Investigation on the effect of static magnetic field on liquid-solid phase transition of α-Synuclein protein

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In recent years, liquid-liquid phase separation (LLPS) and liquid-solid phase transition (LSPT) have been found of important physiological or pathological significance in biological systems, among which aberrant LSPT is often a key process in major diseases such as neurodegenerative diseases. Once it occurs, it is often characterized by slow but persistent irreversibility, which is one of the fundamental reasons for the lack of effective treatment for these diseases. Therefore, in-depth research into this process is expected to provide a breakthrough in the development of new therapies. We recently discovered that the magnetic field can significantly inhibit the LSPT process of α-Synuclein protein, which is closely related to Parkinson's disease (PD). This finding suggests that special environments such as magnetic fields can serve as new options for intervening in LSPT and play an important role in the treatment of neurodegenerative diseases or other major diseases. Based on this, we proposes to systematically study the effect of magnetic field on LSPT and its underlying mechanism. The researches include: 1) the effect of magnetic field on the LSPT of α-Synuclein amyloid fibers, 2) theoretical mechanism by which magnetic fields affect α-Synuclein LSPT. *In vivo* experiments demonstrated that A53T transgenic PD mice exposed to a 10 T static magnetic field (SMF) for 14 consecutive days exhibited improved motor function, as evidenced by reduced descent latency in the pole test at days 7 and 14 post-treatment. *In vitro* studies further revealed that 10 T SMF significantly suppressed α-Synuclein amyloid fibrillization, attenuating both the kinetics and extent of aggregate formation. These findings collectively indicate that high-intensity SMF modulates protein phase transitions, thereby inhibiting pathological aggregation.

This research is expected to provide new therapeutic opportunities and a theoretical foundation for interventions targeting neurodegenerative diseases such as PD and other related disorders.