
Preface by the Editor

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The genome has been compared with a cookbook. Each gene is a recipe, with detailed instructions on which ingredients (amino acids) for the cooks (ribosomes) to combine in which order to produce the final dish (protein), with various non-coding regions that indicate what to cook when and where and even to generate the cooks themselves (ok, the metaphor breaks apart there). Each cell in an organism has the same genome, the same set of recipes to choose from to make the cells, their components, and their secretions. Just as a cookbook has appetizers, soups, mains, and desserts, so too does the genome cover far more proteins than any given cell needs to make at any given time.

If the genome is a cookbook, then the transcriptome is the order tickets: what that particular kitchen is in the process of making right then and there. The transcriptome is the messenger (RNA) between the genome and the ribosome, that says what protein to make right now at this place and time. A transcriptome is a snapshot of what proteins a cell is in the process of making: what genes are being transcribed for the ribosomes to translate. While a genome tells you what the organism can do in theory, a transcriptome tells you what the organism, tissue, or even single cell actually does and was doing at the time one extracted the RNA from it. By comparing different tissues or species, and/or varying the conditions or times or environments, one can see how the variables affect gene translation at that time, and help translate the wealth of potential information encoded in a genome into more practical and grounded data with tangible significance. Transcriptomics, the sequencing and analysis of transcriptomes, combines the relative simplicity of genomics with the empirical nature of proteomics.

Entomologists have been using transcriptomics for decades, but no reference on the subject of transcriptomics in the field had existed. It was each

individual scientist's unspoken responsibility to discover transcriptomics on their own and decide whether and how they could use it, which of course means one usually will not encounter transcriptomics unless working with a senior researcher who already has. To bring such researchers and the curious neophytes together, in 2017 I organized the symposium 'Revelations from Insect Transcriptomics' at the annual meeting of the Entomological Society of America in Denver, Colorado, USA. My goals were to showcase not only the diversity of ways in which transcriptomics can be used within entomology, but also the diversity of the scientists themselves. The invited speakers included students and tenured faculty alike, consisted predominantly of women's voices, and represented a broad range of races, nationalities, sexualities, and abilities. The event drew a larger crowd than anticipated, and caught the eye of the publishers. The book you are reading now is the direct product of this symposium, and many of its chapter authors were original symposium speakers.

The purpose of this book is to serve as an introduction to transcriptomics and present an array of its uses in entomology, past and present, though of course it can be just as easily applied to any other branch of biology. I have laid out the menu from general to specific. We start with a thorough introduction to how transcriptomics works, its history, and some of its broad-stroke uses in insect science (Chapter 1). This chapter is followed by an exhaustively comprehensive look at how transcriptomics analysis is performed, and the software packages available to help one go from next-generation sequencing data to an interpretable dataset (Chapter 2).

We continue with reviews of how transcriptomics has been used within larger subfields of entomology, showing different applications of the basic techniques covered earlier. Transcriptomics and other next-generation sequencing technologies are ushering in radical new ways to approach pest management by finding new targets for control, genes responsible for pesticide resistance, and even novel pathogens (Chapter 3). This is exemplified by the many studies done on the aphids, often with non-model but economically significant species for whom genomic data does not exist, which have succeeded in finding critical genes involved in aphid-plant interactions and host specificity and finding targets for biocontrol by blocking transcription of key genes (Chapter 4). Identifying new pathogens has been particularly important for honey bees, where transcriptomics revealed several new pathogens with potential links to Colony Collapse Disorder (Chapter 5). Discoveries within insects can have implications throughout biology: researchers use transcriptomics to accelerate the discovery of certain large yet conserved gene families, such as the hyper-diverse and multifunctional cytochrome P450s of interest to toxicologists, physiologists, agriculturalists, pharmacologists, and more (Chapter 6).

We end with case studies going into more depth on how transcriptomics has been used to reveal more specific facets of a particular system. With its high power and low bias, transcriptomics is ideally suited to generate information for non-model organisms, cryptic species, and organisms that cannot be cultured in a laboratory, including insects, endocellular symbiotic

microbes, or even both at the same time. The cases presented here include untangling insect-microbe interactions in cryptic parasitoid wasps (Chapter 7), identifying conserved insect digestive enzymes from the silverfish transcriptome (Chapter 8), discovering the function of mysterious organs in the stick insects (Chapter 9), and using functional transcriptomics to describe the chemical defenses of the bombardier beetle (Chapter 10).

It is my hope that the readers of this book will be inspired by the many possibilities transcriptomics offers to find a way to apply it to their needs and their research systems, and that the chapters herein can provide some practical information on how to get started. The power of this method to reveal the unknown is immense, and we have barely scratched the surface. Do not take my word for it, though. The authors and their references can speak for themselves.

Special thanks to Ward Cooper for suggesting this book, the Entomological Society of America for bringing all relevant minds together, and the contributors for donating their time and text to this tome.