Foraminifera are commonly applied as essential geological tools for relative time control and interpretation of paleo/environmental conditions. These unicellular, mainly marine organisms leave in the sedimentary rocks two types of fossil records, i.e. mineralized tests (shells) and their organic linings. Although both types of microfossils differ in extraction procedures, they represent the same tests of the same individuals. Consequently, at least in theory, their mineral and organic records should be complementary. Every mineral shell should fossilize a single organic lining. This is not the case, and the mineralized shells often leave extraordinary records, in contrast to highly biased, fragmentary records of acid resistant organic remains. Our main objectives are therefore focused on foraminiferal organic linings and include (1) documentation and interpretation of preservation patterns in relation to different groups, followed by (2) identification of primary and secondary factors responsible for variability of the fossil record, as well as (3) exploration of complex functionality of organic linings in living organisms.

Our innovative approach combines observations based fossils and living organisms and cross a wide range of disciplines. Evolutionary trends in preservation of foraminiferal organic linings will be established on the broad spectrum of taxa analyzed based on classical dissolution experiments of extant and fossil shells from the Cenozoic, Mesozoic, and Paleozoic supplemented by published records of foraminiferal organic linings. Newly designed dissolution experiments will be documented under environmental Scanning Electron Microscope and optical microscopy. Staining experiments will be done on fixed and live foraminifera and analyzed under modern types of imaging, including confocal fluorescent microscopy, and confronted with high resolution correlative TEM and SEM. Most experiments will be run in our foraminiferal culture laboratory. This is the only such dedicated lab in Poland established to apply an actualistic methods in micropaleontology.

Our preliminary meta-analysis of the published record of foraminiferal organic linings indicates that nearly all (> 97%) linings reveal globular chambers connected, following minimized distances between apertures. These two diagnostic morphologic features classify them into the same Globothalamea class, including foraminifera with globular chambers. The question therefore is why organic linings of other foraminiferal classes are so rarely fossilized. Do all foraminifera of all classes truly produce foraminiferal linings? Are they compositionally and structurally diverse? What is their fossilization chance? If the foraminiferal linings vary in different groups, they might be involved in specific functions, likely associated with morphogenesis, biomineralization, and other physiologic tasks. All these questions encourage novel interdisciplinary studies on organic linings as a critical research target explored based on integration of classical experimental methods with innovative application of modern visualization tools. The results of this project may have a crucial impact on understanding of foraminiferal organic linings, testing contradictive functional hypotheses, and interpretation of neglected phylogenetic and taphonomic patterns. This project should have a considerable impact on several Earth science disciplines, including micropaleontology, palynology, functional morphology, and paleoceanography. It also explores complexity of organic-mineral interfaces located at the frontline of biomaterial science.