Week 10 Class 2: Group 1-1

Decide Today's Group Roles (you decide and fill in who does what today, but then your roles must rotate every class period)

Interpreter Name: Jacob Engle (job: read directions, make sure everyone in group understands goals).
Recorder Name: Dan Pomeranz (job: accurately write group answers so that group can STUDY from this worksheet later in the semester).
Skeptic Name: Connor Gifford (job: challenge accuracy of answers; always push for better or more clear answer).

Part 1: Why sex?

Content adapted from "Why Sex is Good" by Clyde Freeman Herreid, Department of Biological Sciences, University at Buffalo State University of New York

Why do so many organisms go through sexual reproduction? It seems like every organism we think about does it: clams, jellyfish, trees, and elephants. And while we’re thinking about it: why only two sexes? It doesn't have to be that way. For example, some fungi have dozens of sexes. Sex really isn't necessary for reproduction. Bacteria and many one-celled organisms like amoebae reproduce quite nicely by simply dividing in half (binary ssion). They produce identical copies of themselves, quite an efficient way of sending one’s genes on to the next generation.

Complex organisms can do it too. Below is a list of multicellular organisms that reproduce that use alternative strategies to pass their genes from one generation to the next. Research your assigned organism and answer the questions below. Be prepared to share your responses with the rest of the class.


Questions

How does your assigned organism pass genes from one generation to the next? How is this different from sexual reproduction involving separate male and female individuals? Use a flowchart to demonstrate the life cycle of your organism on the whiteboard.

The Honeybee, has a Queen bee that is responsible for storing sperm and laying many eggs in each cell of the honey comb. Some of these eggs fertilize to become worker female bees, and others do not and they become male, drone bees, their purpose is to protect the hive. Female worker bees cannot fertilize, but they can give birth to more male, drone bees.

Propose a hypothesis to explain why sexual reproduction has evolved. (At least 20 have been suggested!)

Sex allows for a continuation of a species, and it’s a far simpler process than the processes of beings such as the Honeybee. The evolution of sex is important as it allows for a continuation of a species without killing the parents, thus insuring the kin is not left without a parent. Sex also increases the rate of genetic variation among siblings, thus speeding up the spread of beneficial traits and helping to eliminate bad mutations.

Can you propose an experiment to test your hypotheses?

We can set up trials of different animals mating, and document the differences in their reproduction process compared to the familiar human process of sexual reproduction.

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Part II: Why sex? video

Taken from NOVA PBS Documentary "Why Sex" (2:42-14:30)

Link to the video on YouTube

Why are Jerry Johnson and his team rounding up lizards?
These lizards have a different reproductive strategy, as they are all only females, yet they reproduce. Each baby lizard is a clone of their mother.

**Why is it strange that males exist? What percentage of genes do females pass to their offspring in asexual populations? What percentage of genes do females pass to their offspring in sexual populations?**

Cloning is very efficient and it raises the question of why men are necessary. 100% for asexual and 50% in sexual populations.

**Describe the fish system that Robert Vrijenhoek uses to study the advantages and disadvantages of sex.**

Many of these fish systems have abandoned sex as a reproductive tool.

**What causes black spot disease in guppies? What did Vrijenhoek observe about the frequency of disease in sexual and asexual populations?**

Asexual reproducers had more parasites than the sexual reproducers that live beside them.

**What is the Red Queen hypothesis?**

The theory that evolution does not stop at “perfection”, but rather continues to evolve. The moment any species stops evolving, it is doomed. Asexual reproducers are like a sitting target for complications such as parasites in the guppies.

**Why did sexual guppies suddenly show high rates of parasitism after a big drought?**

Sexual species were forced to start over, thus ridding their genetic variation and making them an easy target for the parasite.

**Why did Vrijenhoek move guppies from pools with high variation to pools with low variation?**

To allow for them to encounter a fresh start and reproduce to add in variation, thus diversifying the species all over again.

**What does Vrijenhoek say is the big advantage of sex?**

Genetic Variation makes them more unpredictable to predators such as parasites.

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**Part III: Is Sex Always Good?**

The German biologist August Weismann proposed an answer to the question of “Why sex?” He asserted that **sex increases genetic variation.** When two different individuals mate by joining their gametes together, they produce a brand new genetic mixture and this promotes evolutionary adaptation. This idea held sway for a hundred years until a couple of authors, George Williams and Maynard Smith, said, “Hold on. There are a couple of problems with this scenario.” Sex is not always good.

**Questions**

What are arguments that support asexual populations having an advantage over sexual populations?

Sometimes variation is not favorable, as sex can break up favorable combinations of alleles to it's offspring.

Also sex uses metabolic resources to attract mates. This uses up a lot of their time and energy in order to attract a mate.

Assume that a single female starts a population, and each female in a population can produce exactly two offspring. How many individuals would there be in a sexual population after four generations? How many individuals would there be in an asexual population after four generations?

Considering the numbers you calculated in the question above, what would to expect to happen to the relative proportion of sexual and asexual individuals over time? Why is this the case?
Can you design an experiment to test the hypothesis that asexual reproduction leads to a higher evolutionary fitness (i.e., leads to more progeny) than sexual reproduction? Think about the organisms discussed earlier in class. Would any be particularly useful in your experiment?

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**Part IV: Sex and Stress**

There is a snail that lives in New Zealand lakes that has both asexual and sexual individuals. Curtis Lively (currently at Indiana University) and his colleagues decided that the snails could be used to test the hypothesis that a changing or stressful environment would favor sexual reproduction—the logic being that if the environment changes, then variation (sexual reproduction) is a good thing; some of your offspring might have the right genetic constitution to survive. Here’s the situation the biologists found. The snails live in freshwater habitats and there are over a dozen worm parasites that attack them. The scientists reasoned that there might be a difference in the fitness of the asexual and sexual individuals in ponds where there were different degrees of parasitism. This is what they found: in ponds where there was a high degree of parasitism there was a much higher percentage (2.5 times more) of sexually reproducing individuals.

Describe the host-parasite interaction in the Red Queen hypothesis. When a host is able to fight off parasites effectively, what will happen to the frequency of that host type in the population? When a certain type of host increases in frequency in the population, how do the types of parasites in the population change?

Before carrying out the experiment, why did the scientists expect there would be a difference in fitness between sexual and asexual snails in ponds with different degrees of parasitism?

Are the data they obtained consistent with Weismann's hypothesis? Explain your thinking.

**Extension (potential extra credit)**

If your team finishes early or has extra time at the end of the class period, continue discussing what you learned today. This may also be filled out outside of class.

1. Write down any questions you have about the activity. Explore these questions using internet resources or your textbook and share what you find here.

2. Were you surprised by anything we did today?

3. Did you find any part of the activity particularly challenging?

4. Are there topics you think you now understand really well?