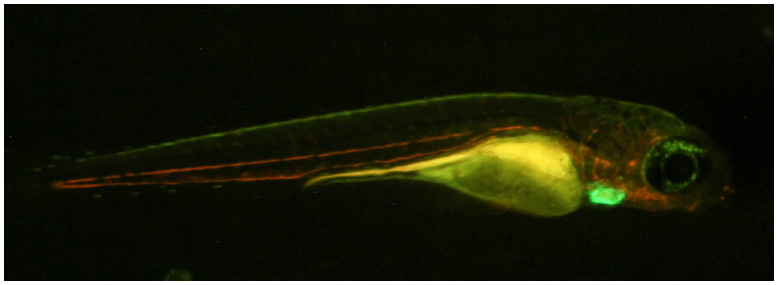
NIGHTSEA

bringing fluorescence to light™

Stereo Microscope Fluorescence Adapter

Applications in Biology Laboratory Education



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Harvard University

Audience - Undergraduates, primarily freshmen. A second semester introductory science course

Life Sciences 1b

An Integrated Introduction to the Life Sciences: Genetics, Genomics, and Evolution

Course description:

How are observable characteristics of organisms influenced by genetics? How do genomes change over time to produce the differences we see among species? This course takes an integrated approach, showing how genetics and evolution are intimately related, together explaining the patterns of genetic variation we see in nature, and how genomics can be used to analyze variation. In covering Mendelian genetics, quantitative genetics, and population genetics, this course will emphasize developments involving our own species.

Role of fluorescence

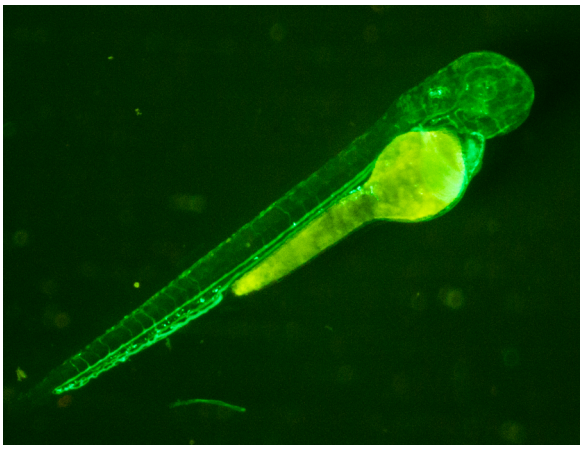
Used early in the semester in a lab to show how gene expression is regulated, using reporter genes

Visualize expression – more concrete, less theoretical

Used to have students take pictures, but now have them draw their observations. E.g. – sketch of worm, draw in the expression pattern

Lesson sinks in better

Understand technology of GFP



Model organisms

Zebrafish – in dishes

C. elegans – on slides

Fluorophore

GFP in different cell types

Fish – red blood cells, neurons

Worm – head, muscles

Microscopes

Zebrafish – stereo microscopes

Worms – Olympus CH-2 compound microscope

Benefit of SFA

An enabling technology for bringing fluorescent zebrafish into the lab with stereo microscopes

Easier to work with worms than with previous illumination technology

Better light source intensity

Colgate University

Audience - Undergraduates

Developmental Biology Laboratory

Visualize effects of pharmacological agents on zebrafish embryo development

Role of fluorescence

Directly observe the transgene (GFP) expression, solidifying the students' understanding of the phenotypes they were observing

Monitor development to determine an optimal time to fix their fish for analysis under the compound microscope

Model organisms

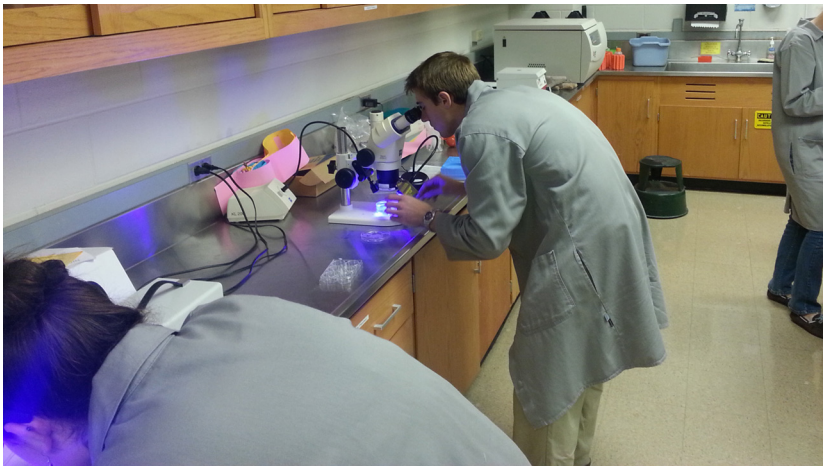
Zebrafish

Fluorophore

GFP in nervous system or vasculature

From the professor –

"The NIGHTSEA system easily adapted to our dissection scopes. For quick screens it actually worked perfectly well in a bright room. For more intimate looking (more than presence/absence calls), we turned out the room lights. Worked better than I'd hoped it would :)"



Boston University

Audience - Seniors and first year Master's

CAS BI 513

Genetics Laboratory

Course description:

Genetic techniques such as mutant selection and screening, complementation, mapping, recombinant DNA, and chemical genetic screening are taught using the genetic model systems *Escherichia coli*, *Saccharomyces cerevisiae*, and *Arabidopsis thaliana*. Short-term and long-term projects in which students formulate and test hypotheses.

Role of fluorescence

Students create their own transgenic plant line, with GFP as the reporter

Learn about growth, selection, gene expression differences

Understand technology of GFP

Model organisms

Arabidopsis thaliana (small flowering plant that is widely used as a model organism in plant biology)

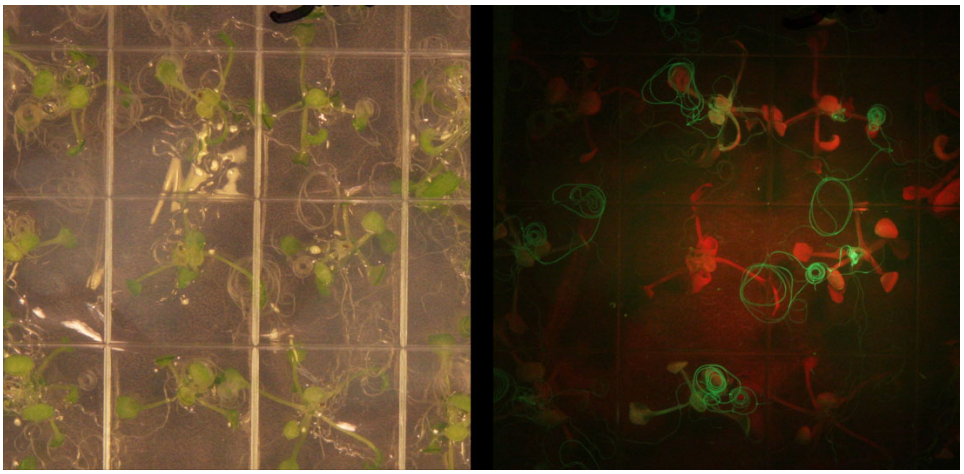
Fluorophore

GFP

Benefit of SFA

Able to use existing teaching lab microscopes

Convenient for dissection



Harvard University

Audience – Grades 9 - 12

Life Sciences Outreach Program
http://outreach.mcb.harvard.edu/

Background info

The goal of this program is to support high school biology education using the many resources at Harvard University. It is hosted by The Division of Science in conjunction with FAS (Faculty of Arts and Sciences). Life Sciences Outreach invites high school biology classes and their teachers into Harvard's undergraduate biology teaching laboratories each spring. Graduate students and post-doctoral fellows lead the laboratories in conjunction with the classroom teachers.

Each spring the progam serves > 700 students from public, private, parochial, and charter schools in MA, NH, RI, ME.

The labs are 3 hours long and use equipment in existing teaching labs.

Students physically draw their observations to reinforce the lesson.

Goals

Generate enthusiasm for science and expose students to techniques and careers in science

Role of fluorescence

<u>*C. elegans* as a Model Organism:</u>

Students learn about the use of reporter genes in studying gene expression in the nematode, *C. elegans*. They analyze mutants and identify wild type versus mutant *C. elegans* based on a behavioral response. They also examine fluorescently labeled samples and discuss the applications of this important microscopy technique.

<u>Zebrafish Embryology:</u>

Students study the fertilization and development of zebrafish, an important model organism. They learn how to stain zebrafish in order to distinguish between mutant and wild type embryos based upon structural differences.

<u>Plant Physiology:</u>

Students learn current methods used to understand the movement of carbon from the atmosphere into a plant. Specific techniques include visualizing the parts of plants that allow for transport of carbohydrates using fluorescent dyes and microscopy.

Coleus, cucumber (*Cucumis sativus*)
Fluorescent dye (CFDA, carboxyfluorescein diacetate) to trace movement of carbon

Benefit of NIGHTSEA SFA

Enabling technology to add the fluorescent component. Previously the only option was an expensive microscope that did not provide a hands-on experience. Fluorescence is now accessible on multiple microscopes, and the system has proved immune to inexperienced student handling.

Student reactions

"They love it! Excitement in seeing a glowing worm moving."

Coastal Marine Biolabs, Ventura, CA

Audience – High school students

Program description

"Involve high school students in authentic and hands-on scientific work conducted within a dynamic and interactive environment that is specifically designed to emulate a graduate school learning setting. By pursuing scientific questions within an authentic research environment, students gain an appreciation for the daily practice of science and a realistic understanding of what scientists do and how they do it. Our goal is not to inspire every student to pursue scientific careers. Instead, we join a growing alliance of academicians who use the process of scientific inquiry as a tool to foster scientific habits of mind (critical and creative thinking, collaboration, strong communication skills) that will empower our students to become more rational and responsible citizens, environmental stewards, and our next generation of leaders and innovators."

Integrated, fluorescence-centric approach

Collect naturally fluorescent subjects from the marine environment
Corynactis californica, a small colonial anthozoan

Clone the genes encoding both yellow and green fluorescent proteins

Deliver the genes into specific subsets of embryonic chick spinal cord neurons using a gene transfer technique called in ovo electroporation

Organisms

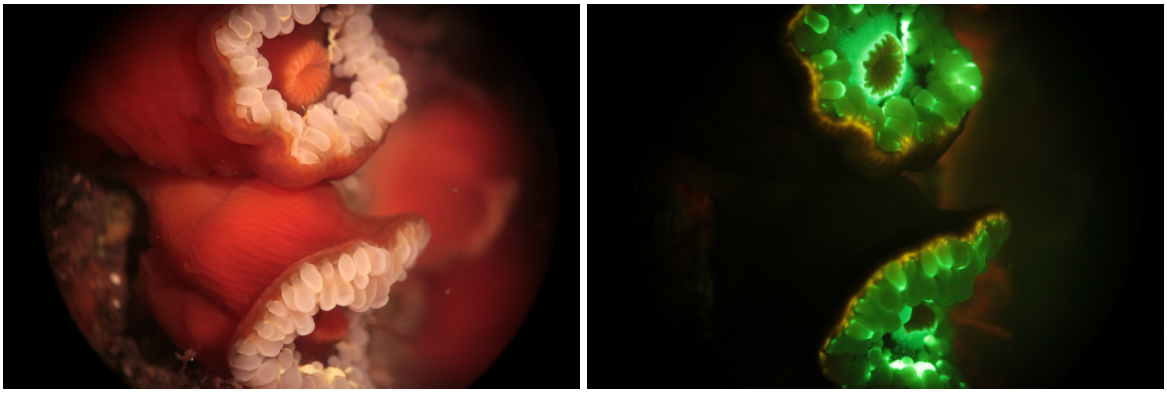
Anthozoan (corallimorpharian) *Corynactis californica*

Chick embryos

Fluorophore

Naturally occurring marine fluorescent proteins

http://www.coastalmarinebiolabs.org



Smith College, Dr. Michael Barresi

Audience – middle school students

General description

Outreach program, bringing science into middle schools. Coordinates with teachers to fit into state teaching goals. Students raise and study zebrafish.

Role of fluorescence

Transgenic zebrafish to view development and expression, and illustrate principles of genetics

Model organism

Zebrafish (*Dania rerio*)

Fluorophore

GFP, expressing in the heart

Benefit of SFA

Easily transportable fluorescence capability

Video about the project

http://videos.masslive.com/republican/2013/01/zebrafish_project.html

spectrUM Discovery Area, University of Montana, http://spectrum.umt.edu

Audience – K - 12

General description

K-12 education at locations on UM campus, in downtown Missoula, and via mobile Montana spectrUM Science Experience (MosSE). Exhibits have been designed around state standards and center around topics such as neuroscience, nanotechnology, motion, health sciences, urban ecology, river dynamics, and much more.

BrainZone

Interactive activities for kids of all ages to explore neuroscience. Experiments range from dissecting a sheep brain, to experimenting with optogenetics in which light is used to activate different brain circuits, to competing in a game involving donning a headset that will read their brain's alpha waves and move a ball.

Role of fluorescence

Transgenic *Drosophila* supplied by UM neuroscientists, to view development and expression, and illustrate genetics.

Model organisms

Drosophila melanogaster

Fluorophore

GFP, expressing in different parts of the body

Benefit of SFA

Use available inexpensive stereo microscope and provide an illumination system that will stand up to youth handling.