SCIENCE AND GENDER

THE RELATIONSHIP BETWEEN SCIENCE AND GENDER has been one of constant controversy for the last half-century and more. Science is frequently taken to be the ideal of objective enquiry, untainted by the class, political and religious conviction, race, or gender of its practitioners. As we have already seen, many developments in the history, philosophy, and sociology of science have in recent decades made this image of science as the ultimate in value-free knowledge increasingly hard to maintain. Few critiques of scientific objectivity have caused more controversy than those mounted by feminist scholars. Feminists have pointed to a number of problems with the traditional picture of objective scientific enquiry. A number of key texts published during the 1960s and 1970s, for example, have accused science of being a fundamentally masculine activity, some even suggesting that there are fundamental differences in the ways in which men and women interact with the natural world. Others have pointed to the fact that science has historically been an overwhelmingly male activity in terms of its practitioners. Others have pointed the finger at historians of science, too, accusing them as well as scientists of simply disregarding women's contribution to scientific endeavor. In this chapter, we will take a look at some of the key issues raised by feminist scholars and the arguments they put forward concerning the fundamentally gendered nature of scientific activity.

Commentators such as Evelyn Fox-Keller and Carolyn Merchant have suggested that the so-called Scientific Revolution of the sixteenth and seventeenth centuries brought about a transformation in the ways in which Europeans interacted with the natural world (see chap. 2, "The Scientific Revolution"). In particular, they associate the Scientific Revolution with

the increasing dominance of a distinctively male way of looking at nature. Broadly speaking, they argue that before the Renaissance natural philosophers emphasized the importance of living in harmony with the world around them. The predominant image of nature was of the Earth Mother. With the rise of the New Science, however, nature increasingly came to be regarded as a resource to be exploited. Natural philosophers increasingly described their activities in terms of the exposure and penetration of a passive and female nature. Women were increasingly marginalized in the search for knowledge. Natural philosophers and scientists were (and still are) predominantly men. Some feminist scholars have suggested that the contributions of women to the study of science have been systematically written out of history. They argue for the importance of studying distinctively female ways of understanding nature by recovering the careers and lives of otherwise forgotten women scientists. By reassessing women's contributions to the sciences and encouraging more women to take up scientific careers, they hope to decisively change the practice of science and its relationship with nature.

Feminist historians of science have argued that women's bodies themselves increasingly became the subjects of scientific inquiry in the aftermath of the Scientific Revolution. The historian Thomas Laqueur, for example, argues that during this period a shift occurred from regarding male and female bodies as essentially similar to regarding them as fundamentally different (Laqueur 1990). While male bodies were considered normal, female bodies were increasingly regarded as pathological and hence more and more subject to medical and scientific intervention. Other historians have charted the ways in which eighteenth-century anatomists represented female skeletons as having smaller skulls (and therefore smaller brains) than their male counterparts. By the nineteenth century, doctors and scientists increasingly regarded women's bodies as being in need of careful medical regulation. While men's bodies were supposed to be securely under the control of their minds, women's minds were widely regarded as being under the control of their bodies, particularly of their reproductive organs. As a result, women were viewed as being inherently mentally and intellectually inferior to men. Claims like these were used later in the century to argue against women's education and against women's participation in the political process. Opponents of women's emancipation (like advocates of white European racial superiority) could argue that science showed that women (like non-Europeans) were physically and mentally unfit for a university education or for anything other than a subservient and domestic existence.

Is science inherently sexist then? Some feminist scholars argue that science as it has developed from the early modern period onward represents a fundamentally male perspective on nature. They argue that science plays a major role (if not the key role) in sustaining an essentially exploitative relationship between humans and the rest of the natural world. Furthermore, science and scientists are guilty of having systematically denigrated other, essentially female, ways of knowing that would encourage a more nurturing and ecologically friendly relationship with nature. There are other ways in which science might be regarded as inherently sexist, too. Science remains by and large an overwhelmingly male activity. It is certainly the case that the practice of natural philosophy and science in previous centuries has been an almost entirely male preserve. The few women who were able to engage in scientific pursuits were usually relegated to the margins of science. This might be taken as evidence of systematic discrimination against women by men of science. Then again it might be taken as evidence that science is the result of fundamentally male ways of thinking and that as a result few women find it an attractive pursuit. There are several ways of looking at these issues, and in this chapter we will only be able to provide a brief overview.

Mastering Nature

Some feminist historians of science have viewed the Scientific Revolution of the sixteenth and seventeenth centuries in a very different light from the way in which it is conventionally portrayed. Traditionally, at least, the Scientific Revolution has been widely regarded as the dawn of a new age of enlightenment. According to this view, the emergence of the New Science heralded the victory of experience over authority. The rise of the experimental method and the systematic application of human reason to understanding the laws of nature were seen as having decisively broken with the old scholastic Aristotelian philosophy. From this point of view, the Scientific Revolution was unquestionably progressive and essentially benevolent. It was fundamentally a good thing. As we have already seen, a new generation of historians of science has cast some doubt on this rosy traditional picture of unproblematic scientific progress (see chap. 2, "The Scientific Revolution"). Historians and philosophers of science are now far less convinced that there is any such thing as a unique scientific method. Historians of science are now more inclined to see the emergence of the New Science in the particular context of early modern European culture rather than regarding it as the inevitable outcome of the application of a univer-

sal human reason. Some feminist historians of science have suggested, in addition, that the Scientific Revolution was in theory and practice an overwhelmingly male and sexist enterprise.

In an influential account of the emergence of modern science published in 1980, the feminist environmental historian Carolyn Merchant suggested that the Scientific Revolution overturned traditional ideas about living in harmony with nature in favor of ecological exploitation that also sanctioned the subjugation of women (Merchant 1980). She pointed to the "age-old association" between women and nature and argued that the Scientific Revolution was responsible for bringing about a new mechanistic worldview that was directly responsible for the exploitation of both women and nature. Traditional philosophies of nature had regarded it as essentially feminine. The earth was a nurturing mother who provided for the needs and wants of humankind. This image of the earth as a mother carried with it strong ethical constraints against the exploitation of natural resources. For humankind to pillage the earth of its resources would be the moral equivalent of a child turning on its mother. From this perspective, traditional philosophies of nature advocated living in harmony with nature rather than seeking to exploit it. Along with the image of nature as a mother came the view that the cosmos should be regarded as an organic unity. The dominant metaphor for the universe was that it was a living body (fig. 21.1).

Merchant and others, such as Evelyn Fox-Keller, have argued that a key outcome of the Scientific Revolution was to overturn this traditional metaphor of the universe as a living female being and replace it with the image of the universe as a machine (Merchant 1980; Fox-Keller 1985). Where premodern Europeans had regarded the cosmos as being alive, the instigators of the Scientific Revolution argued that it was best understood as an inanimate collection of mechanical parts. The clock was their favorite metaphor for the operations of nature. The Greek philosopher Plato in his *Timaeus*, for example, explicitly described the universe as a living being with a female soul. His Neoplatonist Renaissance successors such as the English alchemist Robert Fludd similarly portrayed the world soul as a woman. Images like this expressly supported the idea that the universe itself was a living (female) being. Promoters of the New Science, including René Descartes, conversely , viewed nature in explicitly mechanical terms. Nature was a soulless machine set in motion by God. Even animals had no souls, according to Descartes. Other seventeenth-century natural philosophers such as the Englishman Francis Bacon or the Anglo-Irish Robert Boyle

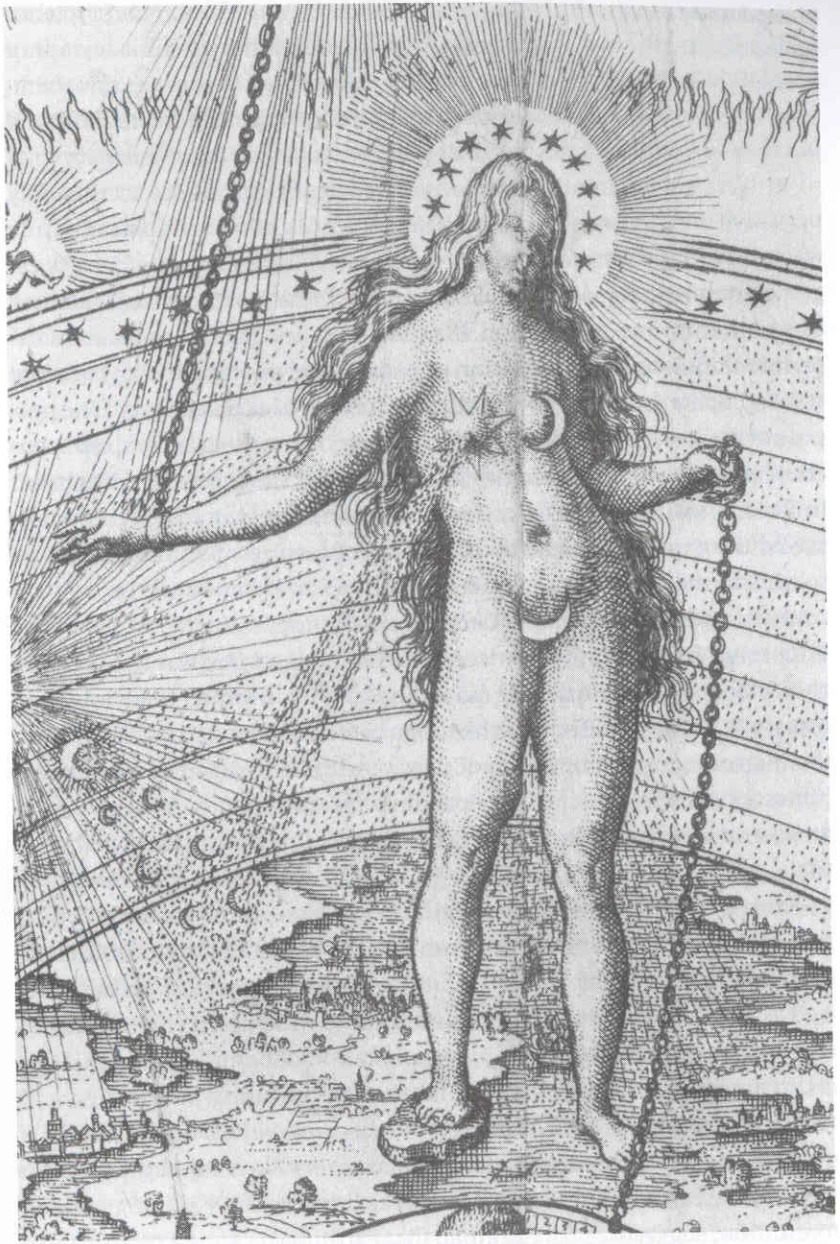

FIGURE 21.1 The female soul of the world, illustrated in Robert Fludd, *Utriusque cosmi maioris scilicet et minoris metaphysica* (1617).

viewed nature in much the same light. What feminist historians of science have suggested is that the increased dominance of the machine metaphor brought about a radical change in the way in which Europeans saw themselves in relationship to nature. Nature was no longer a nurturing mother but a resource to be exploited.

In fact, some feminist historians have suggested that the increasingly pervasive metaphor describing the New Science's relationship with nature was that of rape. Insofar as the Scientific Revolution's instigators still regarded nature as female, they described their relationship with it in terms of domination and penetration. Francis Bacon described the process of experimentation as "the inquisition of nature" and suggested "that there are still laid up in the womb of nature many secrets of excellent use." The purpose of the New Science was to unveil nature, lay bare her secrets, and penetrate her mysteries (Merchant 1980). Fox-Keller similarly draws attention to Bacon's use of language in this context and the way in which he portrayed the experimental method in terms of forcing a feminine nature to submit to masculine power and authority (Fox-Keller 1985). Bacon's account of the scientific utopia of Solomon's House in the *New Atlantis* has little room for women's knowledge. Natural philosophy was increasingly characterized as an inherently masculine activity in which there was little if any role for women. Feminist historians of science draw parallels between the increasing masculinization of science with the rise of the mechanical philosophy and the increasing economic marginalization of women and attacks on women's cultural place through institutions such as witchcraft trials.

From this perspective, the Scientific Revolution is viewed as being intimately linked to the rise of capitalism and the beginnings of industrialization (see chap. 17, "Science and Technology"). Modern science is characterized as a philosophy that at minimum justifies widespread environmental destruction and the systematic overexploitation of natural resources. Merchant argues that organic views of nature as a nurturing mother figure at the very least acted as a brake on excessive environmental abuse. She points out that ancient authors such as the Roman writer Pliny explicitly drew on the Mother Earth metaphor in warning against excessive mining and deforestation, suggesting, for example, that earthquakes were expressions of the earth's displeasure at such pillage of her treasures. Destroying the sanctity of the earth's body through overeager exploitation of resources was regarded as an expression of avarice, selfishness, and lust. By destroying traditional accounts of the cosmos as an organic unity and describing it as a soulless machine, the mechanical philosophy sanctioned widespread attacks on the environment. Natural philosophers such as Bacon were explicit in their claim that "knowledge is power" and that the purpose of natural philosophy was to make nature's resources available for man's economic benefit. Natural philosophy in general—and the mechanical philosophy in particular—might be regarded in this way as philosophical and ideological justification for unlimited commercial and industrial expansion.

These arguments concerning the relationship between science as an expression of male power and as both a tool and a justification for environmental exploitation are an indication of the increasing links between the feminist and environmental movements during the second half of the twentieth century. Carolyn Merchant, for example, was quite explicitly trying to foster the growth of radical ecofeminism through her writings. Merchant and others saw their accounts of science both as efforts to place what they perceived as modern science's masculine perspective in historical context and as attempts to revive a more holistic and feminist view of humanity's relationship to the natural world. Much of what they have to say about early modern natural philosophy as a fundamentally masculine and antifeminine activity is difficult to argue with. The worldview of seventeenth-century natural philosophers was unquestionably and overwhelmingly male-oriented. Whether this makes natural philosophy any more of a gendered activity than any other during the early modern period is, however, rather more questionable. Their claims about the more organic and female-oriented philosophies of ancient and medieval writers are a little more difficult to accept at face value. More or less organic and mechanistic views of nature alike have been put forward by different thinkers throughout history. There seems little evidence that more organically inclined philosophers, like Plato, for example, were notably more woman-friendly than their mechanistic counterparts.

Scientific Heroines

While some feminist historians of science seek to demonstrate the essentially male-gendered nature of scientific activity, others try to demonstrate that women have in the past made a number of important and influential contributions to scientific knowledge. The main purpose of such studies is often twofold. On the one hand, some feminist historians attempt to show how male scientists (and historians of science) have systematically discriminated against women, belittling or ignoring women scientists' achievements. On the other hand, many efforts to recover the lost histories of female contributors to the sciences are frankly celebratory in

nature. Their aim is simply to celebrate women's contribution and to offer female role models to aspiring women scientists (Alic 1986). Some also try to offer the example of past women scientists as case studies of the ways in which women approach the study of nature differently from men (Fox-Keller 1983). In this way, they hope to demonstrate that women's participation in the sciences might change the nature of scientific knowledge itself. At the very least, looking at women's contributions to the development of the sciences helps shift the focus away from the traditional view of science as the outcome of successive heroic discoveries and insights by great men. It helps demonstrate the extent to which a range of alternative views as to what science is, how it should be practiced, and by whom have always been with us (Abir-Am and Outram 1987).

One woman cited by Carolyn Merchant among others as an important example of the ways in which women's approach to the study of the natural world might differ from that of the prevailing male ethos is the early modern natural philosopher Anne Conway (Merchant 1980). Born into a well-to-do and politically influential family (her father had been Speaker of the House of Commons), Conway carried out an extensive correspondence with the Cambridge Platonist Henry More, who had been one of her brothers' tutors. In letters to More, she embarked on a philosophical critique of Cartesian dualism. She also corresponded with the Hanoverian philosopher Gottfried Wilhelm von Leibniz, who was later a particularly vociferous critic of Newtonian natural philosophy. Leibniz probably derived the term "monad," used in his philosophical attacks on dualism, from her writings. In later life, Conway became a Quaker—a dangerously independent move in seventeenth-century England (see chap. 15, "Science and Religion"). She died young, and her only complete philosophical work, *The Principles of the Most Ancient and Modern Philosophy,* was published posthumously in 1690. Conway's philosophical acumen was widely admired. More claimed that he had "scarce ever met with any Person, Man or Woman, of better Natural parts than Lady Conway." Feminist scholars frequently cite her Platonism and her opposition to Descartes's philosophical dualism and materialism as indicative of a distinctively feminine opposition to the prevailing trend toward the mechanical philosophy in early modern intellectual circles.

Like Conway, the English philosopher Margaret Cavendish was also an opponent of materialism. Coming from a family of Royalists during the reign of Charles I and the English Civil War, Margaret was one of the queen's ladies in waiting and fled with her mistress to Paris after the Royalists' defeat. There she married William Cavendish, a prominent Royalist and eminent natural philosopher. During her exile in France and after her return to England, Cavendish published widely on a number of topics, including natural philosophy. This in itself was highly unusual for a seventeenth-century woman. In 1667 Cavendish was granted permission to attend a meeting of the Royal Society to witness experiments carried out by Robert Boyle. Fellowship of the Royal Society was, of course, limited to men only, and there was considerable debate over whether a woman, however eminent, should be allowed to attend a meeting at all (see chap. 2, "The Scientific Revolution"). In a utopian tract published in 1666, *The Description of a New World Called the Blazing World,* Cavendish described an ideal scientific academy headed by a woman (herself) in which knowledge of nature was acquired through the help of anthropomorphic animal helpers. In writings like her *Observations upon Experimental Philosophy* (1666) and her *Grounds of Natural Philosophy* (1668), she argued for a view of nature as self-knowing and disputed some of Robert Boyle's claims concerning the role of experiment in natural philosophy.

The nineteenth-century woman about whom some of the most grandiose claims concerning her scientific contributions are made is undoubtedly Ada Lovelace (Stein 1985). She is often hailed as the "first computer programmer." Lovelace was the daughter of the English romantic poet Lord Byron and his wife, Anne Isabella. Her parents separated soon after her birth and she never met her father. Ada was privately educated by, among others, the Cambridge mathematician William Frend and Augustus de Morgan, the first professor of mathematics at the University of London. Ada moved socially in philosophical circles and was acquainted with a number of eminent scientists including Michael Faraday and Charles Babbage. In 1843 she translated for Babbage a description of his analytic engine by the Italian engineer L. F. Menebrea, including her own notes in which she described, among other things, a possible method for programming the analytic engine to tabulate Bernoulli numbers. This is the basis for her claim to fame as the first computer programmer or even, more recently, the "first computer hacker." Despite the utter anachronism of the description in an age more than a century before the invention of the first electronic computer, Lovelace does provide a good example of the kind of role some women did play in the early nineteenth-century scientific community (Toole 1992). She had a social status that allowed her to move easily in philosophical circles. She had the leisure and the inclination to become well-informed in natural philosophy, and her views and opinions were

clearly taken seriously by her male scientific interlocutors. What she did not have as a woman was a systematic scientific education or the opportunity to join scientific societies and become a recognized contributor to science in her own right.

It was only toward the end of the nineteenth century that women started to get access to university-level scientific education in any numbers, though it is worth noting that until the middle of the century relatively few male scientists received formal university training in their subjects either. One of the first women to make a significant impact on the increasingly professional world of late nineteenth-century physics was Marie Curie, born in Poland as Maria Skodlowska. Educated in Paris at the Sorbonne, she had become interested in investigating the mysterious new form of radiation noticed by the French physicist Henri Becquerel in samples of uranium salts. Along with her husband Pierre Curie, Marie isolated two new radioactive substances—polonium and radium. In 1903 she and her husband were awarded the Nobel Prize for their research. Marie Curie was the first woman to be awarded the honor. Following her husband's death, Curie continued her research as the leading authority in the new field of radioactivity that she had played a key role in establishing. Curie became a real power in the world of physics not only by continuing to make important contributions but by becoming director of her own laboratory and building links between science and industry, too (fig. 21.2). Despite her stature however, she certainly found more obstacles on her path to success than would have been the case for a male scientist. Her career was almost destroyed, for example, when she was suspected of having an affair with fellow physicist Paul Langevin (Curie 1938; Quinn 1995).

The example of Rosalind Franklin is often used to illustrate graphically the difficulties and prejudices faced by women scientists in gaining recognition for their work (Maddox 2002). Franklin studied natural sciences at Newnham College, Cambridge, and gained her degree there in 1941. She completed a PhD in physical chemistry in 1945 before going to work in the Laboratoire Central des Services Chimiques de l'Etat in Paris, where she became familiar with the latest techniques in X-ray crystallography. Working at King's College, London, during the early 1950s, she was the first to produce clear X-ray pictures of DNA, which proved crucial in helping Francis Crick and James Watson discover the double helix structure of the DNA molecule. Her contribution to the discovery was consistently underregarded by her male colleagues, and she often found herself excluded from the informal gatherings where they discussed their work. Her pioneering X-ray photographs of DNA were shown to Crick and Watson without her

FIGURE 21.2 Marie Curie at work in her laboratory (image courtesy of the American Institute of Physics, College Park, MD).

permission (see chap. 8, "Genetics"). Franklin died of ovarian cancer in 1958, at the age of thirty-seven, four years before Crick and Watson, along with her King's College colleague Maurice Wilkins, were awarded a Nobel Prize for the discovery. James Watson, in his bestselling *The Double Helix*, describing the discovery of the structure of DNA, characterized Franklin as a frustrated and obstructive bluestocking, largely dismissing the role of her photographs in clarifying DNA's structure (Watson 1968).

Franklin's case is a good example of the difficulties faced by women scientists in a male-dominated professional world. Her fellow X-ray crystallographer, Dorothy Crowfoot Hodgkin, has been used as an example of the ways in which a woman scientist might try to forge a distinctive female career in a male-dominated scientific world. Dorothy Crowfoot studied chemistry at Oxford before moving to Cambridge to work with the Irish X-ray crystallographer and Marxist, J. D. Bernal. Like her mentor she was a socialist and a pacifist and was actively involved in groups such as the Association of Scientific Workers and the Cambridge Scientists' Anti-War Group. She married Thomas Hodgkin, a lecturer to the Workers' Education Association, in 1937. Hodgkin carried out her scientific research using X-ray crystallography to help work out the structure of medicinally valuable molecules such as insulin, vitamin B_{12}, and penicillin. Her explicit aim in this work was to put scientific knowledge to humanitarian use. She was awarded the Nobel Prize in Chemistry for her crystallography work in 1964. In keeping with her socialist ideals, Hodgkin also regarded science as a cooperative, rather than individualist activity. As a laboratory director, she encouraged openness and the sharing of ideas rather than competition. Traits such as these have been regarded as indications of a distinctively female approach to science (Hudson 1991).

Individual female scientists' careers have, as we can see, been used in a number of different ways by historians of science. They have been used to demonstrate that women have indeed made important contributions to scientific inquiry. They have been used to show the extent to which women have been marginalized and denigrated in their scientific efforts. They have been used to show how some women scientists have practiced a distinctively female science. Historians of science have also started looking more generally at the ways in which women have supported and sustained scientific activity. During the eighteenth and nineteenth centuries, wives and sisters to men of science frequently played important roles as helpers and assistants. The French chemist Lavoisier's wife took an active part in his experimental research, and the Anglo-German astronomer William Herschel was often assisted by his sister, Caroline Herschel. Nineteenth-century women such as Jane Marcet or Mary Somerville played important roles as scientific popularizers, writing scientific books for wide audiences (Neeley 2001). In addition, women were often an important component of the audience for science during the eighteenth and nineteenth centuries (see chap. 16, "Popular Science"). They also regularly played important roles in furthering alternative sciences, such as mesmerism and phrenology (Winter 1998). This is increasingly the way that historians of science now look at the role of women in science. Rather than trying to fit women into the traditional picture of a succession of great men making great discoveries, they look at the changing place of women within scientific culture.

Defining the Body

Much recent historical attention has been devoted to the ways science has been used in the past as a way of defining gender characteristics. Feminist historians often argue not only that science itself is a predominantly (or even essentially) male activity but that the ways in which science has in the past described and defined women and women's bodies are inherently sexist as well. According to this perspective, women's bodies have in the past been characterized as inherently inferior to those of men, and that inferiority has been assumed to have consequences for women's mental capacities and their place in society. Women's bodies—their reproductive organs in particular—have been regarded as making them particularly susceptible to mental or nervous disorders. Women have been characterized as being less capable than men of abstract reasoning (and hence as less capable of being good scientists). During the nineteenth century, these kinds of arguments were frequently put forward in opposition to women's education. New theories in physics, for instance, the conservation of energy, and in the life sciences, such as Darwin's theory of natural selection, were used to explain the inherent inferiority of women, both mentally and physically. In much the same way that scientific racism was used to justify the subjugation of non-Europeans, these kinds of scientific theories were used to justify the social subordination of women to men.

The historian and anthropologist Thomas Laqueur has suggested that the modern view of male and female bodies as being inherently and essentially distinct is of comparatively recent origin (Laqueur 1990). From the time of the ancient Greeks through to the early modern period, the physical difference between men and women was often characterized as one of degree rather than kind. Women's bodies were simply regarded as being less perfect versions of male bodies. Women's reproductive organs were viewed as being inverted male reproductive organs. The ovaries were regarded as equivalent to testicles, for example. The uterus was an inverted scrotum. The vagina was an inverted penis. According to the Greek philosopher Aristotle, the primary difference between male and female bodies lay in the amount of heat each possessed. Male bodies were hotter than female bodies, and it was this that resulted in male genitalia being pushed outward while female genitalia remained within the body. Up until the sixteenth or

seventeenth centuries, popular tales of young women being transformed into men as a result of a sudden shock causing their reproductive organs to fall outward were widely circulated and taken at face value by natural philosophers and medical men. Increasingly, from the seventeenth century onward, however, men and women's bodies were regarded as being anatomically distinctive. The one-sex model of gender was being replaced by a two-sex model.

The historian of science Londa Schiebinger suggests that by the end of the eighteenth century anatomists were increasingly taking the view that the physical difference between men and women entailed much more than a difference in the location and function of the reproductive organs. It encompassed the entire body. She quotes an early nineteenth-century commentator as observing that the "entire life takes on a feminine or masculine character" (Schiebinger 1989). By the middle of the eighteenth century, a new generation of anatomists were drawing illustrations of the details of the human body—the skeleton in particular—that showed men and women as being anatomically distinctive at all levels. Male skeletons were typically drawn with longer legs than their female counterparts. Female skeletons were represented as having a broader and stronger pelvic girdle as befitted their function as childbearers. Female skulls were also often drawn as being proportionally smaller with regard to the rest of the body than were male skulls, as a mark of men's superior intellectual capacities. In his 1829 *Anatomy of the Bones of the Human Body,* the Edinburgh anatomist John Barclay drew the male skeleton compared with a horse, accentuating the male's structural strength and robustness. The female skeleton, by way of contrast, was drawn compared with an ostrich, emphasizing the large pelvis, the elegant neck, and the comparatively small skull (figs.21.3, 21.4).

By the nineteenth century, women were increasingly being represented as particularly prone to nervous and mental disorders resulting from their physical constitution. As several historians have pointed out, male bodies were typically regarded as normal, while female bodies were regarded as pathological and hence in need of constant medical and scientific intervention (Moscucci 1991). Women were viewed as being particularly susceptible to hysteria as a result of the disturbing action of the reproductive organs on the brain. In fact the term "hysteria" derives from the Greek word for "uterus." Mid-nineteenth-century experts on women's nervous diseases, such as the Edinburgh professor Thomas Laycock, argued that disorders of the female reproductive organs stimulated a reflex action in the brain, bringing about mental instability. As a result of such disorders, the "gentle, truthful, and self-denying woman" became "cunning, quarrel-

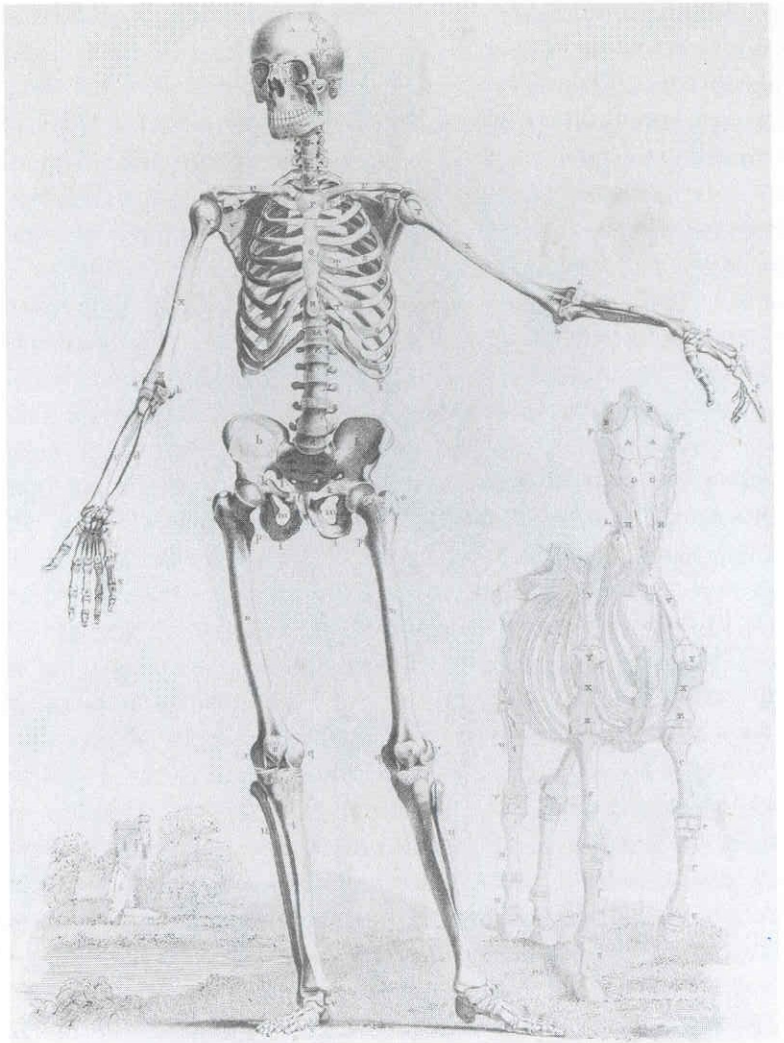

FIGURE 21.3 The human male skeleton's robust and masculine qualities demonstrated by comparison with the skeleton of a horse, from John Barclay, *The Anatomy of the Bones of the Human Body* (1829).

some, selfish; piety has degenerated into hypocrisy, or even vice, and there is no regard for appearances, or for the feelings of others." Victorian ideals of femininity were represented as scientifically established norms of female behavior (Showalter 1987). Deviations from that ideal were therefore often regarded as evidence of mental illness. Experts such as Laycock or Henry Maudsley in midcentury or such as Jean-Martin Charcot or Sigmund Freud

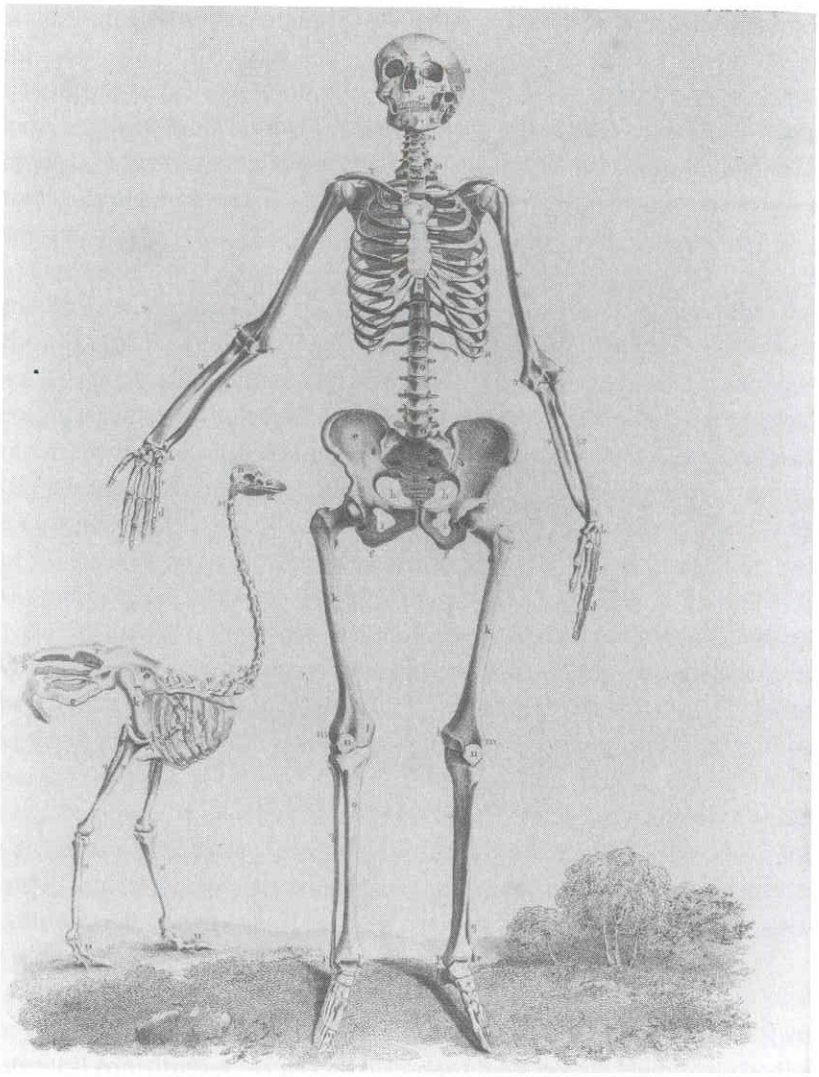

FIGURE 21.4 The human female skeleton's fragile femininity emphasized by comparison with the skeleton of an ostrich, from John Barclay, *The Anatomy of the Bones of the Human Body* (1829).

later in the century represented themselves as having a properly scientific knowledge of the workings of the female mind and body that allowed them to keep women's natural tendency toward mental deviance under control (Masson 1986).

As new scientific theories came along, they were often quickly adopted

to provide an explanation for women's intellectual and physical inferiority. The mid-nineteenth-century physical theory of the conservation of energy is a case in point. Many nineteenth-century doctors and scientists broadly subscribed to the view that the human body contained only a finite amount of nervous force and that using too much of that energy for one purpose would lead to their not being enough available for other functions. The theory of the conservation of energy provided a powerful new rationale for this widespread assumption. It demonstrated, among other things, the dangers of women's education. If women became too educated, too much of the body's finite resources of nervous energy would be used up by the brain with the result that not enough would be available for other uses, such as reproduction, for example. The conservation of energy could therefore be used as an argument suggesting that allowing women access to university education would lead to sterility. It also suggested why most women were incapable of taking advantage of such an education. Quite simply, so much of their available store of nervous energy was used up in maintaining their reproductive organs that there was comparatively less available for intellectual activity. The very physics of women's bodies seemed to suggest that they were better suited for domestic life rather than public or professional activity (Russett 1989).

In much the same way, Darwin's theories of evolution by natural selection were used to show how women's place in society was determined by nature rather than by any social constraints. According to this view, those physical and mental characteristics that Victorians regarded as typically male or female were simply the result of evolution by natural selection. In particular, Darwin argued that the differences between men and women were largely due to the process of sexual selection. Men competed with each other to gain access to the most sexually attractive women. The result was that only the strongest and most resourceful bred successfully. Women in these circumstances were selected for simply on the basis of sexual attractiveness rather than any other qualities such as physical strength or intellectual capacity. Darwin's view was that the end result of natural and sexual selection was "man attaining to a higher eminence, in whatever he takes up, than women—whether requiring deep thought, reason or imagination, or merely the use of the senses and hands." Views like these concerning the evolutionary adaptation of men and women for particular roles in society were also developed by others, such as Darwin's friend and ally T. H. Huxley (see chap. 6, "The Darwinian Revolution' and chap. 18, "Biology and Ideology"). Late nineteenth and early twentieth-century anthropologists argued in a similar way concerning the ways in which men and

women were adapted for particular social roles in different cultures (Richards 1989).

Examples such as these, feminist historians of science argue, show how science has been used to provide powerful support for the social subordination of women. Science from this perspective can be seen to have reinforced, if not actually created, social attitudes prejudicial to women's place in society. Arguments like these have often been put forward as examples of the way in which misogynist male scientists have allowed their prejudices to distort their scientific objectivity. According to this view, it is not so much science itself but individual male scientists who are responsible for promulgating stereotypical views of female inferiority. Similar arguments have been made concerning scientific racism. This view takes for granted that science is essentially objective and untainted by the culture in which it takes place. It assumes that there are "good" and "bad" ways of doing science and that sexist science, like racist science, is simply bad science. Others argue that science itself is inherently sexist and that it is therefore unsurprising that it produces views of women that reinforce male prejudices. From this perspective there is no such thing as good science. If we take the view that science is always the product of particular cultural circumstances, however, we might be less surprised to note the ways in which it often reflects the values of those particular cultures in which it was produced.

Is Science Sexist?

The most radical feminist perspective on science is that science itself, or at least science as it is currently practiced, is an inherently sexist activity. This argument is usually expressed in one of two forms. Some commentators point to substantial gender imbalance in the makeup of the scientific community both now and historically. They argue that this is an indication of institutional sexism within the scientific community, discouraging women from participating in scientific activity. Some such commentators argue for the need to introduce particular measures to make science appear more attractive to women. This is one motive for the trend we discussed earlier of attempting to recover the role of women in the past as significant contributors of new discoveries and insights. Some historians hope that such figures could be put forward as role models for potential women scientists. More radical feminist critics of science, however, see the gender imbalance as evidence of a deeper problem. According to this view, women tend to be underrepresented within the scientific community because science is the outcome of overtly male, fundamentally sexist ways of thinking and interacting with the world around us. From this perspective, the gender imbalance is far more than just a correctable historical trend: it is built into the very fabric of science itself (Harding 1986).

To a large extent, this argument is built on the claim, which we discussed at the beginning of this chapter, that modern science emerged from a view of nature as a female body waiting to be violated. These radical feminists critics point to the prevalence of metaphors of penetration, rape, and violation in early modern accounts of the scientific method—the experimental method, in particular—and draw the conclusion that they are an indication of something fundamental about the way science, then and now, regards the world. They take the view that metaphors like these are integral to the scientific worldview—that they are at the very heart of scientific inquiry. Furthermore, radical feminist critics argue that the kind of thinking that they say lies at the heart of science is fundamentally male. From this perspective it is hardly surprising that women tend not to become scientists. To become scientists, they would have to start thinking like men.

At the core of many of these feminist critiques of science lies the view that modern science maintains a fundamentally exploitative and destructive relationship with the natural world. This is what Harding has in mind, for example, with her characterization of science as maintaining "a conception of nature as separate and in need of control." Again, feminist critics argue that this is a characteristically male way of thinking. Men typically regard themselves as apart from nature and therefore as needing to be able to control it, while women typically regard themselves as part of nature and therefore as being in harmony with it. The critic of science Brian Easlea, in his influential book *Science and Sexual Oppression*, argues not only that science is inextricably linked to male oppression of women, but that it is more widely associated with (male) Western oppression of non-European cultures and environmental destruction. Easlea suggests that "when the potential that science offers and continues to offer for improving the life of all humankind is measured against the oppression and destructive reality that has so often characterized post-sixteenth-century science, then there can be little doubt that scientific practice has been overwhelmingly irrational" (Easlea 1981). He suggests that the only way of redeeming science is to overturn the dominant male perspective on nature and social relations at its foundation.

As an alternative to male science, many feminist critics offer the possibility of a science based on essentially female ways of knowing. They argue that rather than acquiescing to the dominant male perspective, women should develop their own feminist science. At their most radical, such com-

mentators argue that far from encouraging more women to take up careers in science, feminists should actively try to dissuade women from engaging in a fundamentally misogynistic enterprise. This feminist science would be built on essentially female characteristics promoting harmony with nature. According to this view, just as male science is based on fundamentally male ways of thinking, a feminist science would be based on fundamentally female ways of thinking. Such a science would be intuitive rather than rational, for example, practical rather than abstract, cooperative rather than competitive, or nurturing rather than exploitative. Ironically, perhaps, some of these feminist critics of science appear to agree with their misogynist Victorian forebears that men and women do indeed think in radically different ways. In fact, they often appear to agree as to just what those differences are. The contrast, of course, is that feminist critics celebrate these essentially female ways of knowing as being superior to male perspectives on the world, while Victorian thinkers denigrated them.

Some feminist critics of science, however, have turned to postmodernism as offering a solution to the problems of masculine science. Rather than attempting to replace male scientific objectivity with an opposing and supposedly more inclusive female objectivity, feminists such as Donna Haraway advocate an acceptance of the fact that there are an indefinite number of ways of interacting with and making sense of the natural world. She suggests that all these different ways of knowing should be recognized as being equally valid (Haraway 1991). The model she offers is one of conversation. Haraway argues that rather than seeing the world as something passive to be mapped out and manipulated, scientists should regard nature as having its own agency and interact with it on those terms. Rather than adopting the traditionally masculine view of scientific objectivity as the "view from nowhere" she suggests that scientists and others should recognize and celebrate the fact that all knowledge is "situated." Haraway suggests that "Situated knowledges require that the object of knowledge be pictured as an actor or agent, not a screen or a ground or a resource, never finally as slave to a master that closes off the dialectic in his unique agency and authorship of 'objective' knowledge" (1991, 188). What she means by this is that postmodern perspectives can be taken to suggest that scientists should visualize themselves as being on the same level as the rest of the natural world (rather than somehow above or outside it) as they try to understand it.

Conclusions

As we have seen, feminist accounts of science operate on a number of levels. Some feminist historians of science have argued that science was imbued from its very beginnings with masculine, if not outright misogynist, implications. They argue that science adopted a view of nature as female, passive, and available for domination and control. Other historians of science have attempted to recover the contribution made by women in the past to scientific development. They argue that women's contribution to the sciences has been unjustly neglected and try to find scientific heroines to match scientific heroes such as Newton or Einstein. Others try to recover the wider role of women in the sciences as audiences, helpers, or popularizers. Most successfully, perhaps, some feminist historians of science have demonstrated how particular scientific theories and practices have been used in the past to sustain prevailing beliefs about the proper and subordinate place of women in society. Science was invoked to demonstrate that women's subordination was the result of nature rather than of culture. Some feminist historians have expressed this view in terms of male scientists' deliberate distortion of the evidence to support their misogynist beliefs, producing "bad science" along the way. Others have recognized that such "distortions" are the product of particular historical circumstances rather than being the result of a deliberate conspiracy.

Some feminist accounts of science are, as we have already hinted, inclined toward essentialism. In other words, they take it for granted that science has an "essence"—an unchanging core of defining features that remain static through its history. As historians, philosophers, and sociologists of science increasingly move toward the view that science is best understood as a patchwork of often competing activities, attitudes, ideas, practices, theories, and worldviews in a constant process of change, it becomes more difficult to accept that science is an inherently masculine institution or that there are inherently male and female ways of knowing. Not all the different feminist perspectives on science outlined here are mutually coherent. It is difficult to reconcile the view of some feminists that science is inherently sexist, for example, with the efforts by others to demonstrate women's scientific achievements as a way of providing role models for budding female scientists. According to the first view, after all, presumably there should be no good female role models in science. Feminist historians of science have nevertheless played a crucial role in producing a more balanced and nuanced account of scientific activity and its social relations. Very few historians of science would now deny that science has in-

deed in the past played a central and deleterious role in sustaining social inequality. It is also clear that scientific institutions have often been, in modern terms, institutionally sexist, discouraging and excluding women from equal participation in scientific activity. Feminists have certainly been successful in demonstrating that if gender discrimination exists in any society, then since science is a cultural activity, the science that society produces will reflect that discrimination, too.

References and Further Reading

Abir-Am, Pnina, and Dorinda Outram, eds. 1987. *Uneasy Careers and Intimate Lives: Women in Science, 1787–1979.* New Brunswick, NJ: Rutgers University Press.

Alic, M. 1986. *Hypatia's Heritage: A History of Women in Science from Antiquity to the Late Nineteenth Century.* London: Virago.

Curie, E. 1938. *Madame Curie.* London: Heinemann.

Easlea, Brian. 1981. *Science and Sexual Oppression: Patriarchy's Confrontation with Women and Nature.* London: Weidenfeld & Nicolson.

Fox-Keller, E. 1983. *A Feeling for the Organism: The Life and Times of Barbara McClintock.* San Francisco: W. H. Freeman.

———. 1985. *Reflections on Gender and Science.* New Haven, CT: Yale University Press.

Haraway, Donna. 1991. *Simians, Cyborgs, and Women: The Reinvention of Nature.* London: Routledge.

Harding, S. 1986. *The Science Question in Feminism.* Ithaca, NY: Cornell University Press.

———. 1991. *Whose Science? Whose Knowledge?* Ithaca, NY: Cornell University Press.

Hudson, G. 1991. "Unfathering the Thinkable: Gender, Science and Pacifism in the 1930s." In *Science and Sensibility: Gender and Scientific Enquiry, 1780–1945,* edited by M. Benjamin. Oxford: Blackwell.

Laqueur, Thomas. 1990. *Making Sex: Body and Gender from the Greeks to Freud.* Cambridge, MA: Harvard University Press.

Maddox, Brenda. 2002. *Rosalind Franklin.* London: HarperCollins.

Masson, J. M. 1986. *A Dark Science: Women, Sexuality and Psychiatry in the Nineteenth Century.* New York: Farrar, Straus and Giroux.

Merchant, Carolyn. 1982. *The Death of Nature: Women, Ecology and the Scientific Revolution.* San Francisco: W. H. Freeman.

Moscucci, O. 1991. *The Science of Woman: Gynaecology and Gender in England, 1800–1929.* Oxford: Oxford University Press.

Neeley, K. A. 2001. *Mary Somerville.* Cambridge: Cambridge University Press.

Quinn, Susan. 1995. *Marie Curie: A Life.* New York: Simon & Schuster.

Richards, Evelleen. 1989. "Huxley and Women's Place in Science: The 'Woman Question' and the Control of Victorian Anthropology." In *History, Humanity and Evolution,* edited by James R. Moore. Cambridge: Cambridge University Press, 253–84.

Russett, Cynthia E. 1989. *Sexual Science: The Victorian Construction of Womanhood.* Cambridge, MA: Harvard University Press.

Schiebinger, L. 1989. *The Mind Has No Sex? Women in the Origins of Modern Science.* Cambridge, MA: Harvard University Press.

Showalter, Elaine. 1986. *The Female Malady: Women, Madness and English Culture, 1830–1980.* New York: Pantheon.

Stein, D. 1985. *Ada: A Life and a Legacy.* Cambridge, MA: Harvard University Press.

Toole, B. A. 1992. *Ada, Enchantress of Numbers.* San Francisco: Strawberry Press.

Watson, James D. 1968. *The Double Helix.* New York: Atheneum.

Winter, Alison. 1998. *Mesmerized: Powers of Mind in Victorian Britain.* Chicago: University of Chicago Press.