

New way for smart biomaterials

Prelims: *Current events of national and international importance | Science & Technology*

Why in News?

Recently, Scientists highlighted how a subtle tweak in molecular geometry specifically adding a single methylene spacer (-CH₂-) to peptide-based molecules profoundly dictates their supramolecular self-assembly.

- **Led by** - Centre for Nano and Soft Matter Sciences (CeNS), Bengaluru in collaboration with researchers from JNCASR, Bengaluru, and Ghatal Rabindra Satabarsiki Mahavidyalaya, West Bengal

Key Highlights

- **Supramolecular Self-Assembly Mechanism**
 - Peptides (short chains of amino acids linked by peptide bonds) can spontaneously self-assemble into ordered supramolecular nanostructures through non-covalent interactions (such as hydrogen bonding, π - π stacking, and hydrophobic forces).
 - However, controlling the precise packing geometry to achieve predictable functional properties has long been a major challenge in soft materials research.
- **The "Methylene Spacer" Tweak**
 - By inserting a single carbon atom (methylene spacer, -CH₂-) between the core peptide backbone and a fluorescent aromatic unit (pyrene), the team drastically altered the relative orientation and packing arrangement of adjacent molecules.
 - This subtle change altered the collective molecular packing, giving rise to unique supramolecular chirality (hand-like asymmetry at the nanoscale) and significantly prolonged fluorescence lifetimes.

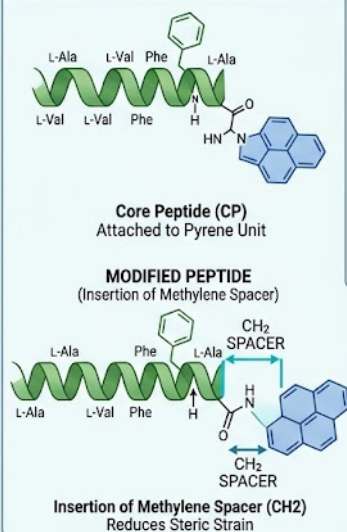
Potential Applications

- **Biosensing & Diagnostic Bioimaging** - The ability to tune optical properties (such as fluorescence emission and lifetime) through geometric modifications allows for the development of highly sensitive fluorescent probes for real-time cellular imaging, disease biomarker detection, and target molecule tracking.
- **Targeted Drug Delivery Systems** - Precision control over supramolecular self-assembly enables the design of stimulus-responsive hydrogels and nanocarriers capable of releasing therapeutic drugs in response to specific physiological triggers (e.g., pH shifts or enzymatic activity).
- Establishes a fundamental design principle in molecular nanotechnology—proving that material function can be tuned through simple geometric spacers rather than complex, expensive chemical syntheses.

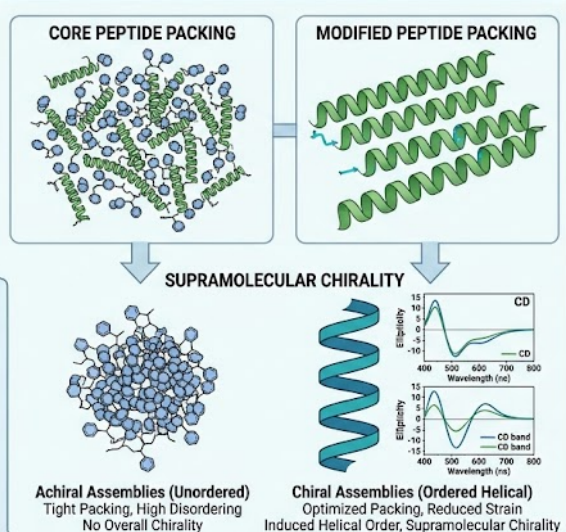
INFOGRAPHIC DIAGRAM: MOLECULAR GEOMETRY TWEAK IN PEPTIDES

Core Peptide Backbone with **Pyrene Unit**, Insertion of Methylene Spacer, Altered Molecular Packing, Supramolecular Chirality, Fluorescence Lifetimes, and **Responsive Nanostructures**.

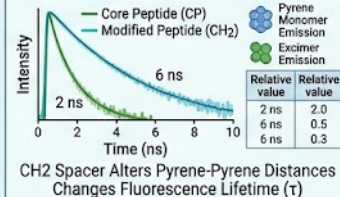
A. MOLECULAR MODIFICATION



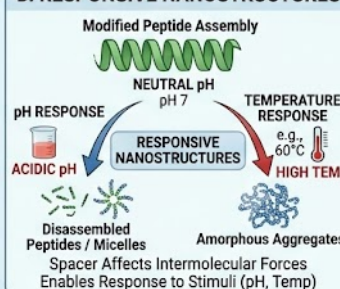
B. ALTERED MOLECULAR PACKING & SUPRAMOLECULAR CHIRALITY



C. FLUORESCENCE LIFETIMES



D. RESPONSIVE NANOSTRUCTURES



Reference

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