Cells contain multiple compartments dedicated to the regulation and control of biochemical reactions. Cellular compartments that are not surrounded by membranes can rapidly form and dissolve in response to changes in the cellular environment. The physicochemical processes that underlie the formation of non-membrane-bound compartments in vivo are connected to liquid-liquid phase separation of proteins and nucleic acids in vitro. Recent evidence suggests that the protein tau, which plays an important role in Alzheimer's disease and other neurodegenerative disorders, phase separates in solution, forms tau phases with microtubules, and associates with phase-separated RNA-binding protein granules in cells. I will discuss the experimental evidence that supports the ability of tau to phase separate in solution and form biomolecular condensates in cells. As for other disease-relevant proteins, the physiological and pathological functions of tau are tightly connected - through loss of normal function or gain of toxic function - and we therefore discuss how tau phase separation plays a role for both, and with respect to different cellular functions of tau.