DNA Nanoarchitecture

Overview:

With the advent of nanotechnology, a variety of nanoarchitectures with varied physicochemical properties have been designed. DNA nanotechnology is the design and manufacture of artificial nucleic acid structures for technological uses. In this field, nucleic acids are used as non-biological engineering materials for nanotechnology rather than as the carriers of genetic information in living cells. Researchers in the field have created static structures such as two- and three-dimensional crystal lattices, nanotubes, polyhedra, and arbitrary shapes, as well as functional devices such as molecular machines and DNA computers. The field is beginning to be used as a tool to solve basic science problems in structural biology and biophysics, including applications in crystallography and spectroscopy for protein structure determination. Potential applications in molecular scale electronics and nanomedicine are also being investigated.

Owing to the unique characteristics, DNAs have been used as a functional building block for novel nanoarchitecture. With the rapid growth of DNA nanotechnology, self-assembled DNA materials have been designed and manufactured. Due to the precise controllability and intrinsic selective specificity, nucleic acids, i.e., DNA or RNA, can be used as generic nano-brick-and-mortar material. For example, a self-assembly of long DNA molecules via a piece DNA staple has been utilized to attain such constructs. However, it needs many talented prerequisites (e.g., complicated computer program) with fewer yields of products. In addition, it has many limitations to overcome: for instance, (i) thermal instability under moderate environments and (ii) restraint in size caused by the restricted length of scaffold strands. Alternatively, the enzymatic sewing linkage of short DNA blocks is simply designed into long DNA assemblies but it is more error-prone due to the undeveloped sequence data.

To date, several complexes of DNA origami have been achieved that includes sphere, hexagon, tube, Mobius, and emoticon shapes. Furthermore, such DNA can be practically used as a seed template of DNA crystal or as a therapeutic agent or its vehicle. To construct these shapes, there are several methodologies have been developed. For example, stapling of long and single DNA resulted in forming DNA ropes. In past, enzymatic interlinking of single DNA blocks have been investigated for higher DNA structure.

The conceptual foundation for DNA nanotechnology was first laid out by Nadrian Seeman in the early 1980s with the word written as “It is possible to generate sequences of oligomeric nucleic acids which will preferentially associate to form migrationally immobile junctions, rather than linear duplexes, as they usually do.”, and the field began to attract widespread interest in the mid-2000s.Three decades later the field has outgrown its roots in protein crystallography and delivered numerous advances in the control of matter on the nanoscale. This use of nucleic acids is enabled by their strict base pairing rules, which cause only portions of strands with complementary base sequences to bind together to form strong, rigid double helix structures. This allows for the rational design of base sequences that will selectively assemble to form complex target structures with precisely controlled nanoscale features. A number of assembly methods are used to make these structures, including tile-based structures that assemble from smaller structures, folding structures using the DNA origami method, and dynamically reconfigurable structures using strand displacement techniques.

Seeman had wanted to organize proteins in three-dimensional (3D) crystals so that he could study their structure with X-ray crystallography. (Fig. 1). The history and state of the art in structural DNA nanotechnology have been widely reviewed2–7.. These tiles could be used to assemble higher-order periodic and aperiodic lattices17–30, and nanotubes31–37. A landmark of periodic DNA structure assembly was achieved by Seeman and co-workers38 in 2009 with the formation of 3D DNA crystals from tensegrity triangles39 that diffract X-rays to 4 Å resolution.

In this course the internationally acclaimed academics with prove record in thefield will enlight the participants about the field, technological importance and stimulate discussions about the future of the field. The course will be planned and offered as per the set norms.

Objectives:

The primary objectives of the course are as follows:

- Exposing participants to the fundamentals of Nanotechnology, Nanobiotechnology, and DNA Nanotechnology.
- Letting the participant know about the synthesis methodologies and application of DNA nanotechnology and nanostructures.
- Providing exposure to practical analytical and characterization methods of DNA nanostructures.
- Discussing with the participants about the recent research publications in Nature/Science about the role of DNA nanostructures to increase their knowledge for establishing research in this new emerging field.
- Stimulate discussions about the future of the field.

Course Details:

Inauguration and Course introduction: Feb. 20, 2017.

Day-1 (Feb. 21, 2017)
Lecture-1:Fundamentals of Nanotechnology, Synthesis methods and applications

Lecture-2: Characterization techniques used in Nanotechnology,

Tutorial-1. Exposure of the participants to Characterization tools available in University (Central Instrumentation Faciltiy and Centre for Nanoscience and Nanotechnology)

Day-2 (Feb 22, 2017)
Lecture-3: Fundamentals of Nanobiotechnology, Combinational Synthesis methods and applications

Lecture-4: Characterization techniques used in Nanobiotechnology,

Tutorial-2. Exposure of the participants to Characterization tools available in University (Central Instrumentation Faciltiy and Centre for Nanoscience and Nanotechnology)

Day-3 (Feb. 23, 2017)
Lecture-5: Fundamentals of DNA Nanotechnology,

Lecture-6: Synthesis methods, characterization and applications of DNA nanobiotechnology,

Tutorial-3. Exposure of the participants to Characterization tools available in University (Central Instrumentation Faciltiy and Centre for Nanoscience and Nanotechnology)

Day-4 (Feb. 24, 2017)
Lecture-7: Examples of various DNA nanostructure and their possible

Lecture-8: Presenting a model Research Paper published in Nature/Science

Tutorial-4. An open group discussion on DNA nanotechnology

Day-5 (Feb.267, 2017)

Lecture-9: Sharing research experience on DNA nanostructures

Lecture-10: Future applications for structural DNA nanotechnology

Day-6 (Feb.28, 2017)

Examination and Evaluation

Foreign Teaching Faculty:

Name of the foreign expert:	Prof. Sung Ha-Park
Designation and affiliation:	Associate Professor, Department of Physics, Sungkyunkwan University
State & Country	Suwon, South Korea
Official e-mail ID	sunghapark@skku.edu

BIOGRAPHY:

Sung Ha Park is an associate professor of physics & Sungkyunkwan Advanced Institute of NanoTechnology (SAINT), SungkyunkwanUniversity, Republic of Korea. He got his Ph.D. in physics at Duke University, USA (2005). From 2005-2007, he worked at Caltech, USA asa postdoctoral researcher studying the subject of DNA Nanotechnology and DNA computing. Up to now, he have published more than 80 research articles in scholarly journals, such as Science, Nature Nanotechnology, Nano Letters, ACS Nano, JACS and Angewandte Chemie. Currently he is a member of the Korean Physical Society and the KoreanBiophysical Society and serves as an associate editor for a journal of NANO, World Scientific.

Further details about Prof. S.H. Park can be seen at his homepage: http://dnanano.skku.edu/

Who Can Attend:

- Executives, engineers and researchers interested in Nanotechnology from industry and government organizations, including R&D laboratories.
- Student at all levels (BTech/MSc/MTech/PhD) or Faculty from reputed academic institutions.

Registration Fees:

Participants from abroad : US $200

Industry/ Research Organizations: 5,000/-

Academic Institutions:

Faculty members: Rs. 2000/-

Students: Rs. 1000/-

The above fee include all instructional materials, computer/lab use for tutorials/labs (if any), refreshments, and 24 hr free internet facility.

Proposed Budget:

S. No.	Description of budgetary head	Amount (Rs.)
1.	International Expert Air Fare,	1,00,000
2.	Honorarium to Expert	2,94,000

3.	Lecture Notes/video-learning material preparation	50,000
4.	Video recording of lectures	30,000
5.	Contingency & miscellaneous expenditure	70,000
6.	*Course coordinatorhonorarium	20,000
	TOTAL (sum of S. No. 1-5)	**5,44,000 (~ 8000 USD)**

***** *Honorarium to course coordinator should be paid from the earning for the course through registration fee collection.*

Course Coordinator:

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