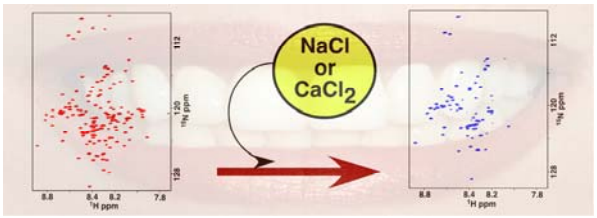
Baby Teeth

New knowledge gained about nanosphere self-assembly and enamel formation

New studies reveal how the hardest material in the human body, tooth enamel, starts to form at the molecular level. Researchers from the Pacific Northwest National Laboratory and University of Southern California used nuclear magnetic resonance resources at the Department of Energy's EMSL to study the mechanisms behind self assembly of the protein, amelogenin, into nanospheres – an initial step in building enamel.



Self-assembly of amelogenin was monitored by following changes to the NMR spectra (^{1}H-^{15}N HSQC) of amelogenin without salt (left, monomers) and after the addition of salt (right, dimers and larger).

Amelogenin provides a matrix upon which another protein, hydroxyapatite, builds a strong three-dimensional structure to form enamel. Using solution-state NMR spectroscopy and dynamic light scattering, the research team followed the initial steps of amelogenin matrix formation in solutions containing different levels of salt, a variable that triggers protein self-association. Two salts were tested (sodium chloride and calcium chloride), and both yielded similar step-wise results for amelogenin interaction. At low pH with no salt in solution, amelogenin exists as individual protein molecules, (monomers). Upon adding salt to the solution, pairs of amelogenin monomers start to interact at their N-termini to form dimers. As the salt concentration is increased further, the interaction between pairs of monomers grows stronger as the association extends to include interactions between the C-termini. Dimer formation is the first step in amelogenin self-assembly; the full self-assembly process yields amelogenin nanospheres.

The team's research provides a better understanding of the formation of nanospheres thought to have an essential functional role in enamel formation. Their work also offers insight into the nature of orthodontic diseases, such as amelogenesis imperfecta, which results in defective enamel formation.

Scientific impact: The research team's amelogenin self-assembly studies provide a better understanding of the role nanospheres have in biological systems. Further, this work supports EMSL's goal to predict biological functions from molecular and chemical data.

Societal impact: Amelogenin research gives insights into the nature of orthodontic diseases such as amelogenesis imperfecta, which results in defective enamel formation and has been tied to N-terminus defects in amelogenin.

For more information, contact EMSL Communications Manager Mary Ann Showalter (509-371-6017).

Reference: Buchko GW, BJ Tarasevich, JG Bekhazi, ML Snead, and WJ Shaw. 2008. "A Solution NMR Investigation into the Early Events of Amelogenin Nanosphere Self-Assembly Initiated with Sodium Chloride or Calcium Chloride." *Biochemistry* 47(50):13215-13222. doi: 10.1021/bi8018288.

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