Bile acids are physiologically important metabolites, which are synthesized in liver as the end products of cholesterol metabolism and then secreted into the intestines. They play a critical role in the digestion and absorption of fats and fat-soluble vitamins through emulsifications. The amphipathic and chiral nature of bile acids makes their unique building blocks for assembling supramolecular structures including vesicles, fibers, ribbons and hollow tubes. Lithocholic acid (LCA) is a secondary bile acid. Our studies show LCA can self-assemble into helical tubes in aqueous solution by the linear aggregation and fusion of vesicles. The objective of this dissertation is to tune the structure of helical tubes and functionalize them by the co-assembly of ionic LCA and cationic cetyltrimethylammonium bromide (CTAB) and ionic LCA and cationic cyanine dye (CD), respectively. The first part of this dissertation focuses on the ionic-assembly of LCA and CTAB to synthesize the helical tubes with varied diameters and pitches. Our studies show that LCA and CTAB can self-assemble into helical tubes in NH4OH aqueous solution. The diameter of the helical tubes can be changed by adjusting the molar ratio of LCA and CTAB. The pitch of the helical tubes can be tuned by varying NH4OH concentrations. Differential scanning calorimetry studies indicate that there is a homogeneous composition distribution in the LCA/CTAB helical tubes. X-ray diffraction analysis studies show that the helical tubes have multibilayer walls with an average d-spacing of 4.11nm. We demonstrate that the helical tubes with varied diameters and pitches can be transformed into helical silica through the sol-gel transcription of tetraethoxysilane (TEOS). The second part of this dissertation is to use the ionic self-assembly of LCA and CD to design light-harvesting tubes by mimicking green sulfur bacteria that are known to be a highly efficient photosynthesizer. X-ray diffraction and optical spectra show that LCA and CD can co-assemble into J- or H-aggregate tubes, depending the condition under which the self-assembly occurs. We demonstrate the feasibility of using the J-aggregate nanotubes in the sensitive and selective detection of mercury (II) ions by the photoinduced electron transfer under sunlight. The presence of mercury (II) ions in aqueous solution could be detected for concentrations as low as 10 pM.

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The public is welcome to attend.