Some questions to get you thinking...

- Why does sex exist?
- Why are there two sexes?
- Is sexual behavior determined by our genes?
- Is sexual reproduction better than asexual?
- How did sexual reproduction start?
- Is the human species overly concerned with sex?
- How much of human sexuality is unique to our species?
- Who benefits most: males or females?
- Is sexual reproduction cooperative or competitive?
- Would humans exist in a world w/o sexual reproduction?

Are there enough questions on this slide?
### What is the “biology of sex”

- male/female stuff - that’s gender, not sex
- everything from A-Z (anthropology to zoology)
- behavioral studies
- social studies
- structure and function of reproductive systems
- regulation of reproduction by chemicals
- effects of reproductive hormones on other systems
- evolution of sexual organs
- cellular basis of sexual reproduction
- effects of sex upon organisms (physiologic)

**Biology of sex is a huge area of research (lots of people and money)**

### The biological basis for sex

- invented 4 billion years ago by bacteria
- a method for shaking up and rearranging instructions for making more bacteria
- now adopted by almost all forms of life
- nature evolved inducements to encourage sex
- in higher mammals associated with intense stimulation of pleasure centers in the brain (perhaps without which we wouldn’t have sex)
- limbic system associated (basic drives, the four “F’s”)
- overlaid and modified by cerebral cortex (reasoning)

**Passing on genetic material to the next generation with increased variation**
Why does sex exist? Three hypotheses

1. **DNA repair**: fragile DNA susceptible to damage over time. Constant shuffling and mixing of DNA creates opportunities for error correction and mutation, but truly harmful mutations will be removed from the population before reproducing, ensuring the best or least deleterious mutations will be passed on.

2. **The Tangled Bank**: (Williams / Ghiselin) create offspring different from you to exploit niches in the environment. (does not seem to be supported by observations that asexual organisms more likely to be found in varied niche environments and that sexual organisms produce fewer offspring)

3. **The Red Queen**: (Van Valen) organisms under attack from parasites that evolve very quickly. By mixing and shuffling DNA, organisms try to stay ahead of the parasites by altering their defenses. Thus the parasite has less chance of finding the key to unlock the host defense and the "Red Queen" race has begun - running to stay in the same place.

If it were not for disease we might not have sex at all!

Asexual reproduction: **advantages/disadvantages**

- no searching for a partner
- no competition for mates with others of your sex
- reproduction is guaranteed
- offspring are just like you - genetic fitness
- desirable traits not diluted out by breeding
- slow plodding evolutionary pace
- undesirable traits not diluted out by breeding
- doesn’t mix up the gene pool
- reduced coping capacity of the population
- your population can be decimated under stress

We are here **because** of sexual reproduction
Mutational rates - slowing evolutionary mistakes

- mutation - low level can be adaptive, high level fatal
- inherent limits on mutation per generation
- a “brake” on runaway mutation - messes up DNA code
- organisms with high mutational rate are already at limit
  (combining two high mutational rates would be deadly)
- some organisms share DNA without reproducing
  (increasing genetic variation without risk or rapid evolution)
- under stress, variations are selected for fitness
  (population crash, non-adaptive mutations weeded out)
- organisms with mixed genes survive better
- sharing of beneficial mutations enhances fitness
- sharing adaptive mutations increases survival
- evolve toward coordinated exchange of genes

Sex and mutation drive genetic variation

Origins of sex - are parasites involved?

- the “Red Queen” model:
  “In this place it takes all the running you can do, to keep in the same place”
- Alice in Wonderland - running to stay in the same place
- parasite take advantage of host genetic markers and weaknesses
- sexual reproduction scrambles genetic makeup
- host genes are changed, parasites left behind
- New Zealand: snails move from asexual to sexual reproduction when exposed to trematode parasites
- Mexican Poeciliid fish: sex = parasite resistance
- Topminnow fish: sex = resistance to parasite worm

Sexual reproduction persists because it enables many species to rapidly evolve new genetic defenses against parasites that attempt to live off them.
Let’s all be hemaphrodites! Maybe not...

- if sexual reproduction is two organisms combining, then why not have both male and female so we can donate and receive sperm and carry babies? Wouldn’t this double our reproduction rate?
- Bobbi Low (au: “Why Sex Matters?”) hypothesizes that once there are two types of gametes that have specialized into large energetically costly nutritional support (egg) and small energetically cheap for insemination (sperm) that you automatically have the sexual characteristics that favor success of one gamete over the other.
- example: a hemaphrodite gene that favored spreading sperm rather than growing babies would increase genetic fitness of the carrier by allowing for more reproduction. Alternatively, controlling eggs and choosing who inseminates them could increase genetic fitness of a hemaphrodite evolving toward egg production.
- Once both sexes began specializing to increase their genetic fitness, then there’s no turning back because of inter-sex competition. Males compete with other males for better insemination, whereas females compete to be better at producing eggs, growing babies, and selecting mates. The sexes become separated.

Optimum characteristics of each sex for their reproductive role are not just anatomy and physiology, but are also linked to behavior.

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Essay: The Advantage of Sex by Matt Ridley

A variety of theories have been proposed over the years to explain why sexual reproduction may be more advantageous than asexual reproduction, and, for that matter, why sexual reproduction even exists at all. For years everyone accepted the general proposition that sex is good for evolution because it creates genetic variety, which, in turn, is useful in adapting to constantly changing and challenging environments. But it may give organisms a very different kind of edge.

By the late 1980s, in the contest to explain sex, only two hypotheses remained in contention.

One, the deleterious mutation hypothesis, was the idea that sex exists to purge a species of damaging genetic mutations. Alexei Kondrashov, now at the National Cancer for Biotechnology Information, has been its principal champion. He argues that in an asexual population, every time a creature dies because of a mutation, that mutation dies with it. In a sexual population, some of the creatures born have lots of mutations and some have few. If the ones with lots of mutations die, then sex purges the species of mutations. Since most mutations are harmful, this gives sex a great advantage.
essay: The Advantage of Sex by Matt Ridley

Can sex earn its keep?

But why eliminate mutations in this way, rather than correcting more of them by better proofreading? Kondrashov has an ingenious explanation of why this makes sense: **It may be cheaper to allow some mistakes through and remove them later.** The cost of perfecting proofreading mechanisms escalates as you near perfection.

According to Kondrashov's calculations, the rate of deleterious mutations must exceed one per individual per generation if sex is to earn its keep eliminating them; if less than one, then his idea is in trouble. The evidence so far is that the deleterious mutation rate tecters on the edge; it is about one per individual per generation in most creatures. But even if the rate is high enough, all that proves is that sex can perhaps play a role in purging mutations. It does not explain why sex persists.

The main defect in Kondrashov's hypothesis is that it works too slowly. Pitted against a clone of asexual individuals, a sexual population must inevitably be driven extinct by the clone's greater productivity, unless the clone's genetic drawbacks can appear in time. Currently, a great deal of effort is going into the testing of this model by measuring the deleterious mutation rates, in a range of organisms from yeast to mouse. But the answer is still not entirely clear.

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essay: The Advantage of Sex by Matt Ridley

Enter the Red Queen

In the late 1980s the Red Queen hypothesis emerged, and it has been steadily gaining popularity. First coined by **Lewin in 19th century literature**, it refers to *Lewis Carroll's Through the Looking Glass*, in which the Red Queen tells Alice: "**If I had to run even to keep in the same place, I must run very fast.**" This never-ending evolutionary cycle describes many natural interactions between hosts and disease, or between predators and prey: As species that live at each other's expense evolve, they are engaged in a constant evolutionary struggle for a survival advantage. They need "all the running they can do" because the landscape around them is constantly changing.

The Red Queen hypothesis for sex is simple: **Sex is needed to fight disease.** Diseases specialize in breaking into cells, either to eat them, as fungi and bacteria do, or, like viruses, to subvert their genetic machinery for the purpose of making new viruses. To do that, they use protein molecules that bind to other molecules on cell surfaces. The arms races between *advantage* and their hosts are all about these binding proteins. Parasites invent new keys; hosts change the locks. For if one lock is common in one generation, the key that fits it will spread like wildfire. So you can be sure that it is the very lock not to have a few generations later. According to the Red Queen hypothesis, sexual reproduction persists because it enables host species to evolve new genetic defenses against parasites that attempt to live off them.
Keeping variety in store

Sexual species can call on a "library" of loci unavailable to asexual species. This library is defined by two terms: heterozygosity, when an organism carries two different forms of a gene, and polymorphism, when a population contains multiple forms of a gene. Both are lost when a species becomes inbred. What is the function of heterozygosity? In the case of sickle-cell anemia, the sickle gene helps defeat malaria. So where malaria is common, the heterozygotes (those with one normal gene and one sickle gene) are better off than the homozygotes (those with a pair of normal genes or sickle genes) who will suffer from malaria or anemia.

One of the main proponents of the Red Queen hypothesis was the late W. D. Hamilton. In the late 1970s, with the help of two colleagues from the University of Michigan, Hamilton built a computer model of sex and disease, a slice of artificial life. It began with an imaginary population of 500 creatures, some sexual and some asexual. Death was random. As expected, the sexual race quickly died out. In a game between sex and "asex," asex always wins -- other things being equal. That's because asexual reproduction is easier, and it's guaranteed to pass genes on to one's offspring.

Adding parasites to the mix

Next they introduced several species of parasite, 200 of each, whose power depended on "virulence genes" matched by "resistance genes" in the hosts. The least resistant hosts and the least virulent parasites were killed in each generation. Now the asexual population no longer had an automatic advantage -- sex often won the game. It won most often if there were lots of genes that determined resistance and virulence in each creature.

In the model, as resistance genes that worked would become more common, then so too would the virulence genes. Then those resistance genes would grow rare again, followed by the virulence genes. As Hamilton put it, "A parasite adaptation is in constant oscillation." But in contrast to asexual species, the sexual species retain unfavored genes for future use. "The essence of sex in our theory," he wrote Hamilton, "is that species genes that are currently bad but have promise for reuse. It continually tries them in combination, waiting for the time when the focus of disadvantage has moved elsewhere."
Oddities of sex associated with humans

- take longer to reach sexual maturity than most species
  (take even longer to reach intellectual maturity and social independence)
- we lack a mating season - or have one long continuous one for decades
- purpose of sex broadened from procreation to social ends

Humans can produce offspring while still socially regarded as mentally and/or emotionally immature
Placing human sexuality in perspective

• teens learn proper place and role of sex in human relationships
• 30,000 years of evolution has provided for higher order control of sexual urges - societal / personal
• motivation for sex can be extremely powerful (the fourth “F” is one of the most concentrated and mind-numbing feelings that can be experienced
• craving to repeat as often as possibly permitted
• onset of a sexual relationship can transform social relationships - intimacy, self-worth, understanding...

Is “casual sex” a biological oxymoron?

Is Love in Our DNA?

Ask any person what he or she wants in a mate, and you’ll likely get the same answer: eye-popping, elegant plumage. A peacock with a set of big, provocative tail feathers is doomed to a frustrating sex life. Peacocks always pick well-endowed suitors over drab ones, and biologists see the evolutionary logic behind it — healthy birds, with showy feathers, are likely to father healthy offspring.

But ask any person what he or she wants in a mate, and the range of answers is bewildering. “A kind heart.” “Great legs.” “Someone who loves kayaking.” Yet some scientists in a field called evolutionary psychology propose that we all share instinctive preferences, and that what we humans find alluring in a mate is rooted in our evolutionary past.

Much of the science of evolutionary psychology is controversial — but nonetheless thought-provoking. Judge for yourself.

Did evolution shape your taste in a mate?

Yes / No

http://www.pbs.org/wgbh/evolution/sex/love/index.html
Is Love in Our DNA?

Consider this...

Anthropologists maintain culture plays a heavy role in what each group defines as beautiful. For example, inflexion is considered not particularly attractive in our modern society, but is considered a sign of wealth and prosperity in other cultures. Also, tastes change over time. What was beautiful, fashionable, and attractive twenty years ago may look rather silly today. Take large sideburns in men. They’ve come and gone in fashion many times over the past hundred years, so frequently that men who have them might feel a RATHER NERD.

—Wendell Smol, What’s Love Got to Do With It?, 1995

The idea that beauty is important or a cultural construct is the real beauty myth. We have to understand beauty, or we will always be enslaved by it...beauty is a universal part of human experience...it provokes pleasure, rivets attention, and impels actions that help ensure the survival of our genes. Our extreme sensitivity to beauty is hard-wired, that is, governed by circuits in the brain shaped by natural selection. We love to look at smooth skin, thick shiny hair, curved waists, and symmetrical bodies because in the course of evolution people who noticed these signs and deemed their possessors had more reproductive success. We are their descendants.

—Nancy Etcoff, Survival of the Prettiest, 1999

(Endnote added.)

Is Love in Our DNA?

Consider this...

The classical interpretation of physical attractiveness was that physical attractiveness is just arbitrary, it’s in the eye of the beholder, beauty is in the skin deep, that kind of stuff. And what research has shown is that that is absolutely wrong. In fact, beauty is the promise of function in terms of the health of the individual, and function in terms of the ability to deal effectively with environments that are hostile -- environments of our evolutionary past.

—Randy Thornhill, interview for the PBS series Evolution, 2003

You can never be too rich or too thin.

—Anonymous

There is no evolutionary precedent for the slim ideal. Matter of fact, selection should work against such a preference. It has been known for some time that women with eating disorders suffer disruptions in fertility and reproduction...Extreme thinness is in a fashion, a fashion set by the highest social classes, as most studies show. Our bodies reflect not only Darwinian forces, which impel us to reproduce, but cultural ones.

—Nancy Etcoff, Survival of the Prettiest, 1999
Is Love in Our DNA?

Consider this...

Beautiful young women are sexually attractive to men because beauty and youth are closely linked with fertility and reproductive value. In evolutionary history, males who were able to identify and mate with fertile females had the greatest reproductive success... A 14-year-old woman has a higher reproductive value than a 24-year-old woman, because her future contributions to the gene pool far outweigh her past contributions. —David Buss, *The Strategies of Human Mating*, American Journal, 1994

When a computer-generated “average” face was made “hyper-attractive” — with plump lips, a short and narrow lower jaw, and high cheekbones — it was judged more attractive by both men and women. Evolutionary psychologist Victor Johnson, who led the study, notes that full lips and a delicate jaw are indicators of high collagen and low testosterone levels — indicators of fertility.

To a primatologist, such preferences must be puzzling. There is not a shred of evidence for any other primate that youth — or specific body parts considered attractive to mate — affect male willingness to mate. Across virtually all primate species, infanticide by the dominant male is more frequent with females who are seen to bring the young ones. Girls with plump lips and high cheekbones who possessed females... based on their probability of producing offspring that survive. —Sarah Batter Hrdy, “Raising Danvers’s Consciousness,” in Gender and Society, 1999

In the end, it matters not the reason why older men have access to younger women, as long as they do, some of them will parents... What is important to question, and to hold to the fire of alternative interpretations, is the logic of the discrepancy, its basis in our genetics rather than in the ecological circumstances in which a genome manages to express itself. —Natalie Angier, *Woman*, 1999

On you first “curvy” woman sizzle? Some scientists argue that a bicep for a small waist and big hips make evolutionary sense. Women who are leaner are more likely to have a resting metabolic rate and lower fertility.

Is Love in Our DNA?

Because ancestral women faced the tremendous burdens of internal fertilization, a nine-month gestation, and lactation, they would have benefited tremendously by selecting mates who possessed resources. Because hierarchies are universal features among human groups and resources tend to accumulate to those who are in the hierarchy, women solve the adaptive problem of acquiring resources in part by preferring men who are high in status. The contemporary evidence across many cultures supports the evolutionary prediction that women key onto this cue. —David Buss, *The Evolution of Desire*, 1994

Evolutionary psychologist Nancy B labell points to Henry Kipling (here with his wife) as an exemplary high-status male.

Our notions of the best mate are sculpted by the culture around us. Women are especially vulnerable to the dictates of family and society. In almost all societies around the world, women have little economic or political power. And so women often want husbands with high socioeconomic status because women usually can’t get money and power themselves. A cultural anthropologist colleague of mine, however, pointed out, “The essence: Women want men who have power and money...” —Natalie Angier, *Woman*, 1999

“Is it laddish and sexist that male BN1 box-office draw? Or something else entirely? Critics of evolutionary psychology point out that their work tends to emphasize female youth and beauty rather than the male equivalent.”

In a call to the lift program “Cip Tub,” one 20-something bachelor asked for advice on what new car would help him woo a 20-something mate.
Is Love in Our DNA?

Consider this...

There is a deep biological motivation in each of us, whether we respond to it or not, to pass on genes. Because we are sexual reproducers, this means finding a mate, and because we have such dependent offspring, it also means long hours of parenting...

It's no surprise, therefore, that people say the most important thing to them in a prospective mate is their personality. If we look at "mateChoice" as long-term relationships in which children are nurtured, rather than an exchange of genes, people should look for a mate who is a good negotiator, someone they can work with.

—Meredith Small, What's Love Got To Do With It?, 1999

I don't know why we choose the partners we do, or what women really want from men and men want from women. What I do know is that nobody else knows either. I know that the deep psychology of human love and human bonding is as yet a great mystery. Though there are a few glinting sequins scattered here and there that might be useful. Oh yes, we see the light... Variation and flexibility are the key themes that get set aside in the breathless dissemination of evolutionary psychology.

—Natalie Angier, Woman, 1999

Time to choose....

Did evolution shape your taste in a mate?

72% voted yes

14% of the people whose final vote was yes changed their minds from no to yes

28% voted no

34% of the people whose final vote was no changed their minds from yes to no