contributors include both developmental and adult stem cell biologists.

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Nuclear Transport: The Bottom Line

Nuclear Transport
Edited by Karsten Weiss
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$104.75

Nucleocytoplasmic transport plays a pivotal role in eukaryotic cell function and is relevant to many areas of cell biology. As such, it is somewhat surprising that books on this subject are in short supply. *Nuclear Transport*, edited by Karsten Weis, is a welcome addition.

To understand the organization of the book, a brief overview of nuclear transport is helpful. Nuclear localization signals (NLSs) and nuclear export signals (NESs) direct proteins to enter or leave the nucleus. Most types of nuclear transport use a set of cytoplasmic receptors derived from a single family of proteins, the importin β (or karyopherin β) nuclear transport receptor family. These receptors are regulated by the binding of a small GTPase, Ran. Ran exists predominantly in its GTP form inside the nucleus (where its GDP-GTP exchange factor, RCC1, resides), and in its GDP form in the cytoplasm (where its GTPase activating protein, RanGAP, is found). This nuclear/cytoplasmic RanGTP gradient was recently confirmed visually using novel fluorescent biosensors (Kalab et al., Science *295*, 2452–2456, 2002).

Getting back to the basics of nuclear transport, an eager import receptor arrives in the nucleus carrying its cargo and is then approached by RanGTP. The import receptor binds to RanGTP, which causes the receptor to undergo a conformational change and release its cargo, completing import. Export receptors show the opposite behavior. They strongly bind to their export cargo (for example, a nuclear protein containing an NES) only when simultaneously bound to RanGTP. The heterotrimeric complex of export receptor/RanGTP/NES-bearing protein translocates through the nuclear pore, a structure ~400 times the size of the export complex. Immediately upon reaching the opposite side of the pore, the export complex dissociates due to the RanGAP tethered to the cytoplasmic filaments of the pore.

Individual organisms contain at least 10–20 members of the importin β receptor family. Some are import receptors, specialized for ferrying different nuclear proteins or snRNP cargo into the nucleus. Other receptors are specific for exporting nuclear proteins, 5S RNA, tRNA, or ribosomal subunit precursors to the cytoplasm. Although most nuclear give-and-take uses importin β-like receptors, the export of mRNA apparently does not. During the splicing process, mature mRNA, a very large cargo, appears to form a complex with a variety of distinct non-importin β-type proteins that together mark the mRNA for export and participate in its egress from the nucleus.

Nuclear Transport provides an overview of much of our current knowledge in the field, summarized in nine chapters by different contributors. Despite variations in style and depth of coverage, the authors have made a largely successful effort to provide an overview of the basic mechanism of transport, as well as comprehensive snapshots of our understanding of specific areas of nuclear transport. The breadth and the highlighting of controversial issues and unanswered questions are strengths of the book.

Strambio-de-Castilia and Rout begin by reviewing many aspects of the *Saccharomyces cerevisiae* nuclear pore complex, revolving around the impressive proteomics work recently published by Rout and collaborators (Rout et al., J. Cell Biol. *148*, 635–651, 2000). The yeast nuclear pore is compared and contrasted to the larger and more complex vertebrate nuclear pore in the next chapter by Fahrenkrog and Aebi. This chapter puts greater emphasis on structural methods, including recent work involving cryo-electron tomography and atomic force microscopy, techniques which are hoped will improve our understanding of the three-dimensional architecture of the nuclear pore.

Also included in the review by Rout is his model for transport, which is presented in a measured and interesting way. Missing from the book, however, is a rendition of a competing model for the mechanism of translocation by Ribbeck and Görlich, EMBO J. *20*, 1320–1330, 2001). It should be noted that, although each of the models has its strong points, experimental proof of such models is hard to come by. Indeed, it has been very difficult to confirm a specific translocation mechanism for the nuclear pore, which contains multiples of 30–50 different proteins in the final 500–1000 protein nuclear pore complex.

In the third chapter of *Nuclear Transport*, Bischoff et al. focus on the small GTPase Ran, a molecule that is appropriately crowned the "king" of nuclear transport elsewhere in the book. This review provides a wealth of structural and biochemical information on the function and regulation of Ran.

Four chapters describe different export receptors and pathways. In the first of these, Fornerod and Ohno focus on the receptor that mediates the export of NES-bearing nuclear proteins and certain ribonucleoprotein complexes, exportin 1 or Crm1. This accessible chapter not only provides a review of the subject and some of the historical background leading to the discovery of exportins, but also discusses general principles relevant to other types of transport receptors. Simos et al. review all aspects of exportin-t, a β-like receptor that is unique in that it directly recognizes an RNA molecule, i.e., tRNA, and exports it to the cytoplasm. Izaurralde next describes the exciting developments in the area of mRNA export. Particularly informative to these reviewers was a final export review by Cullen, detailing the lessons retroviruses teach us on nuclear export.

The comprehensive set of export chapters is punctu-

ated by a review by Conti on the crystal structures of different nuclear import receptors, complexed either with their cargo or with Ran. This chapter includes clearly depicted molecular structures of importin, as well as a detailed discussion of their implications for the mechanism of transport. In truth, the book would have benefited from inclusion of a separate chapter on the cell biology and biochemistry of importins. Several of the chapters refer to such a review, indicating that perhaps this was the original intent. Its absence does not seriously detract from the book, however, since the other reviews masterfully summarize the major points one needs to know with respect to importins.

To conclude, Schuller and Ruis lay out the growing smorgasbord of different mechanisms that our cells have evolved to regulate the transport of individual cargo proteins. These range from phosphorylation and masking of a cargo protein's NLS, to reversibly anchoring a cargo transcription factor in the cytoplasm. General mechanisms are described and the most extensively studied examples are presented to illustrate these mechanisms. This chapter will be of particular interest to researchers in the areas of gene regulation, oncogenesis, and signaling.

The book has a few flaws, in addition to the ones mentioned above. A model for import on p. 41 is in disagreement with the models presented in the other chapters. The interesting details of DNA entry into the nucleus (see Salman et al., Proc. Natl. Acad. Sci. USA *98*, 7247–7252, 2001) are missing. Relative short shrift is given to the work of many nuclear transport labs, as the citations tend to be somewhat "Euro" in nature. Despite this, the interested reader will definitely learn all the rules of nuclear transport from the reviews. Supplementing *Nuclear Transport* with the transport reviews that are published yearly in *Current Opinion in Cell Biology*'s Nucleus issue will assure that the readers' knowledge continues to be up-to-date. The field of nuclear transport has experienced all the benefits and difficulties of having a multitude of bright, aggressive scientists, male and female, studying yeast and vertebrate systems, and hailing from around the world. *Nuclear Transport* does not recreate the excitement and tension that this concentration of scientists has generated: the expert feels its absence, but the calm waters presented in the book should satisfy all others.

Overall, scientists whose work impacts the nucleus in any way will benefit from having *Nuclear Transport* on their shelves. It is appropriate for audiences ranging from the beginning graduate student, to scientists in other fields, to the long-time expert in nuclear transport. A strength of the book is that reading almost any three chapters will easily enable one to consider themselves well-grounded in the ins and outs of nuclear transport and will give them the necessary "bottom line."

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Frog, Fly, Chick, Mouse—Recipes for Making Animals

Essential Developmental Biology
By Jonathan Slack
Boston: Blackwell Science (2001).
304 pp. $39.95

Developmental biologists who feel that theirs is the most exciting field of research should be forgiven their hubris. What more fascinating problem could there be, than that of how the embryo makes an organism? What are the molecular and cellular events that make gut, brain and kidney—sometimes in a day—from a fertilized egg? What manner of interaction between genes and environment yield a field of flowers, each patterned so precisely? The attractions and practical value of studying developmental biology may not have been obvious to those outside a small community till recently. However, the publicity surrounding the sometimes-striking applications of developmental biology has made even the lay public appreciate and understand (and oftentimes be apprehensive of) the applications of research using model organisms. So, as Jonathan Slack points out in his new textbook, the time is indeed ripe to attract undergraduates of diverse inclinations to an introductory course in developmental biology. Doctor, lawyer, scientist, social scientist, physicist—almost every one headed for a university education can find an early exposure fascinating and perhaps even useful in their respective careers. All that is needed is an inspiring teacher. And a great textbook can be a big help.

Historically, developmental biology, or experimental embryology as much of it was, has relied on three deceptively simple tools. The first involved observation of the developing embryo using the microscope. The other two tools involved experimental manipulation of the embryo. Ablations were used to examine the effects of destroying a region of the developing embryo and explants of tissue placed in ectopic locations were used to study regulatory properties of tissues by studying how they affected the development of their new neighbors. The key issues were sharply presented in elegant experiments or ideas. With the advent of the microscope, detailed observation of the developing embryo became possible. Distinct from a view that organisms were pre-formed as miniatures in the egg, Kaspar Freidrich Wolff's observation, in the mid-18th century, of the chick embryo, suggested that the development of form was progressive. In the late 19th and early 20th century, Karl von Bauer and Ernst Haeckel (whose drawings are now thought to have been rather imaginative) pointed out features shared by animal embryos, thereby linking evolution to development. August Weismann, late in the 19th century suggested that factors in the fertilized egg, distributed asymmetrically during cell division, directed the course of development. Wilhelm Roux ablated one cell in a two-cell frog embryo. He found that the remaining cell developed into a half-embryo, suggesting that factors were distributed between daughter cells that put them on mutually exclusive developmental paths. Hans Driesch, Roux's contempo-