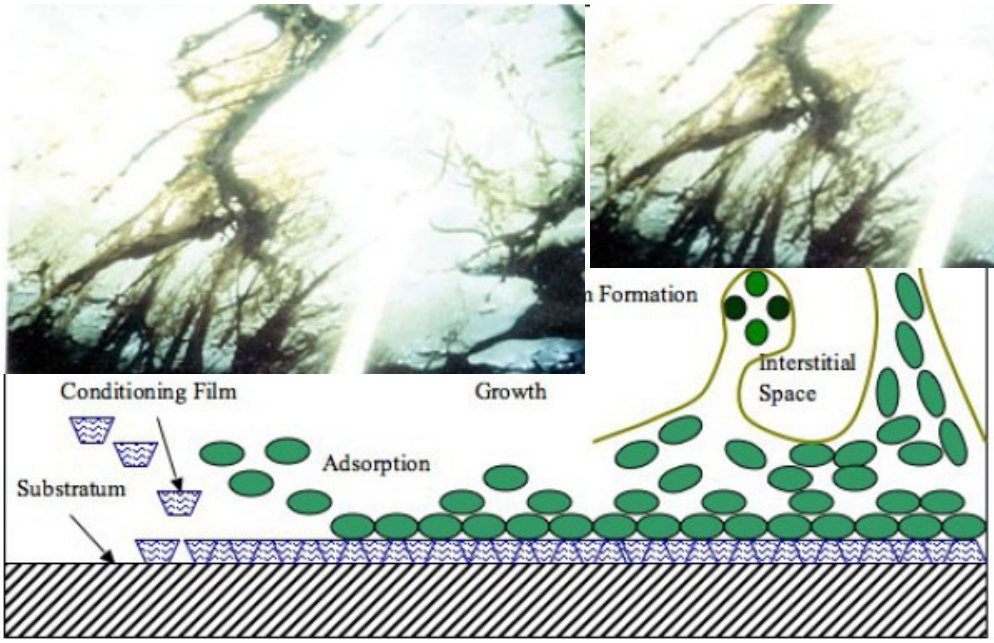
Proteins secreted by the algae Melosira arctica ensure optimal conditions for survival inside watery bubbles in this extremely cold environment by manipulating the formation of ice around the bubble.

https://asknature.org/strategy/secreted-proteins-manipulate-the-formation-of-ice/



Melosira arctica algae dwell within bubbles in sea ice and have evolved ice-binding proteins (IBPs) to make their icy home more habitable. These proteins aggregate into gooey clusters that clog the openings of nascent bubbles during ice formation. This retains liquid water within the bubble, which the algae depend on to survive, and prevents the algae from being pushed out and away from the surface of the ice where sunlight for photosynthesis is more intense. In addition, the proteins influence the shape of the ice around the bubble and the salinity of the water inside which benefit algae survival.

References

"Krembs et al., reported that extracellular polymeric substances (EPS) produced by a sea ice diatom, *Melosira*, created convoluted ice-pore morphologies in sea ice, potentially increasing its habitability and primary productivity. The activity was reduced by heat treatment and glycosidase treatments, suggesting that a glycoprotein was involved. Based on our previous work, it is very likely that the active substance is an ice-binding protein (IBP). All sea ice diatoms examined so far secrete similar ~25 kDa IBPs that bind to ice, distorting its shape as it grows...Together, these studies point out a possible function of algal IBPs, retention of a liquid environment, without which survival is difficult." (Raymond 2011:198).

"EPS effects on ice and pore microstructure improve sea ice habitability, survivability, and potential for increased primary productivity." (Krembs et al. 2011:3653)

"Most pores filled with stained EPS were highly angular and convoluted in shape; the frequency of such complex morphologies decreased for pores only partially filled or devoid of visibly stained EPS" (Krembs et al. 2011:3654)

"The most parsimonious explanation for this result is pore clogging by EPS. The natural EPS we examined featured a broad spectrum of size fractions, including aggregates sufficient to plug pore passages. Evidence of elevated pEPS near the growing ice front in both natural and tank-grown ice evokes clogging in a zone of otherwise high salt fluxes. In this same zone, diatoms were more likely to be retained in a pore even partially filled with EPS than one devoid... In growing sea ice, pore clogging would impede the desalination process while enhancing retention of organisms within the ice where light levels support substantial algal activity." (Krembs et al. 2011:3655-3656).

"The benefits of ice entrainment to algae include stable positioning to capture more light energy for photosynthesis and refuge from predation." (Krembs et al. 2011:3657).

Journal article

Algal ice-binding proteins change the structure of sea ice.

Journal article

Exopolymer alteration of physical properties of sea ice and implications for ice habitability and biogeochemistry in a warmer ArcticProceedings of the National Academy of SciencesNovember 29, 2016
C. Krembs, H. Eicken, J. W. Deming