



## **P51™ Introduction to Fluorescence Lab**

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# **Glow Big or Glow Home**



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# Overview

This lab serves as an introduction to the phenomenon of fluorescence and its applications in biotechnology. It also provides an engaging framework to develop foundational lab skills such as micropipetting and estimating the concentration of a solute through a dilution series. Students will explore the properties of fluorescein, a commonly used indicator in biotechnology applications. By taking an inquiry-based approach, students will grow comfortable in the use of indicator molecules to answer experimental questions. Go fluorescein glow!

## TIME

45 MIN. + 45 MIN.  
 for lab activities for experimental planning and questions

## TECHNIQUES

Micropipetting  
 Fluorescence

## TOPICS

Concentration  
 Scientific notation  
 Fluorescence in biotechnology

## LEVEL



## At a glance



### Preparatory Activities (Instructor)

Dispense reagents and prepare equipment

⌚ 10 min.

### Class-time Activities (Students)

#### A. Estimating concentrations

⌚ 25 min.

#### B. Calculating the molecules to highlight a word

⌚ 20 min.



This lab consists of two investigations:

**Investigation A** leads students through the creation of a dilution series to estimate the concentration of an unknown.

**Investigation B** builds on Investigation A as students use the skills they developed to estimate the amount of fluorescein used when highlighting a word with a highlighter.

# Materials needed

This lab has been written and designed to be used in a classroom where students have access to a source of blue light illumination. Any blue light source in the 460-480 nm range can be used. P51™ Molecular Fluorescence Viewer is an effective, affordable option if you do not have other blue light illuminators in your classroom. Alternatively, you may use blueGel™. If doing so, make sure to remove the gel tray and buffer chamber and lay the tubes flat on the blue base. Using the Fold-a-View™ imaging hood may aid in seeing fluorescence in any brightly lit room and documenting it with a camera.

Supplied in Kit

Reagent	Volume included in kit	Amount needed per group	Storage	Checklist
Concentrated fluorescein	1200 µl	110 µl	4°C	
Phosphate buffer	5 ml	410 µl	4°C	
Unknown	250 µl	25 µl	4°C	

 Available at  
miniPCR.com

Equipment and supplies	Checklist
<b>200 µl strip-tubes:</b> 3 strips of 8 - 200 µl PCR tubes per group. 24 total strips.	
<b>Individual 200 µl tubes:</b> 4 tubes per group. 32 total tubes.	
<b>Microcentrifuge tubes:</b> 3 tubes for each group for distributing reagents. 24 total tubes.	
<b>P51™ Molecular Fluorescence Viewer or other blue light illuminator:</b> eg. blueGel™ or blueBox™ transilluminator.	
<b>Micropipettes</b> 2-20 µl: one per lab group. 20-200 µl: one for the teacher.	
<b>Disposable micropipette tips</b>	

## Other supplies

- Yellow or green fluorescent highlighter
- Camera or phone with photo capabilities for recording results
- Disposable laboratory gloves
- Protective eyewear
- Permanent marker (fine tip is preferable)
- Small beaker for material disposal



# Preparatory activities

The following activities can be carried out by the instructor ahead of class.

Suggested for 8 student groups (4 students per group).

Note: Reagents are stable at room temperature for at least 72 hours or during prep time. However, the Concentrated Fluorescein should be protected from light during storage.



Gloves and protective eyewear should be worn for the entirety of this lab.

- Aliquot reagents into labeled 1.7 ml microtubes. Each group will need the following reagents:

Concentrated Fluorescein	Label as “F”	110 $\mu$ l
Phosphate Buffer	Label as “B”	500 $\mu$ l
Unknown	Label as “U”	25 $\mu$ l

- Distribute strip tubes by group

Each group will need two 8-tube strips with caps.  
 One 8-tube strip will be used in the concentration investigation.  
 One 8-strip tube will be used if doing the highlighter concentration extension.  
 Each group will need 2 single 200  $\mu$ l tubes.

- Distribute aliquoted reagents to groups

## Check

**At the start of this experiment, every lab group should have:**

<b>110 <math>\mu</math>l Concentrated Fluorescein, labeled as “F”</b>
<b>500 <math>\mu</math>l Phosphate Buffer, labeled as “B”</b>
<b>25 <math>\mu</math>l Unknown, labeled as “U”</b>
<b>Two 8-tube strips with caps</b>
<b>2 single 200 <math>\mu</math>l tubes</b>
<b>One 2-20 <math>\mu</math>l micropipette</b>
<b>Micropipette tips</b>
<b>P51™ molecular fluorescence viewer or other blue light illuminator</b>



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- Investigation B: Calculating molecules	P.11



# Background and significance

## Fluorescence and biotechnology

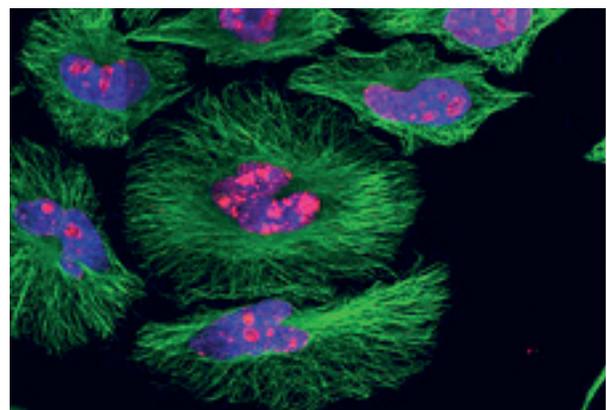
When you bring to mind something that is fluorescent, you probably think of a color so bright that it practically glows. In fact, things that are truly fluorescent actually do emit light. And light being a form of energy, that energy must be supplied from somewhere. Fluorescence is a phenomenon where energy is absorbed from one part of the electromagnetic spectrum and is then released as a different part of the electromagnetic spectrum—visible light. If you have ever seen things glow under a blacklight, you are familiar with the phenomenon of fluorescence. The blacklight emits ultraviolet light, a form of light that your eye cannot see. The fluorescent colors absorb that ultraviolet light and release it back out as brilliant greens, oranges, and other colors.



Different fluorescent solutions illuminated using UV light. Photo: Maxim Bilovitskiy  
*Creative Commons license CC 4.0*

Many organisms have evolved to use fluorescent molecules, especially marine organisms living relatively close to the surface of the water. People also regularly use them in everyday life. Highlighters use fluorescent molecules to make important words stand out to you. Fluorescent lightbulbs save energy and light up our buildings. Fluorescent dyes help plumbers find leaks.

In the biology laboratory, fluorescence is an incredibly important tool because it has afforded scientists a way to visualize structures that were previously invisible or indistinguishable. Fluorescent proteins, such as the green fluorescent protein (GFP) and red fluorescent protein (RFP) are regularly used to track happenings inside the cell by making otherwise invisible structures light up. Fluorescent molecules can also be attached to antibodies which will then bind to specific structures in the cell showing us their location, shape and structure. And because different fluorescent molecules absorb and release unique wavelengths of light, often several of these chemicals can be observed in the cell at the same time, leading to some of the incredibly bright and colorful pictures of cells that you may have seen before.



Cells grown in culture stained with three different fluorescent stains. Photo: Gerry Shaw  
*Creative Commons license CC 4.0*

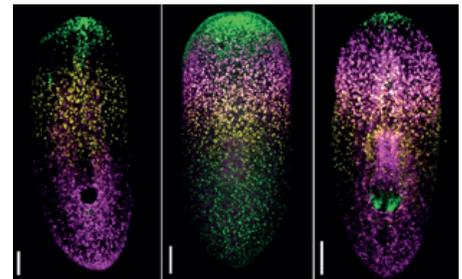


Different fluorescent dyes have been developed that bind to DNA. The most common use of such dyes is to see DNA on an agarose gel, but fluorescent dyes can also be used to quantify DNA. For example, in a process called quantitative PCR (qPCR), DNA molecules are copied and as each new copy is made, a fluorescent dye binds to the DNA. A light beam and optical sensor then record the relative brightness of the dye and tell you how much DNA you have made.

Fluorescence has the added benefits that it makes images that are often quite striking to look at and that it is generally safe to use. Previous to using fluorescence, the most common way of tagging molecules was using radioactivity. While radioactive probes are still sometimes used today, they are generally much more dangerous to handle and not nearly as fun to look at.

## What is fluorescence?

Fluorescence is emitted electromagnetic radiation that results from the release of energy after a substance is struck with electromagnetic radiation of a different wavelength. When a photon (particle of light) strikes an electron, it transfers energy to the electron, causing the electron to jump to an excited (higher energy) state. This excited state is unstable, so the electron eventually falls back to its lower energy state, known as the ground state. But the energy that the electron absorbed from the light must go somewhere. Some of this energy is distributed as heat, and then some may be emitted as electromagnetic radiation in the visible range—light. Because some electromagnetic radiation was lost as heat, the emitted radiation has less energy than when it was initially absorbed, which means the photon emitted will have a longer wavelength than the photon that was absorbed; this is called *Stokes shift*. Therefore, fluorescent substances give off light of a different color than they absorb.



Fluorescent *in situ* hybridization (FISH) image of planaria

Fluorescent molecules only absorb specific wavelengths of light, and then only let off (emit) specific wavelengths of light. This is what allows scientists to use multiple fluorescent molecules at the same time. For example, most green fluorescent proteins absorb blue light (480 nanometers, nm), and emit green light (509 nm), while a red fluorescent protein may absorb yellow light (580 nm) and emit reddish/orange light (610 nm). To make GFP fluoresce, the scientist must use a blue light and the appropriate filter. But under blue light the scientist will see a diminished response from the RFP. To see RFP fluoresce, the scientist must use a yellow light and appropriate filter, which will get a dimmer response from the GFP.



## Today's lab

In this lab, you will explore the basic uses of fluorescence in biotechnology. You will use the fluorescent dye fluorescein, a molecule commonly used in biological applications, to explore how fluorescence can be utilized as an indicator. First, you will establish the concentration of an unknown sample, much like how fluorescence is used in applications such as qPCR and DNA quantification. Second, you will measure the amount of fluorescein used in a common task, highlighting a word with a highlighter.

## Fluorescein - the basics

A bright, fluorescent molecule, fluorescein has been used in biological research, medicine, air rescue, and even plumbing. Having been first synthesized in 1871, we've been using fluorescein for a while. Fluorescein has been used by NASA to more easily spot spacecraft that splash down in the ocean upon return to Earth. For decades, plumbers have used fluorescein to find leaks in water systems. The city of Chicago even used fluorescein to dye the Chicago River green for their annual St. Patrick's Day celebration until they switched to more environmentally friendly dyes in the 1960s.

Fluorescein is also widely used in biotechnology applications. In some cases, fluorescein is attached to molecules so that we can visualize their location in a tissue or inside a cell. Sometimes it is attached to other molecules in a way that it requires a chemical reaction to release the fluorescein and allow it to fluoresce; thus specific enzymatic reactions can be tracked, seeing where and when the fluorescence occurs. Fluorescein can also be attached to probes used to detect specific macromolecules, such as nucleic acid probes used for in situ hybridization and antibodies used to detect proteins.

Fluorescein has a strong maximum absorption at 494 nm, which is seen as blue light, and maximum emission at 512 nm, which is seen as green light. This means that blue wavelengths of light will cause the most fluorescence and we will see that fluorescence as green. When using strong blue light, it helps to view your sample through an amber filter. Because amber absorbs blue light it will subtract out the background and allow the non-blue fluorescence to stand out.



The Gemini IV spacecraft releases fluorescein into the surrounding ocean so it can be more easily spotted by the recovery helicopter.



# Laboratory guide



Gloves and protective eyewear should be worn for the entirety of this lab

## Observation: Behold fluorescein

Observe a tube of diluted fluorescein compared to water.



- Take two individual 200  $\mu$ l tubes.
- Add 20  $\mu$ l Phosphate Buffer (labeled “B”) to each tube.
- Add 5  $\mu$ l Concentrated Fluorescein (labeled as “F”) to ONE of the tubes.
- Pipette up and down to mix the two liquids.
- Place tubes in P51™ or other blue light illuminator.
- Record your observations.

### Observations

**With Fluorescein**

**Without Fluorescein**

The “Without Fluorescein” tube can be considered a negative control. Why is it important to have a negative control? Why might just looking at one tube not give enough information?



# Investigation A: Estimating concentrations

## Making a dilution series

When investigating or establishing concentrations, scientists often make what is called a dilution series. A dilution series is a sequential dilution of a solution. This results in dilution factors increasing on an exponential scale instead of a linear scale. For example, if making a 10-fold dilution series, you might put 100 microliters ( $\mu\text{l}$ ) of your original solution in your first tube. You might then set up 7 more tubes, each with 90  $\mu\text{l}$  water. You would take 10  $\mu\text{l}$  of your original solution and add it to the 90  $\mu\text{l}$  in the second tube. This second tube is now  $1/10^{\text{th}}$  the concentration of the original solution. You would then take 10  $\mu\text{l}$  from tube 2 and dilute it in the next tube of 90  $\mu\text{l}$  of water. This third tube would have  $1/10^{\text{th}}$  the concentration of tube 2, and  $1/100^{\text{th}}$  the concentration of the original tube. To continue, you would take 10  $\mu\text{l}$  of this and add it to the 90  $\mu\text{l}$  of water in the next tube and so on. To make a 5-fold dilution series, you might take 20  $\mu\text{l}$  of your solution and add it to 80  $\mu\text{l}$  of water, then take 20  $\mu\text{l}$  of that solution and dilute it in your next tube of 80  $\mu\text{l}$  of water and so on and so on.

Fill in the remaining boxes in the table to establish how different dilution factors affect concentration. The fluorescein we will be using today is provided to you at a concentration of 50 nanograms (ng) per microliter.

	Tube	1	2	3	4	5	6	7	8
<b>10-fold series</b>	Dilution factor	1	10	100	1,000	10,000			
	Concentration	1	1/10	1/100	1/1,000				
	Amount of fluorescein	50 ng/ $\mu\text{l}$	5 ng/ $\mu\text{l}$	.5 ng/ $\mu\text{l}$					
<b>5-fold series</b>	Dilution Factor	1	5	25					
	Concentration	1	1/5						
	Amount of fluorescein	50 ng/ $\mu\text{l}$	10 ng/ $\mu\text{l}$						
<b>2-fold series</b>	Dilution factor	1	2	4					
	Concentration	1	1/2						
	Amount of fluorescein	50 ng/ $\mu\text{l}$							



**What might be the advantages of using a larger dilution factor, like in a 10-fold dilution series?**

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**Disadvantages?**

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**What might be the advantages of using a smaller dilution factor, like in a 2-fold dilution series?**

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**Disadvantages?**

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**What is the effect of always taking from the previous tube when creating a dilution series? For example, why not just add a smaller and smaller amount from your original stock solution to each tube?**

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## Estimating concentration

You have been given an unknown concentration of fluorescein, labeled “U”. Your job is to figure out how concentrated your unknown is.

1. Get a new strip of eight tubes.
  - Label the tubes 1-8.
2. Add 20 µl of your Unknown Concentration (labeled “U”) to tube 8 of your 8-tube strip.
3. Add 20 µl of your Concentrated Fluorescein (labeled “F”) to tube 1 of your 8-tube strip.
4. To view fluorescence, place the strip in the P51™ Viewer or other blue light illuminator and record your observations.

Your group must now decide on whether you would like to make a 10-fold, 5-fold or 2-fold dilution series.

### What fold dilution series will your group make?

### Why did you decide this?

## Make a dilution series

1. Follow the table below to create your dilutions series.
2. First, add the appropriate amount of Phosphate Buffer (labeled “B”) to tubes 2-7.
3. For tube 2, add the fluorescein solution from the original stock solution (tube “F”).
4. For tubes 3-7 add the solution from the previous tube.
5. Mix thoroughly before removing solution to add to the next tube in the dilution series.
  - To mix, pipette up and down repeatedly.

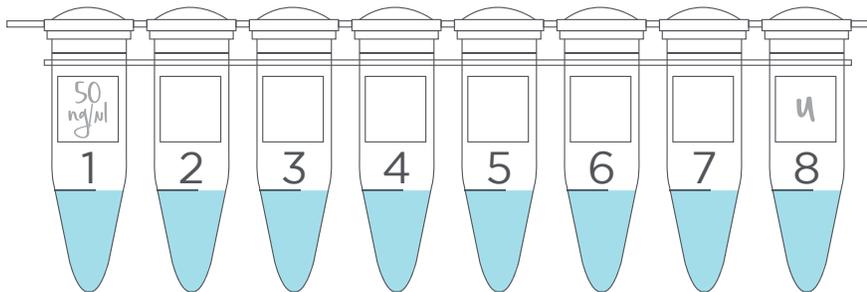
	Tube	2-7
<b>10-fold dilution series</b>	Volume of buffer added to each tube	18 µl
	Volume of fluorescein or liquid added from the previous tube	2 µl
<b>5-fold dilution series</b>	Volume of buffer added to each tube	20 µl
	Volume of fluorescein or liquid added from the previous tube	5 µl
<b>2-fold dilution series</b>	Volume of buffer added to each tube	20 µl
	Volume of fluorescein or liquid added from the previous tube	20 µl



**Through comparison, estimate the concentration of fluorescein in your unknown**

1. It may help to separate tube 8 from the other tubes.
2. Separate the other tubes where you think tube 8 will best fit in the sequence.
3. Put all 8 tubes in the illuminator in order.

In the graphic below, write the concentration of fluorescein that is in each tube.



Circle the tube that your unknown seems closest to. If it appears to be between two tubes, circle both tubes.

Approximate concentration of **unknown solution**: \_\_\_\_\_

**Were you able to estimate an approximate concentration using the dilution factor you chose?**

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**If you were to try this again, what dilution factor would you use? (It may help to compare your results to those from another group)**

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**Justify why you think the dilution factor you chose in the previous question is a good choice**

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Save this dilution series for Investigation B.



## Investigation B: Calculating molecules

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### How much fluorescein makes the word fluorescent fluoresce?

Highlighters can use a few different molecules to make them look very bright. One molecule that some highlighters use is fluorescein. For this investigation we will assume that the highlighter you are using contains fluorescein.

### Make a solution of fluorescein from a highlighted word

1. Use a fluorescent yellow/green highlighter.
2. On the right side of this page use a highlighter to highlight the word “Fluorescent”.
3. Use scissors to cut the highlighted word out of the paper.
4. Label a 200  $\mu$ l tube “H” for highlighter.
5. Put your cut out piece of paper into the tube. You will need to fold or roll the paper some to fit it in.
6. Add 100  $\mu$ l of Buffer to the tube. If you are using a 20  $\mu$ l micropipette you will need to add 20  $\mu$ l five times.
7. Close the lid and shake the tube well. Holding the tube with one hand and using a finger to flick the tube repeatedly works well. Or, just vigorously shake the tube repeatedly. Continue shaking for at least 30 seconds.
8. Shake all the liquid to the bottom of the tube by flicking your wrist.
9. Open the tube and remove the paper. You will likely need to use a pipette tip or something similar to fish the paper out, while making sure that the liquid stays in the tube.
10. Close the lid to your tube.


 Fluorescent



## Calculate the concentration of the highlighter fluid in solution

1. Compare this tube to your dilution series from Investigation A.

- Remove your old unknown from the dilution series. Twist and pull to break off the tube if needed.

2. Place your dilution series from Investigation A and your highlighter fluid extract in the P51™. Turn on the P51™ and view.

### Can you tell how concentrated your new solution is by comparing it to your original dilution series?

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### What can you do to make a solution that you can measure? Make a plan with your group and describe it here. You have buffer and an 8-tube strip to use how you see fit.

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Your teacher may want to approve your plan before proceeding.



## CER Table

### Question:

What is the concentration of your original tube of highlighter solution?

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### Claim

### Evidence

Provide data from the lab that supports your claim

### Reasoning

Explain clearly why the data you presented supports your claim.



## Practicing calculations with scientific notation

How many molecules of fluorescein made the word fluorescent fluoresce?

Important values for calculating:

- 1 nanogram (ng) is equal to  $10^{-9}$  grams (g).
- 1 microliter ( $\mu$ l) is equal to  $10^{-6}$  liters (l).
- The mass of a single molecule of fluorescein is  $5.5166 \times 10^{-22}$  g.

Metric prefixes for small numbers		
mili (m)	$10^{-3}$	0.001
micro ( $\mu$ )	$10^{-6}$	0.000001
nano (n)	$10^{-9}$	0.000000001
pico (p)	$10^{-12}$	0.000000000001

Using the concentration you calculated for your highlighter solution, can you calculate approximately how many molecules of fluorescein you used when you highlighted the word fluorescent?

The concentration of my highlighter solution is \_\_\_\_\_ (from previous page)

**Knowing the concentration of your solution and the mass of one molecule of fluorescein, how many molecules are in one microliter of your solution? Use the space provided to show your work.**

**How many total molecules were in your original 100  $\mu$ l of solution? Use the space provided to show your work.**

I used \_\_\_\_\_ molecules of fluorescein to make fluorescent fluoresce!



# Additional Student Supports and Extension Activities

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# Overview

## Additional supports

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Students performing this lab should have some basic experience using a micropipette. Importantly, this lab asks students to mix two liquids using a pipette. Inability to mix liquids well will result in inaccurate dilution series. We recommend having students practice this in advance. Mixing different colors of food coloring is a good advance practice activity. For one such set of activities, please visit [www.minipcr.com/micropipetting](http://www.minipcr.com/micropipetting)

## Extension activities

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The extension activities described below are included in the Instructor's Guide only.

### 1. Measure the number of molecules in a highlighter.

This activity builds on Investigation B. Instead of extracting the highlighter fluid from paper, try pulling a highlighter apart and measure the concentration of highlighter fluid directly.

### 2. Uses of fluorescence in biotechnology

Fluorescein is a molecule that is regularly used in scientific investigations. Scientists use many different fluorescent molecules in many different protocols and applications. Have students investigate ways that fluorescence is used and report back to the class with a mini presentation. Suggested topics and resources



# Extension 1: Measure the concentration of fluorescent dye in a highlighter

## Can you estimate the concentration of fluorescein that is used in a highlighter?

Green/yellow highlighters can use a few different fluorescent molecules to make the color in the highlighter stand out. Fluorescein is one of the common dyes used; for this exercise, use any bright yellow/green highlighter and assume the fluorescent molecule being used is fluorescein.

You will likely need to destroy one highlighter for this activity. Depending on the highlighter construction and your care in disassembling it, the highlighter may be reassembled and still be usable.



Wear gloves during this activity and be careful not to stain clothing or other objects.

### Directions

1. Pull the ink reservoir out of a highlighter.
2. Wearing gloves, squeeze the end of the highlighter reservoir into a 1.7 ml tube so that there is at least 25  $\mu\text{l}$  of fluid in the tube (200  $\mu\text{l}$  if doing for the entire class).
3. Put 20  $\mu\text{l}$  of highlighter fluid in the first tube of a dilution series.
4. Create a dilution series using phosphate buffer and highlighter fluid. 5-fold dilution series tends to work well.
5. View your dilution series in P51™ or other blue light illuminator. Decide which tube is within the fluorescent range of the dilution series you made in Investigation A. Compare the brightness of that tube to your dilution series to estimate the concentration of fluorescein.
6. Using the estimated concentration of that one tube, calculate the concentration of fluorescein in the original undiluted sample of highlighter fluid.

### Procedure and results

1. I did a \_\_\_-fold dilution series.
2. The tube of diluted highlighter that best matches a tube from my known dilution series was diluted \_\_\_ times compared to the original highlighter fluid.
3. By comparing this tube to my known dilution series, I estimate that my diluted tube of highlighter fluid has an approximate concentration of \_\_\_\_\_.
4. This means that my original tube of highlighter fluid should have a fluorescein concentration of about \_\_\_\_\_.



## Extension 2: Uses of fluorescence in biotechnology

This lab serves as an introduction to the phenomenon of fluorescence and some of its basic uses in the biological laboratory. As discussed in the background information, fluorescence has many uses. Below are listed some of the common procedures that use fluorescence.

Dye-based DNA quantification  
Droplet digital PCR\*  
Fluorescence proteins  
Fluorescent immunostaining

FISH (fluorescent *in situ* hybridization)  
Microarrays  
Next generation DNA sequencing\*  
qPCR (quantitative PCR)\*

Choose one of the above procedures and research how it is used. Prepare a short presentation to teach your classmates about how your procedure is used.

Your presentation should address the following points:

1. What is this procedure used for?
2. Outline the steps used in this experiment.
3. What is the role of fluorescence in this technique?
4. Is there a way to do this procedure without fluorescence, or is there a related procedure that does not use fluorescence?
5. Are there any particularly interesting or notable uses of this technology?

\*Procedures marked with an asterisk can be read about in DNAdots™ - simple explanations of modern genetic technologies, a free resource provided by miniPCR bio. Find more information at [dnadots.minipcr.com](http://dnadots.minipcr.com).





# Teacher's Notes

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# Teacher's notes and placement in unit

## Teacher's notes

This lab serves as an introduction to fluorescence in the laboratory and as an excellent activity to introduce students to making solutions by pipetting. This lab can be performed with any 460-480 nm blue light illumination system, but has been written to be performed with **P51™ Molecular Viewers**. P51™ is a small, handheld, affordable blue light illuminator designed with classroom use in mind. Ordering information is included in the link below.  
<https://www.minipcr.com/product/p51-molecular-glow-lab/>

## Placement in unit

### Scientific notation

This lab requires students to work with numbers that vary greatly in order of magnitude. Calculating the number of molecules used when highlighting a word gives students a real and authentic example of how scientific notation is useful in working with both very small and large numbers.

### Biology or biotechnology

Use this lab as an introduction to fluorescence in the laboratory. Once students have gained confidence making dilutions and calculating concentrations, go on to perform P51™ Enzyme Lab, P51™ DNA Glow Lab, P51™ Enzyme Lab, or any lab that requires pipetting and calculating dilutions.



# Learning goals and skills developed

## Student Learning Goals – students will be able to:

- Create a dilution series
- Establish concentration of an unknown sample
- Calculate the total number of molecules in a solution

## Scientific Inquiry Skills – students will:

- Understand the physicochemical basis of fluorescence
- Create hypotheses and make predictions about results
- Compare experimental results to their predictions
- Make conclusions based on their experimental results about their hypothesis

## Molecular Biology Skills:

- Micropipetting
- Use of fluorescence as an indicator
- Measuring concentration



# Standards alignment

## Next Generation Science and Engineering Practices

- Asking questions
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

## Common Core English Language Arts Standards:

<b>WHST.9-12.2</b>	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
<b>WHST.9-12.9</b>	Draw evidence from informational texts to support analysis, reflection, and research.
<b>RST.9-10.3</b>	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text
<b>RST.9-10.7</b>	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) in words.
<b>RST.11-12.7</b>	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.



# Ordering information

To order P51™ Introduction to Fluorescence Lab or other lab kits:



Call (781)-990-8PCR



email us at [orders@minipcr.com](mailto:orders@minipcr.com)



visit [www.minipcr.com](http://www.minipcr.com)

**P51™ Introduction to Fluorescence Lab (KT-1900-04) contains the following reagents:**

- Concentrated Fluorescein
- Phosphate Buffer
- Unknown Sample
- 1.7 ml microcentrifuge tubes
- PCR strip tubes
- Individual 200 µl tubes

Materials are sufficient for 8 lab groups, or 32 students

All components should be kept refrigerated at 4°C for long-term storage

Reagents must be used within 12 months of shipment



# About miniPCR bio Learning Labs™

This Learning Lab was developed by the miniPCR bio™ curriculum team in an effort to help more students understand concepts in molecular biology and to gain hands-on experience in real biology and biotechnology experimentation.

We believe, based on our direct involvement working in educational settings, that it is possible for these experiences to have a real impact in students' lives. Our goal is to increase everyone's love of DNA science, scientific inquiry, and STEM. We develop miniPCR Learning Labs™ to help achieve these goals, working closely with educators, students, academic researchers, and others committed to science education.

The guiding premise for this lab is that a 45-minute dilution series experiment can recapitulate a real-life biotechnology application and provide the right balance between intellectual engagement, inquiry, and discussion.

Starting on a modest scale working with Massachusetts public schools, miniPCR bio Learning Labs™ have been well received, and their use is growing rapidly through academic and outreach collaborations across the world.