1. Why is Helen Fisher called a Darwinian matchmaker?

2. How many years has it been since Darwin’s *On the Origin of the Species* was published?

3. Name at least 4 areas, other than biology, that Darwin’s Theory of Evolution has influenced.

4. Why does Fisher say that Darwin’s theory is like gravity?

5. How does the article define natural selection?

6. What is the difference between theological thinking and mechanistic thinking?

7. Describe Smolin’s theory of cosmological natural selection.

8. How does evolution apply to computer programming?

9. How did Gerald Edelman use the evolutionary theory?

10. What is the Darwinian two-step?

11. Describe the theory of Neural Darwinism.

12. How does evolution apply to cancer?

13. According to the article, why are humans prone to obesity?

14. What 2 groups are holding out on Darwin’s ideas?

15. According to evolutionary psychologist, Geoffrey Miller, what does art have to do with fitness?
“Survival of the fittest” is helping us understand not only the origin of species but also love, politics, and even the cosmos.

by Karen Wright

You could call Helen Fisher a Darwinian matchmaker. The acclaimed anthropologist from Rutgers University is also a best-selling author of books on love and the chief scientific adviser to an online dating service called Chemistry.com. This service utilizes a questionnaire that Fisher developed after years of research on the science of romantic attraction. It reveals which of four broad, biologically based personality types an applicant displays and helps identify partners with compatible brain chemistry. In designing the questionnaire, Fisher relied on the principles of evolutionary psychology, a field inspired by Charles Darwin’s insights. She has even used those principles to size up Darwin himself. (He is a “negotiator,” “imaginative and theoretical,” “unassuming, agreeable, and intuitive”—but also married, alas, and dead.)

Fisher’s work is just one of the innumerable offshoots of Darwin’s grand theory of life. In the 150 years since the publication of On the Origin of Species, it seems no sphere of human thought or activity has been left untouched by Darwinian analysis. Evolutionary theory has infiltrated the social sciences, where it has been used to explain human politics and spending habits. It has transformed computer science, inspiring problem-solving algorithms that adapt and change like living things. It is cited by a leading theoretical physicist who proposes that evolution helped shape the laws governing the cosmos. A renowned neuroscientist sees ideas of selection as describing the honing of connections among brain cells. Literary critics analyze the plots, themes, and characters of novels according to Darwinian precepts. Even religion, the sector most famously at odds with Darwin, now claims an evolutionary evangelist.

“Darwinian thinking is a little bit like gravity,” Fisher says. “It has infused everything.”

The universal appeal of Darwin’s theory lies in its central tenet: natural selection, or survival of the fittest. That tenet states that organisms best suited to their circumstances will be the ones most likely to reproduce, spreading their adaptive traits and driving out the competition. Natural selection creates a dynamic, ever-changing biota, driven to evolve by genetic variation, adaptation to different environments, competition for limited resources, and cooperative exchanges among individuals. It explains how, from simple beginnings, the diversity and complexity of living things arose.

“The principle of natural selection really is a third way of thinking,” says evolutionist David Sloan Wilson of Binghamton University in New York. In his book Evolution for Everyone, he distinguishes it from theological thinking (God did it) and mechanistic thinking (its parts make it work this way). “Natural selection is a source of insight that is unbelievably powerful,” Wilson says. And its power is not limited to the life sciences. The same selective paradigm can describe the rise of complexity in inanimate systems: stock markets, transit schedules. Though other mathematical models are capable of simulating complex phenomena, only Darwin’s approach shows how certain complex systems not only arise but also adapt over time to the constraints imposed by their environment, as living systems do.

“The only process that is known to generate adaptive complexity is natural selection,” says evolutionary biologist Massimo Pigliucci of Stony Brook University in New York. “That was Darwin’s major insight, his fundamental contribution. But what we’re doing today is going far beyond what Darwin would have dreamed of.”

Darwin could not have anticipated, for example, the work of physicist Lee Smolin of the Perimeter Institute for Theoretical Physics in Waterloo, Ontario. Smolin has utilized Darwinian concepts to shape a theory of the universe that he calls “cosmological natural selection.” He developed a theory that posits the existence of a vast number of unseen universes, each generated by the collapse of a black hole. The conditions of those collapses bestow each universe with its own set of fundamental parameters, such as the masses of its various subatomic particles. Just as life diversified on
Earth, the “multiverse” in Smolin’s theory evolved from simple beginnings into a complex and varied assemblage of universes, each exhibiting a distinctive set of traits.

Art gives a selective advantage because it organizes cooperative behavior. The same idea applies to religion.

Cosmological natural selection could help to solve one of the main conundrums in physics: the seemingly arbitrary values of the fundamental constants in our universe. Why is a neutron, for example, more massive than a proton rather than the other way around? If a wealth of universes with various parameters exists, Smolin says, then our own case does not seem so special or so unlikely. In fact, cosmological natural selection specifically favors universes—like ours—in which massive stars can form and give rise to new black holes. “By using Darwinian methodology, I was able to get an explanation for the improbable complexity of our universe,” Smolin says.

Another application of evolutionary theory outside biology is the computer-programming technique known as genetic algorithms. This approach “evolves” solutions to problems that resist linear thinking by generating populations of different solutions and then testing those scenarios against programmed constraints. Just as natural selection works on living populations to ensure that the organisms best adapted to their environment survive and reproduce, genetic algorithms winnow out the “unfit” solutions and refine the ones that best match performance requirements. In one notable example, contractors used genetic algorithms to design the jet engine for the Boeing 777. In another, researchers at New Mexico State University designed a “faceprint” program for criminal identification that recombines facial features until they match an eyewitness’s recollection of the perpetrator’s visage. “We’re getting Darwin’s ideas to run faster and jump higher,” says David E. Goldberg, director of the Illinois Genetic Algorithms Laboratory in Urbana-Champaign.

John Holland, a professor of psychology and computer science at the University of Michigan, is considered a father of genetic algorithms. He is currently working on a new generation of software tools that can not only optimize design but also adapt to changing constraints as the system elements themselves evolve. Such programs will be able to simulate complex adaptive systems—the stock market, say, or Internet traffic—in which the behavior of participants is not governed by fixed rules. In Holland’s models the resemblance to biological systems is not incidental; it is explicit.

Truer still to the biology model is the work of Nobel laureate Gerald Edelman, director of the Neurosciences Institute in San Diego. In the 1960s he used evolutionary theory to explain how the immune system rapidly creates antibodies targeted to pathogens it has never encountered. He learned that a variation in the DNA of the cells that make antibodies results in a variety of cell types, each with a unique antibody molecule on its surface. When challenged by a toxin or infection, the immune system screens this population for a match, then swiftly multiplies the clonal cell line that produces the matching antibody. Utilizing a kind of natural selection, the immune system chooses the cell line that is highly equipped to deal with an environmental challenge. “One of the most important ideas Darwin had was population thinking,” Edelman says. “It’s the Darwinian two-step: variation and selection, variation and selection, and so on, down the generations.”

In the 1980s Edelman applied the same kind of thinking to brain wiring, showing how memories could be created when interactions with the environment preferentially strengthen the connections between certain populations of neurons. The connections that are not used die out. He calls the theory Neural Darwinism. “My whole career seems to be dominated by Darwin’s thought,” he says. (See the DISCOVER Interview with Gerald Edelman from the February 2009 issue.)

Edelman’s work demonstrates the remarkable applicability of Darwin’s ideas to all aspects of living things. Darwin wrote about how evolution shapes the destiny of whole organisms, but its principles apply to individual cells, too. Cancer cells, for example, compete with native cells for the body’s resources, and the best-adapted ones grow so quickly that they become tumors. “Cancer evolves in our bodies according to principles dictated by natural selection,” says Randolph Nesse of the University of Michigan, a pioneer in the field of evolutionary medicine. Practitioners of evolutionary medicine analyze patterns of disease and morbidity by considering the deep history of our species. From that perspective, it becomes clear that humans are prone to obesity because our bodies evolved in an environment of scarcity, where consuming as much high-energy food as possible was a useful survival strategy. (In a fast-food restaurant, not so much.) An evolutionary perspective also suggests why men die, on average, seven years earlier than women: The factors that maximize their reproductive success also interfere with their long-term health. “Without an
According to Helen Fisher and other proponents of evolutionary psychology, the theory of evolution helps them address questions like “What is love?” and “Why do we vote the way we do?” Many evolutionary psychologists believe that the cognitive and emotional makeup of human beings represents an adaptation to our ancestral environment. Biologist Edward O. Wilson of Harvard University launched the discipline in 1975 with one slim chapter in his book *Sociobiology: The New Synthesis*, suggesting that insights into animal behavior afforded by evolutionary theory could apply to human animals, too.

Today the evolutionary worldview has expanded into analyses of economics and politics as well as of human mating behavior. It has enriched the “rational choice” model long espoused by economists to explain human behavior in the marketplace. Traditional economic models assume that people act exclusively in their self-interest, just as traditional evolutionary theory describes competition among individuals. But cooperation and altruistic tendencies also show up routinely in studies of economic behavior. People who stand to lose from progressive taxation, for example, may still vote for it. “You can’t predict how people will vote on the issue of income redistribution based on their income,” says economist Herbert Gintis of the Santa Fe Institute in New Mexico.

Gintis and other economists have noted [pdf] that the latest elaborations of Darwinian ideas can explain cooperation as well as competition in the economic arena, and they are modifying the rational-choice model accordingly. The template for cooperative behavior comes from so-called group selection, which holds that traits can persist or spread in a population even though they can be costly to the individual if they bestow an advantage on the group. Behavior that is self-sacrificing might create such well-adapted societies that selfish individuals cannot compete with them. In the evolutionary view, group selection fostered pro-social tendencies such as honesty, trustworthiness, consideration, and loyalty—traits that were useful or necessary in the later development of civilization. “Of course, these moral predispositions moderate rather than eliminate considerations of self-interest and loyalties to kith and kin,” Gintis wrote last March in the journal *Science*.

The selective tension between self-interest and collective welfare reflects a long-standing argument in political science. “So much of the debate in the history of political theory ultimately comes down to a debate about human nature,” says Larry Arnhart, a political theorist at Northern Illinois University. In his blog Darwinian Conservatism, Arnhart uses evolutionary principles to critique political issues, such as the bailout packages approved last year by Congress. If humans are noble savages, given by nature to goodness, he argues, then government must take care not to corrupt our lofty intentions. If we are degenerate at heart, then government must act to rein in our base impulses. Because of the interplay of individual survival and group selection, evolutionary biology suggests we might be a little bit of both. “A growing number of political scientists are looking to biological science for guidance on that,” Arnhart says.

Amid the hordes of converts to Darwin’s ideas, two groups remain conspicuous holdouts: artists and religious believers. Artists are “likely to regard science in general, and evolution in particular, as irrelevant to their concerns or even as a threat to everything that they hold dear,” David Sloan Wilson writes in *Evolution for Everyone*. Yet he sees evolutionary theory breaching even that resistance. In 2005 Wilson coedited *The Literary Animal*, a collection of essays applying Darwinian concepts to literary analysis. Literature, he says, is “the fossil record of cultural evolution. If you’re an evolutionist and you like to read, every time you pick up a novel the evolutionary themes just leap out at you”—sex, death, kinship, self-sacrifice, competition.

The very existence of art begs to be explained in evolutionary terms, Wilson says. Artistic expression has all the earmarks of a genetically evolved capacity: It appears early in life, is enjoyable for its own sake, exists across all cultures, and is mediated by ancient neural pathways in the brain. Evolutionary psychologist Geoffrey Miller of the University of New Mexico suggests that art evolved as a way for potential mates to show off their intellectual fitness. (See the 5 Questions column with Geoffrey Miller from the February 2009 issue of DISCOVER.)

Wilson thinks art—especially the collective making of it that is common in traditional cultures—gives a selective advantage because it helps to organize cooperative behavior. The same reasoning applies to religion, he argues. His
studies have documented ways in which religious feeling and organization confer survival benefits on believers by promoting cooperation within, and sometimes between, groups.

Cosmological natural selection could help explain the seemingly arbitrary values of fundamental constants.

“A given religion adapts its members to their local environment, enabling them to achieve by collective action what they cannot achieve alone or even together in the absence of religion,” Wilson writes. “The primary benefits of religion take place in this world, not the next.” The religious emphasis on otherworldly beliefs evolved, Wilson says, because supernatural explanations seem to motivate human cooperation better than factual ones. From an evolutionary perspective, it does not matter what you believe in, as long as that belief works to give you a selective advantage.

Harnessed to a supernatural dimension, the belief in evolution could itself evolve into a kind of religion. Witness the case of one Michael Dowd, an itinerant minister who calls himself an “evolutionary evangelist” and preaches the “holy trajectory” of evolution. “I thank God for the entire 14-billion-year epic of cosmic, biological, and human emergence,” he notes on his Web site. “Ironically, evolution gives us a more intimate and personal relationship with God because God is no longer far off, unnatural, and impotent. And it gives us a way of thinking about religion that helps us understand how and why religions are different, and how we can cooperate across ethnic and religious differences to cocreate a thriving world together. Both of these are, to my mind, really Good News.”

In imbuing science with a sense of personal meaning, Dowd resembles Pierre Teilhard de Chardin, the Jesuit priest and paleontologist who envisioned humankind and the universe evolving in the direction of a divine, infinitely complex consciousness he called the Omega Point. But the two remain an extremely rare breed: devout believers in science whose teleological claims flout the rigors of scientific verification. Unlike Dowd and Teilhard de Chardin, Wilson espouses a strictly secular enthusiasm. However much they may disagree about the ends, though, these very different Darwinian thinkers agree on the means.

“Organisms evolve, and at the end of the day, we are organisms,” Wilson says. “You just can’t deny that.”