# Preface

### Development of the Reader

This compilation of papers was developed in the belief that students should read original science. It was organized in such a way as to give voice to the multiplicity of understandings within the field of hormones and behavior and the study of sex differences of the central nervous system. The small seed planted in the early days of Beach and Young has grown into a giant tree that links body and brain through studies in the fields of behavior, endocrinology, biochemistry and molecular biology of steroid hormones, neurophysiology, neuroanatomy, and neuroendocrinology. It is a wide-branching tree that stands as an example of how science grows and diversifies but all the time is firmly rooted in the soil of human curiosity. If one starts at the roots, travels the trunk, and follows each branch to its full extent, eventually a story that links body and brain, female and male, is revealed.

The chapters in this reader were originally collected for a course that I first taught in 1995, offered jointly through the Departments of Zoology and of Neurobiology at Duke University, "Sex and the Brain: The Science of Gender." It was not a standard hormones and behavior course because, at that time, I did not know about the field of hormones and behavior. I trained in neuroanatomy, not psychology; my expertise is in systems and cellular neuroscience in the areas of vision, aging, memory, and Alzheimer's disease. Embarrassing as it is to admit—I only learned that there was a whole field called hormones and behavior after I put the papers together. So the perspective of the course was from the brain out into behavior.

So, why did I develop the course?

To be honest, putting the course together was a political move. My appointment at Duke was in the Faculty of Medicine but I was also on the advisory board of the Women's Studies Program—their token scientist—and I got it into my head that it would be doing something important for women in the sciences to put together a course whose content was appropriate for cross-listing with zoology and women's studies and that would teach substantive biology. Courses covering the feminist critique of science or the history of women in science were already plentiful. I wanted to devise a course in which, through learning some aspect of the brain, the material itself would naturally lead to questions about sex, gender, and the cultural assumptions underlying the design of the experiments.

Thus, although these readings certainly teach students about estrogens, behavioral paradigms, sexual differentiation, the hypothalamic-pituitary axis and the regions of the brain that mediate aspects of sex, they also stretch students to judge experimental design, assumptions underlying experiments, the data, and the interpretation of the data. That is what I have tried to convey in the introductions to parts I through V.

In the more than ten years of teaching these papers it has been my experience that right from the beginning students are engaged by the material. While at first curious as to why they are being assigned papers more than five years old in a science course, they shortly understand how the papers build on each other conceptually and how, by reading the foundational papers, they are seeing core assumptions of a field being worked out. This is exciting to them. They are being let in on what has always been hidden from them: the human working out of what eventually gets presented in textbooks as fact. By reading these papers, they learn that science, like every other discipline, is knowledge in the making. Would students appreciate reading original and old papers in other fields of biology? Would they get as big a charge out of reading Linus Pauling's papers working out the structure of DNA or Watson and Crick's paper trumping Pauling's model? Possibly. But for teaching an awareness of how science progresses the papers on hormones and behavior have two major advantages over the papers in other fields:

1. The field is beautifully coherent (saying a lot about the collegiality within the field); and

2. The subject matter is sex, a topic that speaks directly to the students' own struggles and engagements on the topic.

### Choice of Inclusion

In turning the course into a reader choices had to be made as to how the story should be developed and by which papers. Choosing which papers to include was, indeed, difficult. Being more knowledgeable now than in 1995 it is now apparent to me that there are some splendid classic papers that are not in this compilation. Likewise, this reader contains some very odd papers. As well, there are some papers with data that were ultimately not replicable, while missing are the papers that later did replicate some initially controversial findings. And, of course, the field is growing, so every day papers appear that should be included. Thus, out of all the beautiful work that is in the field, how did I choose these papers?

In putting this reader together, foremost in my mind was telling a story. The story is the tale we tell when we interpret a paper on sex differences in the brains of gay and straight males or differences in language areas of females and males or books on men being from one planet and women being from another. The story I wanted to tell was that of the science purported to back all that up. If a paper contributed to the flow of that story, it made its way in. Didactically it was important to give representation to how different methods can be used to answer the same question. Physiological or behavioral experiments studying the functional significance of an anatomical finding are included. Papers that allow the comparison of the primate case with nonprimate models are also included. Some papers are included to give a nod to a team that was first to publish a report on a topic. Some review articles are included to keep the story moving. On the basis of these criteria, the reader includes papers by Harris, Beach, Goy, Phoenix, Gorski, Toran-Allerand, Mc-Ewen, Kimura, Arnold, Swaab, Pfaff, O'Malley, and Meany, along with many of their students. Some surprising works by researchers from other fields also appear: Raisman, Goldman-Rakic, LeVay, and Merzenich. All of this makes a very rich blend of perspectives, approaches, methods, and findings.

In the end, the only reason papers were excluded was because the students do not have time to read any more!

### Organization of the Reader

The overarching organization of the papers is not chronological. It starts with the question of what is a dimorphism, what are the behavioral observations, and how is it that the brain is an endocrine organ. It then moves to theories on how dimorphisms are established and how and where estrogens act. After that come the experiments to understand the relation between behavior and the brain, ultimately moving to papers on sexualities and gender identification—aspects of our selves. This compilation of papers poses those questions by having five major sections that build from background concepts to the early experiments establishing the organizational/activational hypothesis, from experimental models to humans, and from molecules to mind. Papers that address traits constitutive of personhood—cognition, gay/straight, and transsexual differences—do not appear until the last section because most would agree these papers are the most speculative and sensational.<sup>1</sup>

Each of the five sections has a number of subsections comprising papers relating to each other within the subtheme. Often papers in the subsections will juxtapose rodent models, primates, and, where possible, human experiments to highlight differences between rodents and humans. The five thematic sections are background; central nervous system dimorphisms; mechanisms for creating dimorphisms; dimorphisms and cognition; and dimorphisms and identity. Included in this collection is also an epilogue, which is by Beach, himself, describing the history of the field.

Each section has an introduction discussing key concepts covered in that section, explaining the reasons for the particular grouping of papers, how the papers relate to each other, what each paper explores, and some questions students might ask while they are reading.

## Use of the Reader

My own use of this collection was as follows. Each week students would read a set of papers addressing one overarching topic within the development of the field or the underlying biology. These readings were juxtaposed with readings in popular press books on sex differences. They were chosen to create a point/ counterpoint in the reductionist/pluralist debate. Myths of Gender or Sexing the Body (Fausto-Sterling) were assigned with the Sexual Brain (LeVay). Each week, students wrote two- to three-page commentaries on the readings to each other and responded to those commentaries also, to each other. After the first few weeks, which were spent making sure everyone had the same background, the students took over presenting the papers. Some years I gave a midterm quiz and other years, not. The final project was always a paper of no more than twenty pages in length dealing with a critique of the literature on sex differences in mental states, neuropsychiatric disorders, steroid biochemistry, or the molecular actions of estrogens.

Throughout the course, students were encouraged to think about (i) how the field developed; (ii) what the first observations were; (iii) what the diversity of opinions on sex differences is—whether these differences are dimorphic; (iv) what the evidence for and against the organizational and activational hypothesis is; (v) what the functional relevance of anatomical differences is; (vi) why the situation is more complicated in humans than in rodents; (vii) what the nature of the field is such that so many disciplines are represented? Reading the original papers allows questions such as these to flow. Always interesting, by opening up these questions students learn quite a lot of biology; by the end they know about the biochemistry of steroid hormones, molecular and cellular actions of estrogens, physiology of single cells, anatomy of the sexual brain, and how the endocrine system mediates many behaviors.

If a class is mixed with biology, philosophy and/or women's studies students there will certainly be the need to fill in gaps in students' understanding and provide current understandings of the science covered in the papers. This can be accomplished in the first three weeks of class, after which students begin to see the same principles repeated because of conceptual overlap between papers. The reader can be used as a primary text, augmented by popular press books like Simon LeVay's The Sexual Brain and/or Anne Fausto-Sterling's Sexing the Body. Alternatively, additional texts could be neuroscience texts or one of the major texts in hormones and behavior. First-person accounts on being transgendered, the David Reimer case, or searching for the "gay gene" open the door to wideranging discussion. For a women's studies course, assigning these papers with any book on gender (e.g., Judith Butler's Gender Trouble or Anne Fausto-Sterling's Myths of Gender) or books questioning the science of difference (e.g., The Mismeasure of Man; The Mismeasure of Woman; The Mismeasure of Desire) could also be useful didactically.

Whether or not this collection is matched with supplemental texts, it can be used to teach students that a scientific paper can be analyzed from a number of often independent perspectives: the design of the experiment, the data, and the interpretation of the data. With adequate discussion, exposure to these papers will give students an appreciation of this beautiful field and enable them to judge science independentlyespecially the current science in this area that is appearing on the front pages of the newspapers everyday either because public figures use it to support their prejudices or because, as humans, we are just plain interested. It is important to know about the development of the field to understand just how far the notion of a dimorphism can be taken. Whether or not individual students go on to a career in science, fostering critical thinking and confidence in intellectual judgment is the essence of our job as educators. These papers and this field support that goal.

#### Note

1. Since these are the papers students take the course to read, another possibility for organization is that the course could start there and then ask, "How did we get to this intellectual point?"