EDUCATOR'S GUIDE

Genetic Diversity: Sexual Reproduction

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the Eyes of Nye

For six seasons, millions of students came to understand, appreciate and enjoy the exploration of science through the series, *Bill Nye the Science Guy*. Bill returns with *The Eyes of Nye*, a more in-depth look at science subjects making news, changing lives, and impacting policy. From the future of alternate fuel sources and genetic engineering to population growth trends and issues of race, Bill and his expert cohorts bring science to life right in your classroom, helping you **Motivate** investigation; **Assess** available information; and **Propose** lines of argumentation.

This Educator's Guide includes:

- An **Introduction** that clearly defines the subject and offers an overview of the issue objectives of the guide; how it relates to science from both a social and personal perspective; as well as pertinent questions and insights regarding the topic.
- A listing of all **National Science Education Standards Addressed**.
- Detailed procedures highlighted in the MAP Framework (**Motivate, Assess, Propose**).
- Illustrative **Video Clips** from *The Eyes Of Nye* DVDs with pinpoint chapter cues.
- **Web Site Resources** to help students further investigate and locate research, charts, data as well as experts featured in the program material.
- Easily downloadable **Support Materials** that include articles, transparencies, charts, and much more.

Introduction:

"Evolution of Sex" refers to the changes and adaptations humans undergo as a result of reliance on reproduction through sexual means. *The Eyes of Nye – Genetic Diversity: Sexual Reproduction* presents a theory that we biologically rely on sexual reproduction because of the benefits we derive through increased genetic diversity, improvement as a species associated with the notion of sexual selection, survival as a result of both, and their effect on the human immune system.

Though the questions posed (e.g., why do we have sex, how does it help us as a species in the fight for survival) do not represent a common topic of debate among non-scientists, they are important when addressing many other issues. Their solution and the objective of this teacher's guide—gaining an understanding of why we reproduce sexually—helps drive our ability to address issues such as cloning (a type of asexual reproduction) and use and reliance on antibiotics, both of which require us to understand scientific evidence and to make

*Check the **MAP Teaching and Learning Framework** to explore the phases (motivate, assess, and propose) used in this guide.*

important decisions. It also informs our quest for understanding about evolution, an important and hotly debated concept germane to the very foundation of our present study of biology.

National Science Education Standards Addressed

Science As Inquiry

- Abilities necessary to do scientific inquiry
  - Identify questions and concepts that guide scientific investigations
  - Recognize and analyze alternative explanations and models
  - Communicate and defend a scientific argument.
- Understanding about scientific inquiry

Life Science

- The molecular basis of heredity
- Biological evolution
- The interdependence of organisms
- Behavior of organisms

Science in Personal and Social Perspectives

- Personal and community health

History and Nature of Science

- Science as a human endeavor
- Nature of scientific knowledge

On the DVD:

Genetic Diversity: Sexual Reproduction – Chapters

Chapter 1: *Genetic Diversity Preview*
Beginning through 1:01
Ends with title screen.

Chapter 2: *Why Sex?*
1:01—4:43
Asks the question, "Why do we have sex?" and suggests the reason is to "…keep up with the parasites."

Chapter 3: *Key of the Immune System*
4:44—11:03 (at present)

Chapter 4: *Sexual Selection and Evolution*
11:03—15:49

Chapter 5: *Benefits and Drawbacks of Sexual Effort*
15:49—19:08

Chapter 6: *Love and Chemistry*
19:09 through end of program

Genetic Diversity: Sexual Reproduction – Chapters

The Race for Diversity
5:01—7:00
(referenced in Educator's Guide step 5)

Research on the Role of Immunity in Mate Selection
7:16—10:46
(referenced in Educator's Guide step 7)

Research on Sexual Selection
12:05—14:13
(referenced in Educator's Guide step 9)

Of Mice and Men?
14:14—14:51
(referenced in Educator's Guide step 10)

Your Brain on Love
19:09—20:28
(referenced in Educator's Guide step 12)

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Procedure: Motivate Phase

1) Write the words *sexual reproduction* and *asexual reproduction* on a transparency or blackboard. Explain to students that reproduction means to create new offspring, but there are differences between these two types of reproduction in process as well as results. Tell them the first involves fertilization of a female egg by a male sperm while the second can be accomplished by splitting or replication, and though both result in offspring, only sexual reproduction results in offspring genetically different from parent organisms.

2) Ask students why organisms reproduce. Discuss suggestions; these may involve reasons that apply in some respects to both asexual and sexual reproduction (e.g., increase or maintain population) or only one or the other (e.g., pleasure of sexual reproduction). In a larger sense, however, *survival* is key to both, and will be related to suggestions students have provided. Play the ***"Chapter 1: Genetic Diversity Preview"*** (end at title frame) which considers the difficulty of sexual reproduction compared to asexual. Pose the question, "Given this, why do we have sex?"

3) Though students will begin to see the importance of this question in considering larger issues at a later point, they will not likely grasp these relationships until they have delved further into the science of the question. Therefore, build students' need-to-know by waiting a moment to restate the question, and ask students why, *given that survival is a key*, do we (humans) biologically reproduce through sexual rather than asexual means. Generate with students several questions that can be investigated in order to address this question. Given the type of question, and its scientific relationship to larger issues (population growth, use of antibiotics, cloning, pollution, etc.) the questions should primarily address the science involved and be narrowed to only a few at this stage (see possibilities below).

Potential scientific questions:

a) What threats must humans overcome in order to survive as a species?

b) What biological advantages do humans gain through sexual reproduction, and how and why do these occur?

Potential social/scientific question

c) In what ways do social aspects influence sexual reproduction?

Procedure: Assess Phase

4) Ask students to consider the first question posed; emphasize straightforward data and statistics are a good place to start in any scientific investigation. Ask them to suggest the biggest threats to survival. Expect a variety of responses including war, starvation, natural disasters, and disease. Most won't be hierarchical (e.g., nuclear holocaust, AIDS, etc.) but you can help students see some similarities and dissimilarities in their suggestions. Provide data on the 15 leading causes of death in the U.S. in 2003 compiled

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See **The Eyes of Nye** *Issue Support* ***15 Leading Causes of Death***

by the National Center for Health Statistics (see sidebar) or have them locate information while addressing the importance of assessing and using credible sources (see sidebar). The data illustrates "disease" is by far the biggest cause of death, even in the United States.

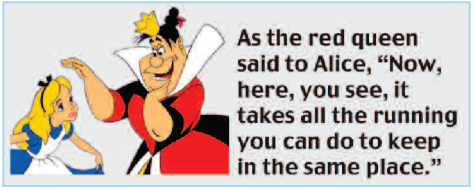
For more on data options, go to eyesofnye.org

For more on the importance of source credibility, see "assess" phase in MAP Framework

5) Ask students if *causes of death* necessarily means *threat to survival* as a species. Since it is an important distinction, help students see making that leap involves the type of assumptions scientists must often make when they seek solutions to important questions. Tell students to *assume* the two are related, and ask them to suggest ways in which we go about combating disease in order to survive as a species. Students will suggest medical remedies (perhaps antibiotics), improvement of foods and environmental conditions, and so forth. Though realizing "immunity" represents a possibility is not a given for students, look for similar suggestions from which to lead further discussion or pose the idea yourself if necessary. Emphasize the notion of "survival of a species" can have very long-term implications. Ask students to consider how immunity and long-term changes in humans could be related as you play ***"The Race for Diversity"*** which presents the possibility that genetic variation over time, especially in our immune system, is the key to our long-term ability to fight disease (or, to *stay ahead of the parasites*).

Teacher Note: *The importance of making* assumptions *(as in the prior step) and recognizing them as such are important aspects of scientific inquiry, as is understanding the meaning of a* theory *(next step) and the further exploration begged by any scientific theory. Epistemological aspects of science such as these describe the nature of science, and you should use the opportunities they present with your students. For more about teaching and learning scientific norms, see the "assess" phase of the MAP Framework.*

6) Tell students to consider this information and encourage brief but open dialogue. Do not limit, but look for the likely suggestion we can't know this is so, or the similar question, "How do we know that is the case?" Write the phrase "Theory of the Red Queen." Discuss the nature of a *theory* and the scientific norms associated with that term, and re-emphasize our "need-to-know" what science there might (or might not) be that supports this claim.



You may wish to include the quote from Lewis Carroll in Through the Looking Glass *that led scientists to use this label to describe the theory.*

7) Ask students to take notes on the research conducted at the University of Chicago by Dr. Martha McClintock as you play ***"Research on the Role of Immunity in Mate Selection."***

Ask students to restate some of the claims expressed and record the suggestions. Read through the list together (see sidebar), asking students if there are any discrepancies or possible points in Dr. McClintock's claims or research that may warrant further investigation. If there are no suggestions, ask students if we should just accept them as they are stated. Suggest that usually scientific research builds on previous research and findings. Tell students they will investigate some of these findings and compare what they learn with Dr. McClintock's claims. First, briefly introduce the term MHC (major histocompatibility complex) as the gene combination in our immune system, unique for each person and genetic make-up.

8) Distribute copies of Role of the MHC in Mate Selection (see sidebar) and ask students to read the article and note each instance of prior research that relates to Dr. McClintock's findings. Break class into groups of 3-4 students and ask them to compare their research points and to synthesize these in order to create one set for the group. Afterward, you may discuss supporting or refuting evidence, or have each group present their points. Students may modify based on other groups' work.

Preview the article and construct a simple points summary before distributing.

9) Recall one of the principal tasks the earliest researchers performed with the Hutterite population was recording genealogies. Suggest this implies long-term changes are important, and we can *assume* this applies to other species as well as humans. Ask if anyone can explain a sense besides "smell" the article suggested was of consequence in mate selection. Reiterate that "sight" is directly mentioned. Students may suggest—rightly so—other senses and factors may also be involved. Point out the word "selection" in the title of the article and introduce the notion that through studying "selection" we may find other relevant scientific clues that may help us to answer the questions we have posed. Ask them to watch as you play ***"Research on Sexual Selection"*** featuring Dr. Marlene Zuk, Pacific Field Cricket Research, University of California, Riverside.

Review concept of "natural selection" and the role of sexual selection in that process. Present a variety of theories regarding "selection."

For additional ideas, go to eyesofnye.org

10) Ask students, "Who appears to be 'selecting,' males or females?" Ask them what they think about that. Expect a number of interesting responses, but address it lightheartedly and ask *is this it?* Ask them to skim the article previously discussed and see if there are references to male selection. Recall the mice studied by Kunio Yamazaki in the '70s. Play ***"Of Mice and Men?"*** in which Dr. Zuk continues her discussion and an involvement of males in the selective process is established.

Before proceeding, allow students to explore experts who have posed claims.

For more on exploring claims and claimants, go to eyesofnye.org

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See ***The Eyes of Nye*** *Issue Support* ***Role of the MHC in Mate Selection***

Procedure: Propose Phase

11) Pose the question to students, "Would you base your choice of a mate on these reasons?" Most will not (or at least not admit it), and you should tell them this is great, because they will now write a persuasive paper to convince another reader these are indeed the biological reasons why we choose a mate. Explain they will, however, get to respond differently in a moment, if they choose.

Persuasive paper format:

- *Introductory paragraph stating view and briefly listing three supporting reasons.*
- *Body consisting of explanation of reasons, preferably in three separate paragraphs.*
- *Conclusion that restates the view as an assertion based on evidence provided.*

12) Ask students to exchange papers with a partner and write a response to each point used in his/her argument for biological selection. Permit use of both scientific and social or emotional reasoning, but encourage them to try to think of a possible cost for each benefit their partner has listed, and provide alternative reasons they consider to be more important where appropriate. Afterward, ask students to let their partner read their responses. Wait a moment for them to read and enjoy the comments, then briefly discuss the responses and ask if anyone said they would choose their mate based on "love." Expect that several have used this reasoning, and ask them why. Tell students that though this is somewhat of a social or emotional reason, it is nevertheless partially scientific because it influences their *behavior*, which in turn influences their biological actions, much like the other phenomena they have been studying. Play ***"Your Brain on Love"*** and briefly discuss the possible impact of love on our drive to have sex, and thus to reproduce sexually.

13) Ask students to describe what types of costs they thought of in response to their partner's arguments. Tell them, though we have discussed "benefits" to sexual reproduction throughout this lesson, we have not really addressed their corollaries. Play ***"Chapter 5: Benefits and Drawbacks of Sexual Effort"*** (end at discussion of sexually transmitted diseases) and briefly discuss why, if sexual reproduction is so necessary and if "selection" is indeed the key, would there naturally be such cost involved. Suggest the nature of science is such that these questions lead to deeper study as we better try to understand their solutions. You may extend students' studies into the topic or underlying science by revising or formulating new questions and re-entering the "assess" phase.

Final Teacher Note: *Chapter 5 of* The Eyes of Nye - Genetic Diversity *(used above) closes with raising again the problem of parasites changing (or mutating) again as we (humans) continue to develop better immunity. The concept provides a lead to issues associated with antibiotic use and/or potential overuse. Likewise, the importance of genetic variation in fighting disease directly connects with the issue of cloning. These represent just two of myriad possibilities, and both are addressed in* The Eyes of Nye *series as well as in accompanying teacher's guides. Get additional information on possible resources that can be used to tie the content in* Genetic Diversity *to these issues.*

For more, go to eyesofnye.org

Further Research

Investigating the Issue: Genetic Diversity

Issues at the front of the public consciousness (e.g., cloning, antibiotic use, and others) deal with numerous concepts and questions important in developing a thorough understanding of the larger issue. Seeking answers to why we (humans) reproduce sexually, and what advantages this provides to us as a species, address this need-to-know; they therefore become issues to the scientific community, and as such to students who are learning to investigate, assess claims, and propose lines of argument. Scientific aspects such as accuracy, precision, and consistency are essential elements in exploring these types of questions, just as social aspects like potential bias or qualifications remain a consideration.

In addition to the information and claims presented in *The Eyes of Nye - Genetic Diversity*, students may access a variety of informative sources related to the questions discussed above to assist them in assessing both scientific and social aspects of claims made. Teachers may direct them to specific information or leave research tasks as open as they feel is necessary for students to adequately explore and assess information related to the potential advantages of sexual reproduction.

Exploring Scientific Evidence Related to Sexual Reproduction

Data, statistics, and case studies: The National Center for Health Statistics as well as the Centers for Disease Control and Prevention provide useful data relevant from the perspective of understanding why the questions are important. Statistics of death rates provide substantive proof that combating disease is an essential undertaking, and learning how we biologically accomplish this task leads to many if not most of the solutions we devise to save and improve lives worldwide. Case studies are available as well, and help provide historical examples when new and innovative approaches emerge. These resources are particularly helpful during the "assess" phase of the teacher's guide. You may have students search for information available at any number of credible research facilities, or choose to start at the Centers for Disease Control and Prevention (http://www.cdc.gov) and the National Institutes of Health (http://www.nih.gov), or for information related to the immune system through the National Institutes of Health at http://www.niaid.nih.gov/final/immun/immun.htm

Theories of Selection

In keeping with the scientific norm that calls for scientific claims to be consistent with outside theory, Evolution of Sex brings certain aspects of "selection" to the fore—namely sexual selection and natural selection. These inform debate and further questions, and views on the extent which one supports or refutes the arguments of the other are as varied as the variations of the theories themselves. A small sampling of "selection" theories on which students may acquire information is provided below, as well as two potential topics that upon further investigation illustrate the relevance of sexual reproduction and disease prevention to the issue of cloning.

Natural selection and evolution

- Darwin
- Wallace

Three theories considering the explanation of female choice in selection:

- Run-away selection theory (Fisher, 1958)
- Good genes theories
  - Strategic Choice Handicap Theory (Zahavi & Biol, 1975, 1977)
  - Revealing Signals Theory (Hamilton & Zuk, 1982)
  - See also related work of Dustin Penn and von Schantz (1989, 1994, 1996), Milinski & Baker (1990), Norris (1993), Petrie (1994), Folstad & Karter (1992), and Dicthkoff (2001).
- Sensory Bias or Passive Attraction Theory (Parker, 1982)
  - See also related work of Pizzari & Birkhead (2000), Jennions & Petrie (2000), Zeh & Zeh (1997), Newcomer (1999), and Evans (2000).

Further, information and studies of related "public-conscious" issues such as cloning, genetically modified food, antibiotics, and addiction represent only a few sources of information and data that provide students a much deeper understanding of the intricacies involved with addressing the advantages conferred by sexual reproduction. Encouraging exploration and perhaps independent research around specific instances (e.g., maize disease in 2000, sire syndrome, etc.) allows students to construct connections and understandings that deepen their appreciation of the scientific enterprise in a way that little else can compare.

Exploring Genetic Diversity Claims and Claimants

Investigating issue-relevant questions involves looking beneath the scientific evidence and viewpoints by acquiring additional information on the experts themselves as well as the organizations for whom they are affiliated. Through such exploration, students are better able to infer social (contextual) factors that may influence the claims. In *The Eyes of Nye - Genetic Diversity*, the principal information was provided by Dr. Martha McClintock and Dr. Marlene Zuk. Teachers may encourage students to conduct open-ended searches for this type of information, or direct students to start at information typically available at the institution at which they are employed. Faculty profiles, for example, often provide useful information about the individual and their qualifications, and the institution's Web site (or department microsite) often gives valuable descriptions of the mission and goals of the institution itself, as well as their philosophies, other work, and so forth. These pages will often lead to other sites with additional information useful for understanding the social contexts in which their work is performed and made available to the public.

Dr. Martha McClintock	University of Chicago Institute of Biology and the Mind
Dr. Marlene Zuk	University of California, Riverside Pacific Field Cricket Research

ISSUES SUPPORT MATERIAL

Genetic Diversity: Sexual Reproduction

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15 Leading Causes of Death

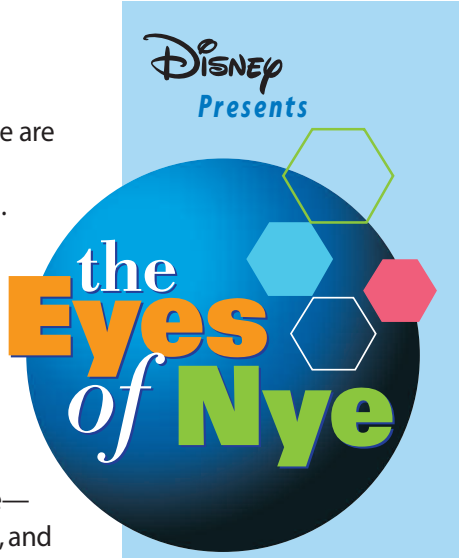
Rank	Cause of death (Based on the *International Classification of Diseases, Tenth Revision*, 1992	Number
1	Diseases of heart	684,462
2	Malignant neoplasms	554,643
3	Cerebrovascular diseases	157,803
4	Chronic lower respiratory diseases	126,128
5	Accidents (unintentional injuries)	105,695
6	Influenza and pneumonia	73,965
7	Diabetes mellitus	64,847
8	Alzheimer's disease	63,343
9	Nephritis, nephritic syndrome and nephrosis	42,536
10	Septicemia	34,243
11	Intentional self-harm (suicide)	30,642
12	Chronic liver disease and cirrhosis	27,201
13	Essential (primary) hypertension and hypertensive renal disease	21,841
14	Parkinson's disease	17,898
15	Pneumonitis due to solids and liquids	17,457
Other		421,226

Preliminary 2003 death totals for the 15 leading causes of death in the United States. Data are based on a continuous file of records received from the States.

National Vital Statistics Reports, Vol. 53, No. 15, February 28, 2005. National Center for Health Statistics.

Disney Educational Productions (800) 295-5010

Role of the MHC in Mate Selection



What draws people of the opposite sex together? Biologists have a general answer—we are members of a sexually reproducing species and need to join up with someone of the opposite sex to mate, conceive offspring, and pass our genes on to the next generation. But what scientists cannot yet fully explain is why people are attracted to particular members of the opposite sex. Why that man and not another; why that woman and not her friend?

Recent research combining genetics and behavior suggests there may be a hidden agenda at work. It looks as if we may avoid prospective mates who are too similar to us in the genes that drive the immune system. And data that may explain some of the basics of human attraction and mating are coming from a very special group of people—the Hutterites, a closed religious sect in which people marry young, stay married for life, and value fidelity.

In a nation that is commonly likened to an ethnic melting pot, the Hutterite communities have remained remarkably homogeneous. Every Hutterite can trace his or her ancestry to the 400 or so members of the Anabaptist sect who migrated from Europe to the United States in the 1870s to escape religious persecution. The founders settled on three communal farms in South Dakota. Today, the Hutterites, more than 35,000 strong, are spread across the northern United States, as well as western Canada, in 350 colonies.

From a population geneticist's point of view, the Hutterites are ideal research subjects. The 400 original settlers themselves were closely related. They are believed to have descended from about 90 individuals. Written genealogies go back nearly 16 generations. The rules of Hutterite culture, which include within-group marriage as well as lifelong fidelity, prevent the usual shenanigans responsible for the exchange of genes across geographic, ethnic, racial and religious borders. As a result, the Hutterites are relatively inbred. In addition, they are highly fertile (with an average family size of nine) and do not practice birth control, allowing a geneticist to get a picture of how genes are passed along under "natural" conditions. In the late 1950s, biologist Arthur Steinberg, and his colleagues at Case Western Reserve University, began visiting the Hutterites for an extensive project that included measuring people, checking their health (administering EKGs, for example, and testing cholesterol levels), drawing blood for genetic studies, and, most important for analysis, recording genealogies. They visited most of the colonies and developed a priceless bank of information about the population. In the 1970s, these data were handed down to Alice Martin of Northwestern University Medical School, who in turn passed them on to Carole Ober, a geneticist with anthropological training now working in the Department of Human Genetics at the University of Chicago. In 1982, Ober began a long-term project on one of the original lineages, focusing on 31 of the 44 colonies in South Dakota.

Ober's main interest is a genetic system found in all vertebrates; the major histocompatibility complex, or MHC (known in humans as human leukocyte antigen system, or HLA), and its effect on fertility and mating. ... Ober found that fetal loss increased significantly when Hutterite parents shared all the genes of the HLA system, or just genes in the HLA-B region.

Ober is quick to say that, at this stage in the research, we cannot declare with certainty that the HLA genes themselves – and not some other genes found in the same region on the chromosome—interfere with fertility, but since pregnancy is essentially an intrusion by foreign tissue, HLA is probably involved. If natural selection is operating so strongly during reproduction, organisms should be "designed" to avoid the fetal wastage that comes with shared HLA genes. But how? In the late 1970s, Kunio Yamazaki and colleagues observed that inbred laboratory mice were more likely to mate with mice having dissimilar MHC genes. Working with mice in a more natural setting (outdoor pens that gave the animals considerably more freedom to move about and interact), Wayne Potts, now at the University of Utah, confirmed Yamazaki's findings. The first generation of offspring in his mouse colony produced far fewer pups carrying matching MHC regions than might be expected if the parents were mating at random.

In some of his experiments, Yamazaki, now at the Monell Chemical Senses Center in Philadelphia, placed newborn male mice with foster mothers of a different MHC strain. He noted that when the time came for these males to choose mates, they avoided females whose MHC genes were similar to their foster mothers', even when that meant winding up in the position of mating with a female whose MHC genes were similar to their own. In other words, exposure during development, rather than some innate MHC mate-choice program, appears to be at work.

These startling results suggested that animals might somehow be able to detect prospective mates whose MHC genes are more or less similar to their own, and then to choose mates accordingly. They may have evolved such an ability because of MHC's importance in the immune system, or simply because MHC sensibility is a way to distinguish relatives from non-relatives, thus avoiding inbreeding. To find out, scientists have shifted their studies of mate choice from the more traditional variables of outward appearance, to the realm of genetics. Inspired by the mouse studies, Ober launched a project on mate choice in the Hutterites in 1992. Hutterites go about finding mates as most people do – by socializing. After graduating from high school, young adults travel with their parents to other colonies. ... These social gatherings are opportunities for young people to interact and are the way that most Hutterites meet their spouses. Most marry in their early twenties, after a year of courtship. The same colonies tend to exchange visits over and over, resulting in a history of marriages between particular colonies, and even particular families. In fact, 20 percent of Ober's sample were "double" marriages, with two or more siblings from one family married to siblings from another.

After genetically typing 411 couples, Ober discovered that, in this inbred population, where there is a much higher likelihood of falling in love with someone carrying a similar haplotype, spouses shared fewer HLA genes than expected. Ober traced HLA inheritance further and found that when a husband and wife did have a matching strand, the set of genes in question most often came from the paternal side, for both the wife and the husband. In other words, men and women appear to have avoided finding a mate with HLA genes that resembled their mother's. It did not seem to matter if their partner had genes like their father's. As in mice, people may somehow imprint on their mother's HLA and then be drawn to someone with genes different from hers. But how do people, or mice for that matter, know who is who

in the first place? Research on mice, rats, and even humans has implicated smell as a possible cue for distinguishing MHC/HLA genes. Mice and rats, researchers have shown, can easily distinguish the urine and body odor of fellow creatures caged in the same way, fed the same food, and bred to be genetically identical in all but their MHC genes. Remarkably, research has also shown that humans can smell the difference in body odor, urine, and feces among mice of various MHC types.

A controversial finding, published in 1995, suggests that the sense of smell also plays a role in human mate choice. Claus Wedekind, and colleagues at the University of Bern, presented women with T-shirts imbued with the body scent of men with various HLA haplotypes. The women (who were not taking birth control pills and were in the middle of their menstrual cycle, and thus at their most fertile) preferred the T-shirts of men with HLA haplotypes unlike their own. The women also tagged these T-shirts as smelling like their current partners, suggesting that odor has something to do with their real-world mate choices. (Interestingly, women who were taking the pill—which simulates pregnancy—preferred T-shirts of men with HLAs like their own.)

Rachel Herz and Elizabeth Cahill, also at Monell Chemical Senses Center, would not be surprised to find that women attempt to sniff out a genetically proper mate. Surveying both sexes about which senses are important, they found that "for females, how someone smells is the single most important variable" in choosing a lover. If odor does provide information about the immune system, it makes evolutionary sense for women to pay attention to smell. They have much to lose if they mate with an inappropriate male and give birth to a baby with a reduced ability to fight off disease. But unlike mice, humans—as primates—rely mostly on vision, not smell, to navigate through life. Perhaps other sensory cues—embedded in facial features or body shape, for example—alert us to the hidden genes in potential partners. However, if those cues are there, Ober and other researchers have yet to discover them.

During our ancient hunter-gatherer days, when humans lived in small bands separated by great distances, finding a mate with a different set of HLA genes and producing children with immunologic advantages may have been critical to survival. At this point in human history, with our restless, globe-trotting populations and relatively unlimited number of possible mates, we are unlikely, even across a crowded room, to spy someone with the same HLA haplotype. But even if we did, as the Hutterites have demonstrated, our genes would probably compel us to look the other way.

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