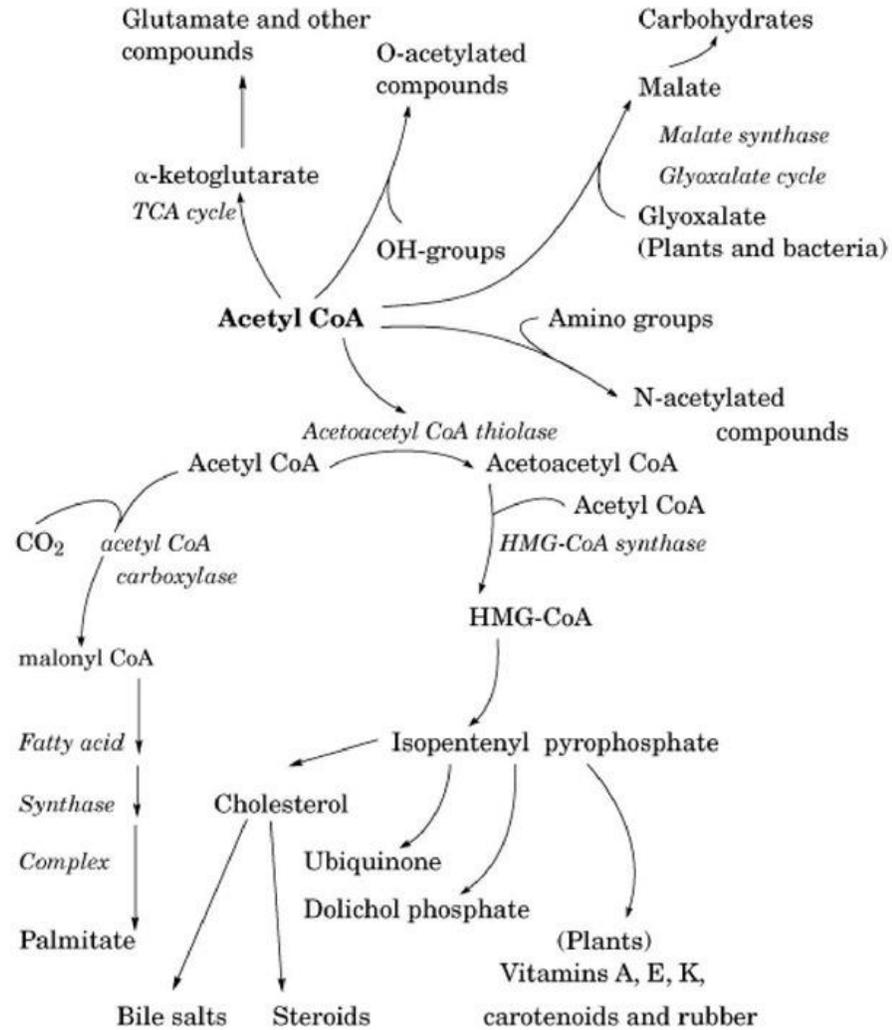
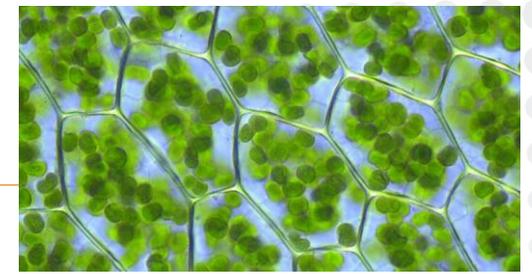


Cu/Zn Superoxide Dismutase



- **Proteins modify the local environment near active sites by changing:**
 - **Acidity**
 - **Concentration of reactants and products**
 - **Hydrophobicity/hydrophilicity**

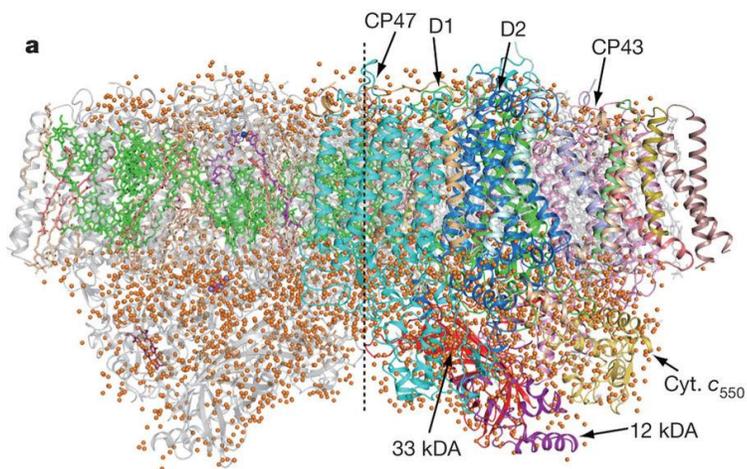
The (sub)Cellular Scale Toolbox



Acetyl CoA

- Wide variety of final products go through the same intermediate

Future of Heterogeneous Catalysis?



fadl.saadi@hq.doe.gov