



## Biograph: [Something's Fishy!](#)

**Introduction:** Evolution is a change in genetic information in a *population* that is observed over many generations. Two important factors contribute to evolution:

- **genetic drift** - a process by which the genetic traits in a population change due to the *random* chance survival and reproduction of particular individuals; and
- **natural selection** - a process by which individuals with certain genetic traits are more likely to survive and pass on those traits to their offspring, making those traits more common in the population.

In this BioGraph Virtual Lab, you will observe how a population of fish in a pond changes over time. By the end of this activity, you will understand how random factors (genetic drift) and non-random factors (natural selection) contribute to evolution.

**The Simulation:** A pond is home to populations of fish and algae. In this, and all of the simulations you will run today, the algae, which the fish eat to gain energy\*, is not evenly distributed in the pond. It is clumped in various areas around the pond. The fish:

- gain energy when they eat the algae in the pond.
- lose (use) energy by swimming and reproducing.
- reproduce only when they have stored up enough energy.
- die if they run out of energy or if they get too old.
- produce offspring that are genetically identical to themselves.

\**Energy* is a term we use to represent what you gain when you eat. For example, energy is measured in *calories*. You need to use energy for movement, work and play, and for building strength and endurance. You also need energy from food to grow and mature into an adult.

**Experiment 1: Uniform Population of Fish in a Pond: Yellow Fish:** Observe a situation in which all the fish in the pond are uniform (exactly the same) in appearance and inherited traits. Click on the link in the title above or on the Quia website to get to the simulation.

🐟 Scroll to Webland (the black area with a green square in it), and make sure the Algae Clumpiness is set to 8. Click **Create Yellow Fish**. Look at the 'Algae Population' counter and the 'Yellow Fish' counter. The simulation should now be populated with 495 algae and 48 yellow fish.

🐟 Click **Run for 30**. Once the clock stops, record the number of yellow fish and the number of algae for this first trial in Table 1 on the worksheet. Then repeat (**Clear, Setup, Create Yellow Fish** and **Run for 30**) for Trials 2 and 3 and record your results and answer question #1 on the worksheet. ✍️

Remember, the yellow fish in the simulation are all *exactly* the same in terms of their inherited traits and their appearance. Every yellow fish (or 'agent' in the simulation) also follows the same instructions (also called 'procedures' in the simulation).

**"Under the Hood" Programming Fish Movement and Traits:** The movements and traits of the fish in the simulation have already been programmed for you, but you can learn how they were programmed by carefully examining the programming "blocks." First, let's look at *how the movement of the fish* has been programmed using blocks in StarLogo Nova.

- Click the “View Code” button
- Scroll all the way down to the bottom of your webpage, where the StarLogo Nova Workspace is located.
- Go to the **Fish** page by clicking the **Fish** tab. You should see something similar to the image on the right. Take a closer look at the green **while Run for 30 toggled** block.
- Answer questions #2 and 3 on the worksheet.



Now, let’s examine *how the fish get energy*. Look at the gray **on collision with Algae** block (located right below the green **while Run for 30 toggled** block). Answer question #4 on the worksheet.

Finally, let’s look at *how fish are lost from the population*. Look at the purple blocks inside the green **while Run toggled** block again. Answer question #5 on the worksheet.

**Experiment 2: Multi-Color Fish with Uniform Traits:** In the next simulation, the population is composed of fish of several different colors. As before, *all the fish, regardless of their color, have the same traits*. In this case, color is only a cosmetic difference and has no effect on the survival or reproduction of the fish.

- Scroll back up to the black simulation Webland with the fish.
- Make sure the “Algae Clumpiness” is set to 8.
- Click **Create Multi-Color Fish**. Look at the counters on the left side of Webland and record the starting number of each color of fish in the “Initial Number of Fish” column in Table 2 on the worksheet.

The simulation is programmed so that there are the same number of each color fish at the start. But remember, as in the last experiment, since the fish are born in slightly different places and move randomly, each fish has a slightly different life *even though they are genetically identical except for color*.

- Click **Run for 60** and observe the simulation as it runs.
- When the simulation stops, look at the fish counters again and record the numbers of each color of surviving fish in the **Run 1** column in the table on your worksheet. Repeat the procedure above for another run (**Clear, Setup, Create Multi-Color fish** to reset the simulation before you start the second run!). Fill out the **Run 2** column. Repeat the same procedure one more time and fill out the information in the **Run 3** column. Answer questions #6-8 and the CER box on the worksheet.

**Experiment 3: Multi-Color fish with Variable Traits (Different Reproductive Strategies):** In Experiments 1 and 2, we observed how the fish population changed when all the fish, regardless of their color, had the same genetic traits. In Experiment 3, the color of the fish will now represent a specific genetically determined trait: **Reproductive Strategy**. This trait is modeled by the amount of energy a fish must accumulate before it can reproduce. Each color fish must store up a different amount of energy in order to reproduce. The offspring of each color of fish are also born with different energy reserves. Look carefully at Table 3 to prepare yourself for Experiment 3.

**Table 3. Reproductive Strategies**

Reproductive Strategy	Color	Energy Units Needed to Reproduce	Energy Units Passed On To Offspring
Very Fast	Red	20	8
Moderate	Yellow	40	16
Slow	Turquoise	70	28
Very Slow	Magenta	100	40

- Discuss with your group and predict what will happen by answering questions #9-11 on the worksheet.

*Testing Your Hypothesis:*

-  Scroll back to Webland. Make sure the “Algae Clumpiness” is still set to 8.
-  Click **Create Multi-Trait Fish**. Look at the counters and record the initial number of each color fish in the “Initial number of fish” column of Table 4 on the worksheet.
-  Click **Run for 90** and observe. Enter data in the Run 1 column of Table 4.
-  Repeat the steps above two more times for a total of 3 runs. **Be sure to click “Setup” to clear the time cache.**

 Now, in Table 5 on your worksheet, rank which colors had the most survivors at 90 seconds by putting a 1 in the box of the color fish with the greatest number of survivors and a 2 and 3 for the runners-up. (If two or three colors are tied, they can share the same rank number.) Then answer questions #12-15 and the CER box.

**Conclusion:** Reflect on the simulation work you did by comparing and contrasting your observations from Experiments 2 (*Multi-Color Fish with Uniform Traits*) and Experiment 3 (*Multi-Color Fish with Variable Traits*) and completing the table on the worksheet.

**In-Class Evolution Activity Extensions**

**Experiment 4: Multi-Trait Fish in Spread-Out Algae Environment:** Under the conditions you have seen so far, algae have grown in clumps. You saw that some fish’s reproductive strategies were more successful than others’ in this pond environment. Now, we will make the algae grow evenly distributed across the pond instead of distributed in clumps. What will happen to the overall population of fish in the pond over time when the algae is evenly distributed? Answer questions #16 and 17 on the worksheet.

*Testing Your Hypothesis:*

-  Scroll back to Webland and set the “Algae Clumpiness” to **1**.
-  Click **Create Multi-Trait Fish**. Record the starting number of fish in Table 7 on the worksheet.
-  Click **Run for 90** and observe. Click **Run for 90** again without resetting the simulation (DO NOT click the Create button again). Has one color fish dominated the pond (killed most, or all, of the other colors of fish)? If not, click **Run for 90** a few more times until this occurs. It is likely that the clock will need to run to around 300 before this occurs. Record your observations in Table 7 on the worksheet. Repeat the run (click **Create Multi-Trait Fish**, then **Run**) once or twice more if you have time.

 In Table 8 on the worksheet, indicate the survival rankings of the colors of fish that survived by putting a 1 in the box of the color fish with the greatest number of survivors and a 2 and 3 for the runners-up. Answer questions #18-24