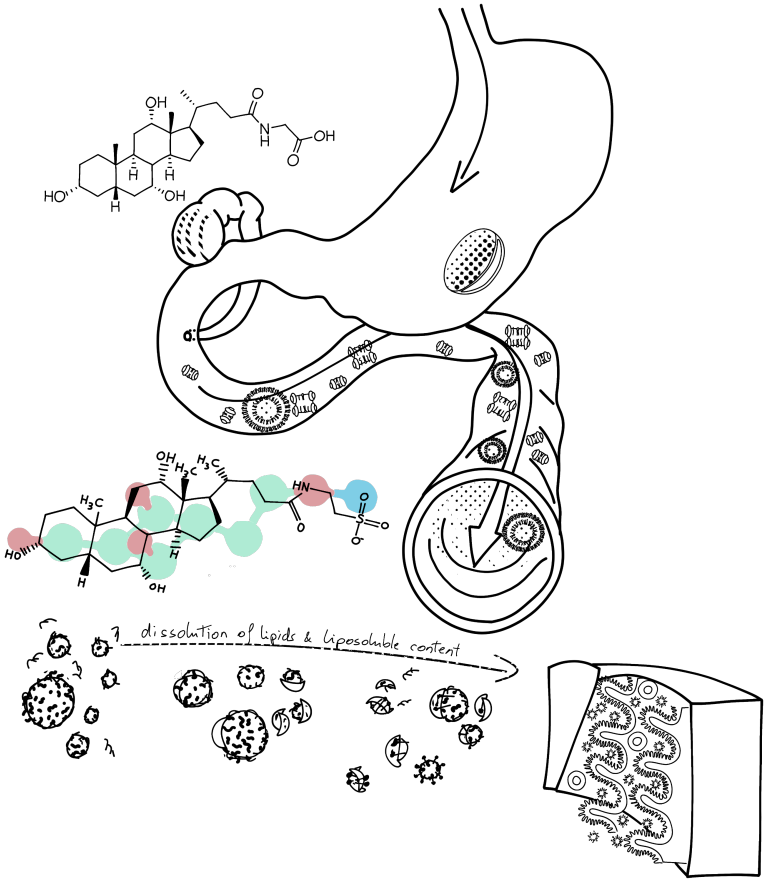
UMR 0782 SayFood
Group Modeling and Computational Engineering
Massy, France

Six-month internship subject (Master 2) | Period: present – first semester 2021

Coarse-grained modeling of bile salts and their emulsification mechanisms



Context & goals

The proposed work is part of the collaborative research *Assembiles* project (France, https://anr.fr/Projet-ANR-18-CE21-0002). The whole project aims to understand the mechanisms of solubilization and intestinal absorption of lipophilic micro-constituents. Our research unit UMR SayFood between AgroParisTech and INRAe in Massy is in charge of the molecular modeling of bile salt/lipid assemblies and its role in facilitating dramatically the concentration of lipophilic compounds. Based on structural measurements and values of cohesion energies of the assemblies already published, the proposed work will contribute to building several models of bile salt/lipid assemblies. The models will be used to evaluate the molecular mechanisms of dissolution and transport of lipophilic constituents during digestion in the small intestine.

Methodology

A generic description at the molecular scale will be developed using the efficient coarse-grained (CG) forcefield Martini. This forcefield replaces four heavy atoms with one CG site. The degrees of freedom are enough reduced to allow the direct simulation dynamics of large assemblies, such as micelles and mixed micelles over long periods. Micelle-water partitioning and interfacial-limited absorption will be accessible to direct simulation. The models will be designed and tested with the open-source molecular dynamics code GROMACS. The stability of tested complexes and their ability to form micelles will be more particularly studied and compared with data from the project partners' literature and measurements. Calculations will be performed on the SayFood cluster (Linux) unit with more than 10^3 cores, including a 256-core node, 1 TB of RAM. The installed computing power will allow the use of all-atom models to validate specific results in explicit solvents and in the presence of electrical charges.

Activities

The student will review the literature to define the simulation hypotheses best suited to the objective sought and the simulation method used. He or she will be associated with the definition, monitoring, and interpretation of the simulations. The student will participate during the project in the good management of the cluster: queue management, traceability, and archiving of calculations. If the results allow it, a scientific publication will be written at the end of the work.

Skills to be acquired or to be developed

Scientific approach, construction of simulation hypotheses, coarse-grain modeling, interpretation of results with statistical physics tools, implementation of parallel calculations.

Prerequisites, student level

Master's student (preference, 2nd year) in bioinformatics, molecular modeling, statistical physics, theoretical chemistry, general engineering. Skills in programming, computing, and Linux will be appreciated.

Host Laboratory

UMR 0782 *SayFood Paris-Saclay Food and Bioproduct Engineering Research Unit* – group MODIC (*Modeling and Computational Engineering*) – AgroParisTech site de Massy, 1 rue des Olympiades, 91300 Massy, France.

Supervisor: Olivier Vitrac, Researcher (INRAE)

How to apply

Send CV, cover letter, transcript to olivier.vitrac@agroparistech.fr