Scholarly Research Journal for Humanity Science & English Language,
Online ISSN 2348-3083, SJ IMPACT FACTOR 2017: 5.068, www.srjis.com
PEER REVIEWED JOURNAL, JUNE-JULY 2018, VOL- 6/28

FINDING DIVERSE PEPTIDE NANO TUBE ARCHITECTURE USING SELF AS SEMBLY OF DESIGHNED AMYLOID-BETA CASSETTES

Acharya Diptesh Satish

Abstract

Nowadays Protein or peptide-based tubular structures, including ion channels and membrane pores, exist widely in nature. To date, non-natural amino acids have been incorporate to control tube size and homogeneity. In efforts to exploit the energetics of the Alzheimer Disease associated amyloid-13 (AI3) fibrils, I discovered conditions for the construction of highly mono-dispersed peptide nano tubes from the self- assembly of short Al3 peptide cassettes. Small angle neutron (SANS) and X-ray scattering (SAXS) defined the outer and inner radius of the M3 (16-22) nanotubesformedinpH240% acetonitrile /water solution to contain a 44 nm inner cavity with 4 nm thick walls. Atomic force microscopy (AFM) and transmission electron microscopy (TEM) images further confirmed the homogenous arrays of solvent filled nano tubes arising from a flat rectangularsheet, 130 nm wide by4nmthick. The sheet coils into helical ribbons, coiling sufficiently to form the Final nano tubes. Isotope-editing IR and solid-state NMR defined the peptide arrays inside nano tubes in anantiparallel 13-sheet orientation with one residue shifted out-of-registry. Characterization of the peptide arrays allowed nano tube assembly to be exquisitely controlled, creating a variety of mono-dispersed morphologies with distinctchemicalandphysicalstabilities.Thesehighlypositivechargedtube surfaces were demonstrated to template metallic nano wire fabrication. Additionally, these
Nano tubes can be bundled in to aligned macro porous filaments with sulfate bridging. These self-assembling elements now define a minimal building block suitable for the construction of arrange of functional Nano devices. Such robust and persistent self- assembling systems not only off era
unique, robust, and easily accessible scaffold for nanotechnology, but also a better understanding of the amyloidfibril structure has been obtained.

Introduction:

Nano material fabrication and self-assembly

Material development has gone through Stone Age, Bronze Age, Iron Age and now a days entered Plastic and Silicon Ages, in which each step has dramatically promoted the human civilization. Nano meter-scale materials are the theme of the contemporaryera because of their unique functional properties in optics, mechanics, electronics and magnetics (Sarikaya2004). Either a "top-down" or "bottom-up" approach can be used to create nano materials. The "top-down" approach refers to etching and molding large-sized materials into smaller and smaller components, where as the "bottom-up" approach involves as sembling structures at ombyatom or molecule by molecule to produce novel supramole

culararchitectures. The "top-down" approach is normally inefficient, requires tring entconditions, and of ten produces toxic byproducts (Niemeyer 2001;Sarikaya 2003). Achallenge of the "bottom-up" approach is a deep understanding of the properties of the molecular building block, such as molecule-mol eculeinteractions, structural compatibility and dynamic behavior.**It**isbelievedthatthelatterapproachtodesignmaterialsbyself-assembly would like lyplay an important role in constructing and processing novel nanomaterials, especially for nano bio materials (Zhang2002).

Self-as sembly is ubiquitous in nature, including lipid bilayerassembly, ribosome formation, and even bacterial colonies, fish schools (White sides 2002).

Literature Review:

By Sarikaya

Material development has gone through Stone Age, Bronze Age, Iron Age and now a days entered Plastic and Silicon Ages, in which each step has dramatically promoted the human civilization. Nano meter-scale materials are the theme of the contemporary era because of their unique function alproperties in optics, mechanics, electronics and magnetics eithera “top-down” or “bottom-up” approach cans be used to create nano materials. The "top-down" approach refers to etching and molding large-sized materials into smaller and smaller components, whereas the "bottom-up" approach involves as sembling structure satom by a tomor molecule by molecule to produce novel supramolecularar chitectures. The "top-down" approach is normally inefficient, requires stringent conditions, and often produces toxic byproducts (Niemeyer2001; Sarikaya 2003).

By Zhang :

A challenge of the "bottom-up" approach is a deep understanding of the properties of the molecular building block, such as molecule-molecule interactions, structural compatibility and dynamic behavior. **It** is believed that the latter approach to design materials by self-assembly would likely play an important role in constructing and processing novel nano materials, especially for nano biomaterials. Self-assembly is ubiquitous in nature, including lipidbilayer assembly, Ribo some formation, and even bacterial colonies, fish schools (Whitesides2002).

Objectives:

- To obtain the import ant peptide registry information using IE-IR and ss-NMR techniques.
- To check out the peptide organizations with in the P-sheet.
- To find out the difference between peptide registry of Nano tubes at pH2 and fibrils at pH6.
- Whether the electrostatic interactions between K and E, together with maximizing the hydrophobic packing, can stabilize the fibril architecture or not.
- To study why pH13 nano tube sad opt the in-register antiparalle lP- sheet structure after the deprotonation of the lysines instead of using the favorable packing as pH2 nano tubes.
- With the same peptide registry, why AP (16-22) forms fibrilsinp H6, however, nano tube sin pH13? Understanding these questions will further the understanding of the amyloid fibril structures.
- To find peptide registry whether the same or different in nano tube sand fibrils?
- What determines the supramolecular organization in nano tubes *vs* fibrils?
- Energetically, what controls the assembly pathway?

Hypothesis:

We have to conduct a hypothesis test about the research proportion. This approach consists of four steps:

(1) State the hypothesis

(2) Formulate an analysis plan

(3) Analyze sample data

(4) Interpret results.

H0: The discovered PNTs possess remarkably similar structural elements to those of the normal as sembledamy loid fibrils, such as cross- Pd if fraction pattern, CR binding and P-sheet secondary structures.

H1: Differently, they differ from the fibrils by extending the lamination from the 6 sheets of Ap (l0-35) fibrils to130 sheets of AP {l6-22) nano tubes.

Scope of the Study:

Life could not exist without proteins. These large biopolymers fold in to a variety of structures and perform various function sin nature. Unfortunately, up to this point, the understanding of how sequence dictates structure remains elusive. Prote in folding cannot be fully predicted and controlled. Several basic forces, such as electric interactions, hydrophobic interactions, hydrogen bonding and vander Waals interactions, have been identified to be crucial to a stable 3- D structure. In addition, protein folding is sensitive to the environment, for example, ionic strength, temperature and pH, making the process even more complicated as the local conditions change during folding. Proteins associated with the conformational diseases, including the notorious Alzheimer' sdisease, are normally soluble and fold normally, but for some reason, populate an alternate structure that allows self- association in to fibrous array sin tissues. Given that understanding the driving forces and mechanisms for prote in folding will be essential not only for designing inhibitors/drugs but also to fabricate novel biomaterials with defined structures, these amyloid models may facilitate the assignment of the sepath ways.

Conclusion:

Ap (16-22) as sembles into different morphologies at various H: nano tube sat pH2 and pH13; fibril satpH6. In this Chapter, important peptide registry information has been obtained by IE-IR and ss- NMR techniques. All have anti parallel peptide organizations with in the P-sheet. Nano tube satp H2 and fibril satp H6 have different peptide registry. Inp H2 nano tubes, the F19 carbonyls are well-aligned with the peptide N-term in us dangling (Fig.6-5c). The driving force for the assembly could be the FF aromatic ring packing (Waters2002). Inp H6 fibrils, the in-register antiparallel P-sheet structure was confirmed by ss-NMR and IE-IR (Fig.6-5a). The electrostatic interactions between K and E, together with maximizing the hydrophobic packing, can stabilize the fibril architecture. Unexpectedly, the peptide registry was predicted for pH2 nano tube sand pH13 nano tube sare different. Further questions have to be addressed: (1) Energetically, why pH13 nano tube sad opt the in-register antiparalle lP- sheet structure after the deprotonation of the lysines instead of using the favorable packing as pH2 nano tubes. (2) With the same peptide registry, why AP (16-22) forms fibrilsinpH6, however, nano tubes in pH13? Understanding these questions will further the understanding of the amyloid fibril structures.

References:

Aggli, A.; Nyrkova, A.; Bell, M.; Harding, R.; Carrick, L.; McLeish, T. C. B.; Semenov,A.N.;Boden,N.(2001)."Hierarchical self-assemblyofchiralrod-like molecules asamodel for peptide beta-sheet tapes, ribbons, fibrils, and fibers."PNAS 98:11857-11862.

Ajayan, P.M.; Ebbesen, T.W.(1997)."Nano metre-size tubes of carbon." Rep.Prog.Phys.60:1025-1062.

Altman, M.; Lee., P.;Rich, A.;Zhang, S.(2000). "Conformational behavior of ionic self-complementary peptides." ProteinSci.9:1095-1105.

Alzheimer, A. (1906). "Uber Eineneigenartigensch were nErkrankungsprozebder Hirnrinde."Neurol.Centr.23:1129-1136.

*Andreu, J. M.; Tim a sheff, S.N.(1986). "The measurement of cooperative protein self-assembly by turbidity and other techniques." Methods Enzymol.**130:**47-59.*

*Antzutk in, O.N. (2004). "Amyloidosis of Alzheimer's Abet peptides: solid-state nuclear magnetic resonance, electron paramagnetic resonance, transmission electron microscopy, scanning transmission electron microscopy and atomic force microscopy studies."MagneticResonanceinChemistry**42:**231.*

*Antzutk in, O.N.;Leapman, R.D.; Balbach, J.J.;Tycko, R.(2002). "Supramolecular structural constraints on Alzheimer's b-amyloid fibrils from electron microscopy and solid-state nuclearmagnetic resonance."Biochemistry**41:**15436-15450.*

Arakawa, T.; Prestrelski, S.; Kenney, W.; Carpenter, J.F.(2001). "Factors affecting short-term and long-term stabilities of proteins." Adv. Drug Delivery Reviews

*307-326.Arimon,M.;Diez-Perez,1.;Kogan,M.J.;Durany,N.;Giralt,E.;Sanz,F.;Fernandez- Busquets, X. (2005). "Fine structure study of A1-42 fibrillogenesis with atomic force microscopy."FASEB J.**19:**1344-1346.*

Arispe, D.; Pollard, H.B.; Rojas, E.(1993)."Giantmulti level cation channels Formed byAlzheimer disease A-Protein[AP-(1-40)]in bilayer membranes."PNAS90:10573-10577.

*Arnold, M.S.; Guier, M.O.; Hersam, M. C.; Stupp, S.I.(2005). "Encapsidationof carbon nano tubes by self-as sembling peptide am phiphiles."Langmuir**21:**4705-4709.*

*Ashburn, T. T.; Auger, M.; Lansbury, P. T., Jr. (1992). "The structural basis of pancreatic amyloid formation: isotope-edited spectroscopy in the solid state." J.Am.Chern.Soc.**114:**790.*

Benzinger, T.L.S.; Gregory, D.M.; Burkoth, T.S.; Miller-Auer, H.; Lynn, D.G.; Botto, R.E.; Meredith, S.C.(2000). "Two-dimensional structure of P-Amyloid (I0-35)fibrils."Biochemistry39:3491-3499.

Bianco, A.; Prato, M.(2003)."Can carbon nano tubes be considered useful tools for biological applications?"Advan.Mater.15:1765-1768.

B lout, E.R.; Lenormant, H.(1957). "Rever sibleconfigurational changes inpoly-Llysinehy drochloride induced by water."Nature179:960-963.

Bong,D.T.;Clark,T.D.;Granja,J.R.;Ghadiri,M.R.(2001)."Self-Assembling

Organic Nanotubes."Angewandte Chemie. 40:988-1011

Aucouturier, P.; Levavasseur, E.; Ballerini, C.; Carnaud, C.(2005). "Prion diseases and the prion protein." Amyloid and Amyloidosis. [International Symposium on Amyloidosis],lOth,Tours,France, Apr.18-22,2004:376-378.

Azuma, T.; Hamaguchi, K.; Migita, S. (1972)."Denaturation of Bence-Jones proteins by guanidine hydrochloride."J.Biochemistry72:1457-1467.

Bai, Q.; Wei., Y.; Geng, X. (1997)."a-Amylase denatured by urea and guanidine hydrochloride. I. Studies on denaturation mechanism and renaturation efficiency by high-performance hydrophobic interaction chromatography."Chinese Journal of Chromatography15:284-287.