Phase separated protein liquid condensate materials

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Phase separation of specific biomolecules into liquid droplet-like condensates (process called liquid-liquid phase separation, LLPS) is a key mechanism to form membrane-less organelles, which spatio-temporally organize diverse biochemical processes in cells. For more clear analysis and ultimately precise manipulation of these condensates, it is critical to have diverse but simplified model systems. Our group have been developing various protein-based *in vitro* LLPS models to elucidate distinct behaviors of biomolecular membrane-less organelles. For example, we designed a strategy for metal ion-induced clustering of minimal protein modules to produce liquid protein condensates, the properties of which can be widely varied by simple manipulation of the protein clustering systems.[1] In addition, various cellular protein condensates were formed with tandemly repeated intrinsically disordered proteins (IDPs) or light-controllable IDPs.[2-3] These strategies provide highly versatile protein condensates, which will greatly facilitate investigation of molecular and structural codes of droplet-forming proteins.[4] For example, we were able to reveal highly enhanced client protein proximity inside cellular membrane-less compartments by using these models.

Liquidic protein condensates also offer new and highly attractive biomaterials that can contain specific sets of biomolecules with extremely high densities and dynamic liquid properties. However, ways to manipulate protein condensate materials remain largely unexplored. We have been also developing strategies to control phase separation and produce diverse condensate materials with intended sizes and properties. For example, protein condensate materials could be used to build artificial cell like entities.[5] Here I also want to introduce our more recently developed strategies to fabricate functional and structurally precise artificial protein condensates.

References

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