Preface

Giorgio Vasari, a painter, architect, and art historian during the Italian Renaissance, is credited with coining the expression "andare a bottega," ("attending the studio") referring to the internship that the apprentice would complete in the master's studio in order to learn what could be uniquely transmitted in person and in that particular environment and that could then lead to making a unique artist of the apprentice.

Nowadays, this same concept holds true in science, and despite the many opportunities for communication and "virtual presence", the real physical permanence in a lab is still the best way for a scientist to learn a technique or a protocol, or a way of thinking. A book of protocols, such as this, humbly proposes itself as the second-best option. Not quite the same as being in person in a lab and witnessing the experts' execution of a protocol, it still holds many more details and hints than the usually brief methods section found in research papers. This book of protocols for DNA nanotechnology was composed with this concept in mind: prolonging the tradition of Methods in Molecular Biology, it tries to simplify researchers' lives when they are putting in practice protocols whose results they have learnt in scientific journals.

DNA is playing a quite important and dual role in nanotechnology. First, its properties can nowadays be studied with unprecedented detail, thanks to the new instrumental nano(bio)technologies and new insight is being gathered on the biological behavior and function of DNA thanks to new instrumentation, smart experimental design, and protocols. Second, the DNA molecule can be decontextualized and "simply" used as a copolymer with designed interaction rules. The Watson–Crick pairing code can be harnessed towards implementing the most complicated and elegant molecular self-assembly reported to date. After Ned Seeman's contribution, elegantly complicated branched structures can be braided and joined towards building nano-objects of practically any desired form.

DNA nanotechnology is somewhat like watching professional tennis players: everything seems so simple, but then you set foot on the court and realize how difficult it is to hit a nice shot. When you see the structural perfection of a self-assembling DNA nano-object, such as a DNA origami, you marvel at how smart DNA is as a molecule and wonder how many different constructs you could design and realize. Among the others, this book tries to show the procedures to follow in order to repeat some of the methods that lead to such constructs, or to the mastering of the characterization techniques used to study them. Many details and procedures are the fruit of the blending of artistry, science, and patience, which are often unseen in a journal paper, but that could be what makes the difference between a winning shot and hitting the net.

Many research groups share their expertise with the readers in this book. For the sake of conciseness, we here mention the group leaders, while it is truly from the daily work of a complete team that the details of a protocol can be worked out. The chapters of this book can be roughly divided into two parts: some deal with the methods of preparing the nanostructures, from the rationale of the operations to the techniques for their handling; some other chapters deal more directly with advanced instrumental techniques that can manipulate and characterize molecules and nanostructures. As part of the first group, Roberto Corradini introduces the reader to the methods and choices for taming helix chirality, Alexander Kotlyar, Wolfgang Fritzsche, Naoki Sugimoto, and James Vesenka share their different methods in growing, characterizing, and modifying nanowires based on G tetraplexes; Hao Yan and Friedrich Simmel teach all the basics for implementing the self-assembly of branched DNA nanostructures, and then characterizing the assembly. Hanadi Sleiman tells about hybrid metal–DNA nanostructures with controlled geometry. Frank Bier shows the use of rolling circle amplification to make repetitive DNA nanostructures, while, moving closer to technological use of DNA, Arianna Filoramo instructs on how to metalize double-stranded DNA and Andrew Houlton reports on the protocol to grow DNA oligonucleotides on silicon. Also with an eye to the applicative side, Yamuna Krishnan instructs on how to insert and use DNA nanostructures inside living cells. On the instrument side, Ciro Cecconi and Mark Williams introduce the readers to methods for the use of optical tweezers, focusing mainly on the preparation of the ideal molecular construct and on the instrument and its handling, respectively. John van Noort and Sanford Leuba give us protocols on how to obtain sound data from single-molecule FRET and apply it to study the structure of chromatin. Claudio Rivetti teaches the reader how to extract quantitative data from AFM of DNA and its complexes, while Matteo Castronovo instructs on the subtleties of using the AFM as a nanolithography tool on self-assembled monolayers; Jussi Toppari dwelves on the very interesting use of dielectrophoresis as a method to manipulate and confine DNA, while Matteo Palma and Jennifer Cha explain methods for confining on surfaces DNA and those very same types of DNA nanostructures that other chapters tell the reader how to assemble. Aleksei Aksimientev shows the methods for modeling nanopores for implementing DNA translocation, a technique bound to find many applications in the near future.

We hope this book will help ignite interest and spur activity in this young research field, expanding our family of enthusiastic followers and practitioners. There are certainly still many chapters to be written on this subject, simply because so much is happening in the labs at this very moment. There will certainly be room for the mainstreaming of protocols on the use of DNA analogues (starting with the marvelous RNA, of course), for the design and preparation of fully 3D architectures, for the development of routes towards functional DNA nanostructures, which will lead to applications. DNA nanostructures can be "re-inserted" in their original biological context, as microorganisms can be convinced to replicate nanostructures or even code them. And eventually, applications will require massive amounts of the nanostructures to be produced and to be manipulated automatically, possibly with a precision and output rate similar to that of the assembly of microelectronics circuitry nowadays.

Our personal wish is that the next chapters will be written by some of our readers.

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