HOMO MYSTERIOUS

EVOLUTIONARY PUZZLES *of* HUMAN NATURE

DAVID P. BARASH, PhD

HOMO MYSTERIOUS

This page intentionally left blank

DAVID P. BARASH

HOMO MYSTERIOUS

Evolutionary Puzzles of Human Nature

OXFORD
UNIVERSITY PRESS

OXFORD
UNIVERSITY PRESS

Oxford University Press, Inc., publishes works that further
Oxford University's objective of excellence
in research, scholarship, and education.

Oxford New York
Auckland Cape Town Dar es Salaam Hong Kong Karachi Kuala Lumpur
Madrid Melbourne Mexico City Nairobi New Delhi Shanghai Taipei Toronto

With offices in
Argentina Austria Brazil Chile Czech Republic France Greece Guatemala Hungary
Italy Japan Poland Portugal Singapore South Korea Switzerland Thailand Turkey
Ukraine Vietnam

Published by Oxford University Press, Inc.
198 Madison Avenue, New York, New York 10016

www.oup.com

Library of Congress Cataloging-in-Publication Data
Barash, David P.
Homo mysterious : evolutionary puzzles of human nature /
David P. Barash.
p. cm.
Includes bibliographical references and index.
ISBN 978-0-19-975194-5 (hardback: alk. paper)
1. Human evolution. 2. Social evolution.
3. Evolution (Biology) 4. Sex (Biology)
5. Sociobiology. I. Title.
GN281.B36 2012
303.4—dc23 2011044302

Printed in the United States of America on acid-free paper

TO ISAAC SANDER BOGAISKY, WHO WILL DOUBTLESS ENCOUNTER MANY DELIGHTFUL MYSTERIES AS HE GROWS UP, AND WHO MIGHT EVEN SOLVE A FEW

This page intentionally left blank

Contents

This page intentionally left blank

Acknowledgments

I thank Abby Gross and Joanna Ng, at Oxford, who contributed mightily (probably more than they know) to this project; my wife, Judith, who tolerated (and contributed to) more diversionary discussions than were reasonable; and the many scientists whose work stimulated this book by asking good questions and seeking ever-better answers. I also thank the students in my University of Washington Honors Arts & Sciences 350 class, who helped me chew over and improve the text.

This page intentionally left blank

HOMO MYSTERIOUS

This page intentionally left blank

Chapter One

In Praise of Mystery: "That's How the Light Gets In"

"Mystics exult in mystery and want it to stay mysterious. Scientists exult in mystery for a different reason: It gives them something to do."

—Richard Dawkins

We are surrounded by mysteries. Indeed, mysteries R us. There are more things in human biology than are dreamt of in our philosophy or—more to the point—known by our science. But don't get the wrong idea, Horatio: Mystery is not the same as mysticism, and *Homo Mysterious* does not refer to some sort of ineffable, spiritualistic claptrap beyond the reach of natural law or human understanding. Just as a "weed" is a plant that hasn't yet been assigned a value, the mysteries we shall encounter in *Homo Mysterious*—such biological oddities as female orgasm, prominent nonlactating breasts, advanced consciousness, the origins of religious faith, and the making of art—are simply scientific questions waiting for answers.

It was a stroke of brilliance as well as immodesty when our species named itself *Homo sapiens*, usually translated as "man the wise." A better rendering, however, would probably have been

"the knowing," since human beings seem more effective at accumulating knowledge than wisdom, although it can be hoped that the former will lead, eventually, to the latter.

In any event, there is no doubt that our collective store of knowledge has been increasing dramatically and that science is largely responsible. At the same time, there is also no doubt that plenty remains to be learned. Although some people gesture toward what has been called "the end of science"—the notion that all the Big Questions have been answered ("mission accomplished" redux), leaving us with mere mopping-up operations—the reality is that there is an awful lot that we still do not know. And ironically, we *Homo sapiens* are both subject and object of much of that unknowing.

"Know thyself"? Easier said than done. Moreover, at the risk of descending into cliché, the more we know, the more we discover how much remains to be learned. Far from discouraging, I hope this will be seen as both a reward for past accomplishments and, no less, a challenge to do more. Who wants to read about a topic when science has already "closed the book" on it? Most books about science are just that: accounts of what has already been learned. This one is different; it's about mysteries, what we don't know—yet.

The *Collins International Dictionary* (2003) defines mystery as "an unexplained or inexplicable event, phenomenon, etc.," which seems reasonable enough . . . until you think about it. For an event or phenomenon to be *unexplained* is one thing, but to be *inexplicable* is quite another. If something is truly inexplicable, it is beyond the possible reach of human understanding and therefore likely to fit a theological rather than a scientific definition of mystery: something unknowable except through divine revelation, such as how wine is "mysteriously" turned into the literal blood of Christ during the Eucharist.

Let me lay my cards on the table here and now. I do not believe in theological mysteries, or rather, I believe that they are simply ways of clothing meaninglessness in gobbledygook. *Homo Mysterious*, therefore, will not be concerned with the inexplicable, but rather with the unexplained, with things about human beings that are currently unknown but that fall within the potential reach of science. After all, the real world poses genuine mysteries aplenty,

that is, puzzles that are not *yet* susceptible to understanding, but that we can be confident will be brought to heel, sometime in the future.

Science, of course, is in the business of doing just this, answering questions about the natural world, *Homo sapiens* included. And since nature does not disclose its secrets readily, scientists are understandably proud whenever they solve any of its numerous puzzles. As a result, we teach courses, give lectures, and occasionally write books whose goal is to share these triumphs. They are, after all, hard-won and often immensely useful. No one, therefore, should begrudge us taking a victory lap now and then.

But just as "the race is not to the swift, nor the battle to the strong" (Ecclesiastes 9:11), the cheers of the crowd do not always bespeak that the race is over, or the battle won.

I have been teaching science courses at the college and university level for 40 years and am no less guilty than my colleagues of providing what may well be a misleading perspective on science. Like everyone else, I teach what is known, often at the risk of misleading students into thinking that today's science is a catalog of established and comprehended facts: *This* is how cells metabolize carbohydrates; *this* is how natural selection works; *this* is how the information encoded in DNA is translated into proteins. The reality, of course, is that we do know quite a bit about how cells metabolize carbohydrates, how natural selection works, and so forth. But another parallel reality is that there is much more that we do *not* know . . . and very few courses that admit it. One of these days, I will design a course titled something like "What We Don't Know About Biology," hoping that my colleagues in chemistry, physics, geology, mathematics, psychology, and the like will join the fun.

But until then, this book will have to do. It is, in a sense, a companion piece to a much more famous publication—or rather, a series of 17 volumes—first published in France between 1751 and 1765 and best known as the *Encyclopédie*, which endeavored to summarize all human knowledge in its 18,000 pages of text, 75,000 different entries, and 20 million words. Its primary editor, Denis Diderot, was one of the heroes of the Enlightenment, and indeed, the *Encyclopédie* represents a culmination of Enlightenment thought, which valued reason, science, and progress—what we know—above all else. Its frontispiece is especially delightful,

Detail from frontispiece of the *Encyclopédie*, published in 1772. Truth is surrounded by a bright light (a frequently employed symbol of the Enlightenment). Reason and Philosophy, on the right, are undressing Truth, by pulling off her veil.

depicting Truth (surrounded by a bright light, the traditional symbol of the Enlightenment itself) as an attractive young woman being disrobed by Reason and "Natural Philosophy" (i.e., Science). The illustration is more than a bit erotic, as Truth is revealed to be both alluring and accessible, albeit appropriately shy.

Just as Diderot's *Encyclopédie* was a paean to Enlightenment values—notably the upside of human knowledge—*Homo Mysterious* is similarly enamored of reason, science, and progress, even though it is superficially dissimilar, and not merely because its goals and reach are much more limited. Nonetheless, in *Homo Mysterious*, we shall continue the tradition of the *Encyclopédie*'s frontispiece, attempting to get a closer look at Truth, but instead of undressing her, we shall proceed nonvoyeuristically, pointing out where, despite the best efforts of Reason and Science, she continues to be at least somewhat clothed. "All women, O, are beautiful," wrote

Theodore Roethke, "when they are half-undressed." The same applies to Truth itself.

Unlike the *Encyclopédie*, which took all knowledge as its subject, in *Homo Mysterious* we shall limit ourselves to human beings.[i] Not only that, we'll be concerned only with certain characteristics of *Homo sapiens* as seen through the lens of evolutionary biology.

The traits in question are fundamental to being human, stubborn stigmata of our species' unique evolutionary heritage, yet their basis is neither understood by scientists nor for the most part even acknowledged by the public as the puzzles that they are. Most people are unaware that female orgasm, for example, and even religion are biological mysteries, simply because nearly everyone takes the most intimate aspects of his or her life for granted, so deeply woven into our substantive human being that they are rarely identified as legitimate perplexities.

We members of *Homo sapiens* are almost literally immersed in mystery; the evolutionary enigmas of humankind are the seas in which we swim. In *Homo Mysterious*, you will be introduced to this ocean of unknowns, as well as to the major hypotheses that currently occupy scientists who are attempting to unravel each puzzle (including some proposed here for the first time). Like science courses, nearly all science books describe what we know, thereby giving the impression that we know nearly everything, whereas the reality is exactly the opposite: We know very little compared to how much we don't. *Homo Mysterious* is designed for readers likely to be challenged by the blank spots on the human evolutionary map, the *terra incognita* of our own species.

At the risk of channeling former Defense Secretary Donald Rumsfeld, there are "unknown unknowns," things we don't understand and that we don't even know that we don't know! Since we can't identify them, "unknown unknowns" are difficult—perhaps impossible—to write about. On the other hand, there are also "known unknowns," things that we don't yet understand but that we at least have the wisdom to acknowledge as such. Prior to Albert Einstein, Niels Bohr, Enrico Fermi, and others, nuclear energy

---

i. It is an interesting and paradoxical testimony to how much we have learned in the intervening 150 years that today, no one could seriously entertain the prospect of summarizing all knowledge in a book, or series of books, or even via the Internet.

was a known unknown, just as evolution was before Darwin. Today, the underlying basis for homosexuality is similarly a mystery—a phenomenon whose scientific basis is unknown—as is consciousness, the cross-cultural universality of religious belief, the evolutionary basis of artistic creativity, and so forth.

Homo Mysterious will examine these and other perplexities from a perspective that many readers will find unusual. Thus, we shall be less concerned with *how* these things came about than with *why*, not "why" in the metaphysical sense, but that of evolutionary biologists. Were we to ask "how" people became bipedal, the answer would involve changes in muscle attachments, bone structure, and nerve growth; to be concerned instead with the evolutionary "why" is to ask about the likely adaptive pressures that must have conveyed a reproductive advantage to those of our ancestors who walked on two legs, regardless of exactly *how* that posture was achieved.

Similarly, we'll be less concerned with *how* religious belief or homosexuality comes about—the nerves, muscles, brain regions, hormones, or specific genes responsible—than with *why* these behaviors, regardless of their underlying mechanisms, appeared and have persisted in the human population, despite their seeming evolutionary disadvantages.

This approach is familiar to evolutionary biologists and, less so, to most anatomists, physiologists, and the intelligent lay public as well. Not that scientists aren't likely to be "evolutionary" in their thinking; rather, they are more prone to ask questions—and to answer them—in terms of immediate causal mechanisms. Instead, we'll raise questions—and answer them—in evolutionary terms. The underlying conceptual theme is, therefore: "In what way has _____ (female orgasm, concealed ovulation, homosexuality, consciousness, religious belief, etc.) contributed to the ultimate reproductive success of human beings, thus in all likelihood explaining why this particular trait evolved?"

One way of conceptualizing this process is to think about what is sometimes called reverse engineering. In normal engineering, a problem is identified, after which some sort of device or structure is engineered as a solution. Reverse engineering operates, not surprisingly, in reverse: A device or structure (or, in the case of *Homo Mysterious*, a behavior) is identified, after which the evolutionary

biologist tries to figure out how this particular phenomenon came to be "engineered"—which is to say, why it evolved.

In many cases, the process is straightforward and obvious, so that it is rarely even attempted. Why do we love our children? Almost certainly, ancestors who lacked parental love didn't do a very good job of caring for their offspring and therefore didn't become ancestors. In that sense, love may actually be less mysterious than is generally thought! For all its storied and supposedly enigmatic nature, there are other human characteristics far more mysterious than love; once we identify them, we are faced with the question of "reverse engineering" them.

In nearly every such case, we will identify multiple potential evolutionary explanations—although we'll refrain from coming up with *the* explanation, simply because at this point, despite the world's impressive store of accumulated scientific knowledge, final answers just aren't yet available. Hence the mystery, the pleasure, and, eventually, the illumination. "There is a crack in everything," writes poet/songwriter Leonard Cohen. "That's how the light gets in."

Just one modification: There are *many* cracks and, when it comes to some of the most interesting mysteries of human evolution, no reason why a single one should necessarily provide the only illumination. *Homo Mysterious* therefore cannot claim to be exhaustive, just scientifically accurate as far as it goes and, I hope, fun.

Consistent with our slightly lascivious reflections on the frontispiece to the *Encyclopédie*, we'll begin our exploration with some human sexual mysteries. Then, we move above the waist. I hope you enjoy the trip and that along the way, you might even come up with a suggestion or two that could help solve some of the evolutionary mysteries we are about to explore together.

This page intentionally left blank

CHAPTER TWO

Sexual Mysteries I: Menstruation, Concealed Ovulation, and Breasts

Most people would agree that sex is a mystery. But they would probably be thinking of romantic perplexities rather than scientific enigmas. The fact is, however, that when Winston Churchill famously described Russia in 1939 as "a riddle wrapped in a mystery inside an enigma," he could as well have been speaking of some hard-wired aspects of human sexuality. Particularly mysterious, at least from the perspective of evolutionary biology, are some aspects of the sexual biology of women.

The first notable mystery begins when a girl becomes a woman: menstruation. Although a few other species bleed slightly at midcycle, no other organism does so as prominently as *Homo sapiens*. Breast development is another perplexity: Although we take it for granted that women have conspicuous breast tissue even when not nursing, no other mammal is comparably bosomed. Only human beings are blessed (or, in the opinion of some, cursed) with prominent nonlactating breasts.

The mysteries continue. Go to a zoo and take a look at the chimpanzees, gorillas, or baboons (or, indeed, nearly any nonhuman primate). There is no question when an adult female is ovulating.

It is as obvious as the bright pink cauliflower on her behind. Not so for our own species. Given the great importance—socially, biologically, evolutionarily—of reproduction, and thus of ovulation, it is extraordinary and as yet unexplained why even now, in our medically sophisticated 21st century, it is exceedingly difficult to tell something so basic as when a woman is fertile. For reasons unknown, human beings conceal their ovulation and are unique among mammals in doing so. Not only that, but in the great majority of cases, the exact time of a woman's ovulation is even hidden *from herself*. As with menstruation and nonlactating breasts, hypotheses abound, but no one knows the answer.

Ditto for female orgasm. Its male counterpart is a no-brainer (almost literally!), since without ejaculation there would be no fatherhood and thus no evolutionary success. But the data are quite clear: There is no correlation between female orgasm and female fitness in the evolutionary sense. In other words, orgasmic women are no more successful reproductively than their less fortunate, nonorgasmic "sisters." So, why does female orgasm occur at all?

Proceeding along the trajectory of a woman's life, we come to yet another mystery: menopause. By around age 50, a woman can anticipate that she will cease ovulating. Why does reproduction inevitably end, even for the healthiest women, at a time in middle age when many can anticipate several decades of continued and vigorous life? This is especially perplexing since reproductive success is the name of the Darwinian game and simple calculations show that producing just one additional child, compounded over time, would convey a huge evolutionary advantage. Yet menopause is not only a cross-cultural human universal but also one not shared by any other living thing, except possibly for the short-finned pilot whale (but of course, you already knew that).

Let's consider these mysteries, and some possible solutions, one at a time.

A Signal?

It has been suggested that all mammals may in fact shed some of their uterine lining between ovulations, but no other species comes close to *Homo sapiens* in the volume of blood flow and amount of

tissue disruption, which requires women to literally rebuild their uterine lining with each reproductive cycle. The amount of blood loss—about 40 ml—is not enormous but is enough to force many to take iron supplements. It is as though every sexually competent woman is obliged to suffer an automatic monthly deduction from her metabolic checking account. Not only that, but it seems likely that the shedding of fresh blood, sometimes in copious quantities, would make menstruating women more susceptible to predators, many of which are exquisitely sensitive to cues that indicate potential prey.[i] Given that evolution is a stern task-mistress, constantly sifting and sorting through alternatives to find the most efficient and fitness-enhancing way to accomplish the various tasks of living, why have we signed on to such expensive and possibly even risky monthly taxation? And this doesn't even count the cramps, which in some cases are so severe as to be temporarily disabling.

One might even say that menstruation almost literally deserves its old-fashioned descriptor, "the curse." More scientifically, we would expect that women who did *not* menstruate would have been more successful over evolutionary time than those who did. Yet the opposite has clearly been true, since menstruation is something that all healthy premenopausal women do. It may be an annoyance but it is not an illness or a biomedical problem; rather, prolonged amenorrhea—*failure* to menstruate—indicates that something is wrong.

In addition, about 10% of otherwise healthy women suffer from endometriosis, a painful and potentially life-threatening condition caused when cells of the uterine lining are discharged in the wrong direction, into the pelvic cavity instead of outside the body. And of course, menstruation necessitates that for a particular duration (typically 3 to 5 days), pregnancy cannot occur. This is yet another cost of menstruation, which further italicizes the mystery that it exists at all.

For starters, let's ignore the suggestion, repeated through generations of folk "wisdom," that menstruation indicates the "weeping of a disappointed uterus" that has failed its reproductive role.

---

i. It has been claimed, for example, that menstruating women are more vulnerable to grizzly bear attacks; however, I have not been able to confirm whether this is statistically true.

(This notion is especially foolish since the likelihood is that without menstruation, more cycles would be "successful.") Ditto for the theological assertion that it constitutes part of the punishment inflicted by a vengeful deity upon a disobedient Eve. There are, in fact, several possible scientific hypotheses for menstruation.

For one, it could be a signal by which a woman's body tells her brain that she isn't pregnant. After all, that is how menstruation is "used" today, just as, conversely, a failure to "get one's period" is an early signal that a woman may be pregnant. It would clearly be advantageous for a woman to know her reproductive status, and in a world before pregnancy test kits, it is quite likely that by its presence or absence, menstruation gave the first clue.

Fair enough, but logically unlikely. Why should natural selection have favored such an expensive "all-clear signal," especially one that had to be broadcast each month? Wouldn't it have been far more efficient—and not at all beyond the reach of evolution—to endow pregnant women with a distinctive smell, a unique sneeze, or the rapid blinking of their left eye? It seems like blatant overkill to lose much of your physical self—your uterine lining—just to send the message that you are not pregnant. And even if menstruation serves such a signaling function, why isn't it simply a bit of spotting, as in dogs?

The copiousness of human menstrual bleeding nonetheless suggests that maybe it's a social signal, a message intended for others. In many human societies today, the onset of menses indicates the beginning of adulthood. So maybe menstruation—for all its drawbacks—was selected as a way of informing one's surrounding social network that a girl is becoming a woman and should be taken seriously.

One problem with this hypothesis is that such signaling appears more likely to be *disadvantageous* to the signaler. Even though biologists are agreed that male–male competition is typically more vigorous—even violent—than its female–female counterpart, it is increasingly clear that female–female competition also occurs. More subtle than the male–male version, it nonetheless involves situations in which dominant adult females of a number of species actually attack, intimidate, and often inhibit the breeding of subordinates. Assuming that something comparable occurs in our own species (admittedly, an unproven assumption at present),

it would seem to behoove a young woman to, if anything, hide the fact that she is entering reproductive competence, especially since such a signaler would necessarily be young and thus liable to be particularly vulnerable.

The possibility still exists—although a slim one—that menstrual bleeding is not targeted at other women generally, but more specifically aimed at close relatives and others who might be primed to cooperate rather than compete, to render useful assistance to a younger kinswoman once they know of her change in reproductive status. It would be interesting to see if menstrual flow is in any way correlated with presence or absence of potential competitors on the one hand or helpers on the other. At present, however, it is hard to see how menstruation could have evolved as a social signal, especially given that in nearly all human societies today, it is considered awkward, embarrassing, even shameful—the body conveying information that one's mind would prefer to keep under wraps.

A signaling hypothesis for menstruation could still be salvaged, however, if it were directed toward men. But if so, the earlier question repeats itself: Why use such an expensive signaling system instead of, say, employing pheromones? After all, males are sperm makers by definition, and because sperm are cheap and abundant, sperm makers are selected to be highly attuned to indications of fertility on the part of prospective partners.

It is interesting, nonetheless, that in the modern Western world at least, substantial effort is expended to hide the fact of menstruation—which itself paradoxically suggests that in the absence of the "feminine hygiene" industry and its constant efforts to provide women with "protection" from their own bodies, enabling them to hide, suppress, tip-toe around, or otherwise obscure the reality of menstruation, maybe it really did evolve as a signal. In the past it was certainly widely noticed, although generally misunderstood. "Nothing could easily be found that is more remarkable than the monthly flux of women," wrote Pliny the Elder, two millennia ago:

> Contact with it turns new wine sour, crops touched by it become barren, grafts die, seeds in gardens are dried up, the fruits of trees fall off, the bright surface of mirrors in which it is merely reflected is dimmed, the edge of steel and the gleam of ivory are dulled, hives of

bees die, even bronze and iron are at once seized by rust, and a horrible smell fills the air.[1]

Demeaning and inaccurate as such attention has been, if nothing else it encourages us to look for other explanations.

The Cleansing Hypothesis

Here is one. What if menstruation serves a cleansing function, using periodic blood flow to sluice away potentially dangerous pathogens, including—but not limited to—those introduced during copulation?[2] This "explanation" has pros and cons, like nearly all the perplexities to be considered in the present book, and, like most, it has generated fruitful debate. Moreover, it's a nifty idea, not least because it reverses the old canard that menstruating women are somehow unclean or that the phenomenon is a reflection of female weakness, emphasizing instead that the exact opposite is more likely the case: Sperm plus semen are actually more likely to be unclean (not to mention possible pathogens introduced during coitus itself), with menstruation conceivably being a hygienic and even heroic countermeasure.

The reality, of course, is that ovaries and the uterus are internal organs, abundantly outfitted with delicate tissue that is vulnerable to infection. And sexual intercourse necessarily involves introducing foreign material deep inside a woman's body, bypassing most of her traditional defenses. Certain pathogens such as *Chlamydia*—a common cause of pelvic inflammatory disease—hitchhike on the tails of sperm, and bacteria such as *Staphylococcus* and *Streptococcus*, which cause no harm when inhabiting the vagina, can be serious troublemakers when transported via an enthusiastic penis into a woman's upper reproductive tract.

Margie Profet, who developed the "cleansing hypothesis," emphasized that the uterus is "designed to bleed," via its specialized spiral-shaped arteries and arterioles. When these constrict, the uterine lining dies and is sloughed off, presumably taking any unwanted pathogenic invaders along with it. In addition, the resulting copious blood flow essentially "hoses down" the underlying uterine wall. Profet also pointed out that menstrual blood contains a concentration of leukocytes that is about three times higher

than normal blood; these white blood cells, brought directly into contact with the uterus, are thus made available to fight any infections.

There are practical implications of the cleansing hypothesis. If, as the hypothesis holds, menstrual bleeding is an adaptive response to infection or potential infection, then it is clearly normal. What about unusually heavy bleeding (menorrhagia) or intracyclic bleeding (metrorrhagia)? These could be symptoms of endometritis, inflammation of the uterine lining, or they could be part of a body's attempt to fight off such infections. Profet, arguing for menstruation's cleansing role, points out that assuming the former, and therefore using medications to inhibit such bleeding, would be equivalent to "blaming firemen for a fire."

Convincing as it might be at first blush, the cleansing hypothesis also has problems.[3] Menstrual blood contains nutrients—especially iron—that might actually *encourage* pathogen growth. And in fact, many pathogens are specifically iron deprived, such that surrounding them with blood might provide them with just the nutrients they need! There is also no evidence that menstrual intensity—either in human beings or animals—correlates with pathogen load, which would be predicted. Under the cleansing hypothesis, an already "clean" uterus would be expected to correlate with less tissue loss and reduced blood flow. Were this the case, it would doubtless have been trumpeted by devotees of the cleansing hypothesis as evidence in its favor, so the opposite finding must be acknowledged as evidence against.

Suppose, alternatively, that pathogen invasion is difficult for the uterus to detect, which might in turn prevent adaptive modulation of the cleansing response (in fact, insofar as bodies are able to respond to pathogens by killing them, selection would have favored discreet invaders that gave minimal indications of their presence). Even then, however, another correlation could be expected: between sexual activity—either number of partners or frequency of coitus with the same partner—and menstruation. But the reality, once again, is not encouraging: Although some women have relatively heavy menstrual flows and some much lighter, menstrual intensity also does not vary with the number of different sexual partners or with the nature and frequency of sexual encounters. Another strike against the cleansing hypothesis.

Also, if menstruation serves to diminish the uterus's pathogen load, either by flushing them away or zapping them with white blood cells, then there should be fewer bacteria present after menstruation than before. It is notoriously difficult to assess total bacterial load in a given human organ. However, it is relatively easy to determine how many different kinds of bacteria are present, and when this is done, the evidence points the opposite way: more bacterial diversity *after* menstruation than before.

There is yet more evidence against the cleansing hypothesis. It is well established that women in traditional, nontechnological societies enter menarche later and spend more time pregnant and nursing than do Western women. As a result, they experience far fewer menstrual cycles than do Western women, and therefore, according to the cleansing hypothesis, they should be more susceptible to uterine infections. There is no evidence for this. The cleansing hypothesis would also expect that women with an especially heavy menstrual flow would have a lower frequency of pelvic inflammatory disease; this has not (yet) been evaluated.[ii] It is also problematic that oral contraceptives, which substantially decrease menstrual blood volume, do not increase the risk of uterine infection, even though it could be argued that such contraceptive use is balanced by a possible increase in heterosexual activity . . . which is typically why the contraceptives are used in the first place.

The Efficiency Hypothesis

There is another possible explanation for why menstruation evolved, based on energy efficiency: Calculations suggest that it is metabolically cheaper to slough off the uterine lining (which is energetically expensive to maintain) and then regrow it in preparation for the next cycle of ovulation than to maintain it in a high level of vascularization. In support of this idea, anthropologist Beverly Strassman noted that a postmenstrual uterus consumes only about 14% of the oxygen required by a fully prepared endometrium. Not only that, but a woman's overall metabolic rate during the preovulatory ("follicular") phase of her cycle, when the

ii. Unless greater flow was a *response* to greater infection.

uterine lining is regressed, is about 7% lower than during the secretory ("luteal") phase, when it is actively growing.

Efficiency is a less-than-exciting notion, but after all, energy is the basic currency of life, making it not unreasonable that a woman's metabolic economy alternately revs up and down, economizing on the costs of remaining ready to reproduce. The idea is that unlike, say, the lungs or heart, a woman can afford to down-regulate the activity within her uterus, keeping it at a slow idle during those times between ovulations when reproduction is not an option.

On the other hand, the metabolic efficiency hypothesis is not entirely convincing. Why, for instance, isn't the uterus simply kept in a more efficient, low-energy, less vascularized state until needed for nourishing an embryo? That is, why build up a fancy and expensive uterine lining, ready to receive an implanting embryo, only to tear it down every month? Why not just tamp down the endometrium and keep it quiescent until an embryo comes along? That would be more efficient yet.

Part of menstruation's enigma, and the need for all these hypotheses, is that it poses a kind of Sisyphean dilemma. According to Greek mythology, Sisyphus was condemned to spend eternity pushing a heavy rock up a steep hill, only to have it roll back down each time. A menstruating woman finds herself constructing a snazzy, energetically expensive endometrium each month, only to dislodge it again and again. Sisyphus had no choice; ditto for most women. But presumably, evolution did.

A Competence Test?

An alternative explanation is what I have dubbed the "evaluation hypothesis," which derives from the fact that human beings are unique among mammals in how much they invest in each offspring. This makes it especially important that any embryo that is brought to term be an especially capable one. After pregnancy and childbirth comes lactation, followed by years—even decades—of continuing expenditure on behalf of human offspring: spending time and energy, running risks, and so forth. It may therefore be significant that for every successful pregnancy, there are many

"spontaneous abortions," caused by the failure of an early embryo to implant successfully.

For anyone with a scientific mind set and who therefore believes that all phenomena have causes, the very word "spontaneous" should set off alarm bells. Maybe in this case a "spontaneous" abortion really means that the embryo or fetus was tried and found wanting or, at least, not deserving of further maternal investment. And maybe the events surrounding menstruation are how a woman's body evaluates her would-be offspring and does so early in the "investment" cycle, thereby minimizing wasted investment in case of a thumbs down.

A key aspect of early pregnancy takes place when an embryo (really, just a fertilized zygote) begins burrowing into the uterine lining and starts secreting a hormone—human chorionic gonadotropin or HCG—that inhibits menstruation. Early in a woman's menstrual cycle, luteinizing hormone, produced by the brain, not only kick-starts ovulation; it also keeps a woman's ovaries making its own hormone, progesterone, which in turn keeps the uterine lining in place. If no pregnancy occurs, luteinizing hormone levels decline, which in turn causes a precipitous drop-off in progesterone, which results in the breakdown of the uterine lining and, shortly thereafter, menstruation.

Let's consider, therefore, that menstruation, rather than signaling "no pregnancy," is a way of ensuring its absence. But of course, evolution shouldn't promote nonreproduction . . . except perhaps in a species such as *Homo sapiens*, whose investment in offspring is so great that it pays to establish a kind of competence test, making sure that any would-be fetus and eventual child is sufficiently sturdy to warrant all that expenditure of time and energy and running of risks that are to come.

To ward off menstruation, the newly implanted embryo has to substitute its own HCG for the luteinizing hormone produced by the mother. Molecule for molecule, HCG is more potent than luteinizing hormone, and it actually causes an increase in progesterone levels, which in turn prevents menstruation and maintains the uterus as a rich and warmly receptive receiving blanket for the embryo.

The foregoing leads toward a hypothesis whereby menstruation is part of a regularly repeating competence test. Because HCG

is a very large molecule, it cannot pass directly into the mother's body by crossing her cell membranes; it must be secreted directly into her blood. As a result, a human embryo cannot guarantee its survival by simply secreting HCG: It has to get to the endometrium and dig itself in. This Big Dig isn't easy, which might be exactly the point. The process of implantation in human beings is more invasive—and thus more difficult—than in other mammals, consisting of a delicate dance between receptive maternal tissues and a capable embryo. In the earliest stages of pregnancy, it's the embryo that does nearly all the work, struggling to get itself deeply enmeshed in uterine tissue so that it can eventually get nourishment—but first, so that it can secrete HCG to prevent menstruation. If so, then menstruation is a sword held over the head of the as-yet headless embryo.

Implantation itself is a kind of Rubicon. Once crossed, the mother is committed to ongoing investment, and lots of it. This, in turn, may have selected for the mother ensuring that any inadequate early embryos can be weeded out quickly and painlessly. To summarize, perhaps menstruation is essentially a regularly repeating competence test, whereby evolution selects against embryos whose burrowing and secretory abilities are inadequate. Unfortunately for this hypothesis, however, it makes a prediction identical to the cleansing hypothesis, and one that is not supported by reality: Menstruation should be tied to sexual activity. Also, if people have been selected to menstruate as a means of subjecting their embryos to competence testing, then why isn't this the case for other species for whom each offspring also represents a major commitment? Why don't elephants menstruate? Or blue whales, or manatees?

It's a mystery. Period.

Concealed Ovulation: An Evolutionary Shell Game?

Most female mammals are altogether above board when their eggs are ripe and ready to encounter a suitable sperm. In addition to signs of genital swelling, they typically emit characteristic pheromones and their behavior changes as well. Not so for our own species. (Actually, there is growing evidence that women do in fact

exhibit subtle behavioral cues as to their ovulatory status, but the key here is *subtle*; it is only in recent years that these indications have been discovered. If they constituted what scientists call a "robust phenomenon," everyone would have known about them long ago.)

The surprising reality is that very few people can tell—and no one with certainty—when their neighbor, friend, relative, lover, or wife is about to ovulate. Not only that, but most women cannot even tell when, or if, they will do so themselves. To some degree, ovulation can be detected by a very small rise in body temperature as well as changes in the consistency of the vaginal mucus, but both assessments are difficult and unreliable. Indeed, the fact that such careful ascertainment must be exercised only further italicizes the extent to which it is not obvious! Even now, we have no reliable "rhythm method" of noncontraceptive birth control, which is to say, no easy way to know when women are ovulating. Pharmaceutical companies make huge amounts of money marketing test kits that provide anxious women the same information that most mammals get for free.

Concealed ovulation, therefore, is a mystery squared: Not only is the timing of human ovulation hidden, and thus a mystery in itself, but furthermore, it is a mystery why it is such a mystery!

It is, of course, possible that concealed human ovulation hasn't been actively selected for, but rather that shout-out-loud, Technicolor ovulation, á la chimpanzees, is the derived condition—and thus the one that needs explaining—with inconspicuousness, as found among *Homo sapiens*, being the evolutionarily irrelevant default state. This is unlikely, for several reasons. Start with the fact that nearly all mammals (including our closest relatives, the chimps and bonobos) announce their ovulation, which itself is strong presumptive evidence that our ancestors, too, were relatively uninhibited about drawing attention to their ovulatory status.

Beyond this, there is essentially no variability with regard to concealed ovulation in our species. If natural selection were indifferent to whether human ovulation was hidden or advertised, then we would expect substantial variability since public ovulators, concealed ovulators, and in-betweeners would all be pretty much equally fit and thus equally abundant. There is, for example, substantial

variability in human skin color, eye color, blood type, and so forth, all traits about which natural selection is evidently more or less indifferent. But there are no women whose ovulation is even remotely like a chimpanzee's.

The likelihood, therefore, is that human ovulation isn't just neutral or subtle but that it is actively hidden. Yet a moment's thought suggests that if nothing else, any woman who knows when she is fertile (whether or not she informs others) should be better equipped to become pregnant, or avoid pregnancy, or choose her offspring's father than would someone who hasn't a clue and doesn't give any.

Earlier, when considering menstruation, we considered and for the most part rejected the idea that it might have evolved as a social signal. Could the same be true, but reversed, for concealed ovulation? What of the prospect that human ovulation is concealed as a way of *suppressing* a social signal? It is—pardon the expression—conceivable.

Thus, it could be argued that by concealing ovulation, our early hominid ancestors obscured their reproductive status, thereby limiting possible aggressive competition from other, more dominant women. Consistent with this idea, there is growing evidence that—contrary to the generalizations still popular in evolutionary biology about the exclusive maleness of same-sex competition—females generally and women in particular do in fact compete, albeit more subtly than via the chest-beating, fangs-bared style more characteristic of males. Hence, it might well have contributed to a woman's ultimate evolutionary success if she kept her reproductive status under wraps. Almost literally.

This seems a plausible hypothesis, except that it would be stronger if ovulation were more concealed among women living in more densely interactive social environments and comparatively unobscured when the woman in question was the only show in town. This isn't the case. Similarly, this hypothesis would be more convincing if younger, less dominant women concealed their ovulation, while older, more socially and physically secure women flaunted theirs. But they don't.

It is reasonable to hypothesize that concealed ovulation is essentially an evolutionary shell game whereby women who hid their time of maximum fertility kept "their" men in a kind of