

Project Outline: Structure and physical properties of myoglobin

Goals

Use MD simulations and statistical mechanical analysis to investigate the structure and physical properties of myoglobin.

Methods

- Use VMD to visualize the structure of myoglobin and compare differences across species.
- Demonstrate how oxygen accesses the interior of myoglobin during thermal fluctuations (300 K) in the structure. Measure the timescale for O₂ to reach the heme.
- Show how myoglobin resists CO binding:
 - Build a water sphere around Mb
 - In one scenario, bind O₂ to the heme, and in the other, bind CO to the heme.
 - Plot fluctuations in binding angles over time.

Results

- VMD renders will display structure of myoglobin, as well as overlays of different species.
- NAMD simulation of myoglobin at physiological temperatures to watch as O₂ enters myoglobin.
 - The sample case study states that the oxygen binding process is on a very long timescale of nanoseconds to microseconds. These simulations will be very time-consuming.
- NAMD simulation of the Mb heme bound to O₂ and bound to CO.
 - CO's binding angle should be very straight and strict compared to O₂'s shallow and flexible angle.
 - The shortest path to the heme from outside causes the incoming molecule to bind at a shallow angle, which encourages O₂ to bind readily. This will show that myoglobin protects itself from CO.

Conclusions/Discussions

- So, we've displayed the structures of myoglobin, simulated oxygen's entry, and showed how it resists CO binding.
- Discuss major outliers and major similarities in myoglobin structure across species and why.
- Discuss reliability of oxygen entry simulation, since it occurs randomly due to thermal fluctuations.
- Discuss energy cost of enforcing O₂ binding angle.