MICROSCOPES as HIGH TECH TEACHING TOOLS in ANIMAL DEVELOPMENTAL BIOLOGY (ZOOLOGY 303)

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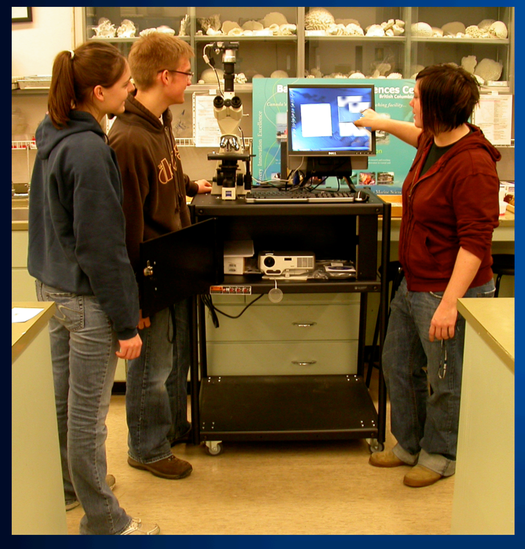
Introduction

In the biological sciences, microscopy has long been a tool for visualizing tiny objects. Teaching concepts or creating learning events that involve the microscope has been challenging, especially demonstrating events in real time. The equipment was costly, clumsy or just could not do the job. With the advent of digital technology and the worldwide web, resource libraries of images became available for describing and relating structures and ideas. However, these remain static. The teacher or student gains much more skill, satisfaction and knowledge with a first hand experience. More recently the technology associated with microscopes, digital imaging and LCD projectors has been integrated into a portable mobile unit to provide a first hand experience, in real time. We call this configuration "the microscopy tool kit." Streamed live events can be projected and viewed by large audiences. In Zoology 303, students are expected to do more, and curricula is being developed that use live organisms, life processes and dissections to provide virtual teaching support. The "tool kit" is used not only for teaching demonstrations but also in generating data that students use in scientific publication level lab reports.

Microscopy Tool Kit

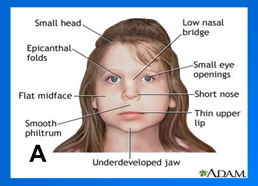


Graduate student teacher, Rheanna Sand, with students Jessica Mewis and Michael Zabrodski using the "tool kit" to display a concept and demonstrating how to use this hands-on technology. The microscope, rolling cart, computer and projector are shown.

Microscopy Tool Kit and Student Lab Experiences

Example: Alcohol-Induced Teratogenesis in Fish Embryos

SIGNIFICANCE. During development, environmental factors can impact formation of the embryo or fetus and in some cases, cause abnormalities. These exogenous factors can be chemicals, viruses, etc., and are generally termed teratogens. Teratogens can affect development directly, or indirectly by impacting the timing or elimination of expression of certain genes. In today's society, ethanol is the most significant teratogen in humans. Ethanol impacts development of the fetus that is manifested in a number of recognizable morphological features, collectively referred to as fetal alcohol syndrome (FAS). Usually, only small quantities need be present, and at a critical stage, ethanol can result in cell death, offspring with a smaller than normal brain, and recognizable facial features of a narrow lip and low nose bridge. FAS children are mentally challenged.



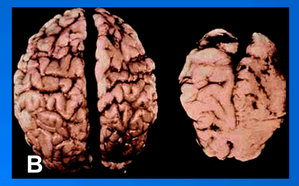
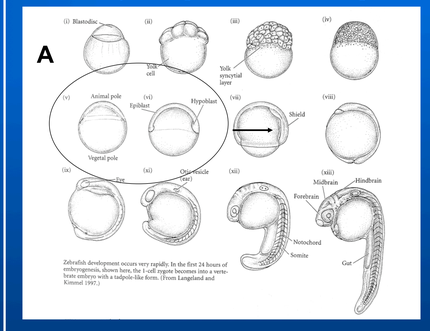
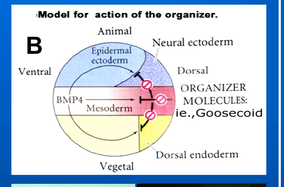
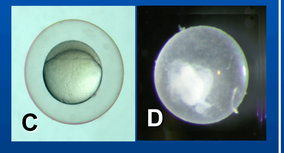


Figure: A, Facial features of FAS; B, Brain of a normal (left) and an FAS (right) child.

OBJECTIVE. The embryonic development of the zebrafish, *Danio rerio*, is affected by ethanol in a manner similar to the higher vertebrates and has been considered a suitable model for studying FAS. The purpose of this lab was to do an experiment to determine the effects of ethanol on the development of zebrafish embryos and potentially relate the deformities to FAS. Results were visualized by observing and recording the physical abnormalities in the developing embryos using microscopy. Students were required to write a lab report using their own data and images collected using the tool kit.

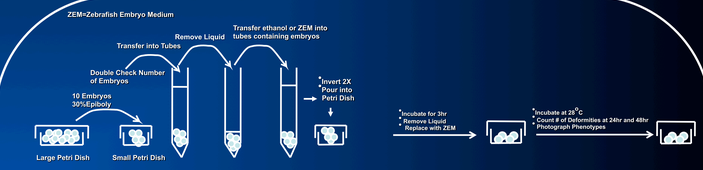






BACKGROUND. In order to understand how the deformities arise it is necessary to know some of the embryology of the zebrafish. During gastrulation, or formation of the three germ layers (ectoderm forms skin, nervous system; mesoderm forms muscle, cartilage; endoderm forms gut, liver) cells begin dividing and moving to cover the top third of the embryo in a process known as epiboly (circled in Figure A). Cells from areas known as the epiblast and hypoblast converge to form the "shield" (arrow in A), which will organize the tissue layers of the embryo. Although little is known about the mechanisms underlying the deformities, it is at this stage and therefore very early in the organization of the head end of the embryo that disruptions occur. Ethanol may change the movements of cells, kill cells or cause some genes, such as goosecoid (Figure B) to be expressed in regions other than normal. Changes in cell movements, cell death, and abnormal gene expression causes changes in facial features, cyclopia or embryonic death.

THE EXPERIMENT. This experiment seeks to determine the effects of ethanol on zebrafish development. The 30% epiboly stage, the stage just prior to gastrulation is used to ensure that ethanol will affect cell movements before they occur. The microscopy tool kit was used to show students the exact stage they should be selecting (Figure C). Students are made aware of what a dead embryo looks like (Figure D) when collecting data.



PROCEDURE. A mosaic of embryonic stages were provided to students in large Petri dishes and incubated at 28˚C along with the solutions used. The microscopy tool kit was used to project images of the 30% epiboly stage so only this stage was chosen for the experiment. They also needed to be aware of cloudy or ruptured embryos, as these are dead, so these were projected as well.

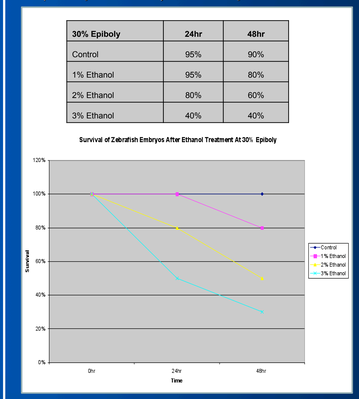
1. Ten embryos were selected for each treatment and transferred into smaller Petri dishes. The embryos were then pipetted with a minimal amount of fluid into 15 ml centrifuge tubes containing ZEM. This was to restrict the contaminants entering the cultures from the spawning process. The fluid was removed.

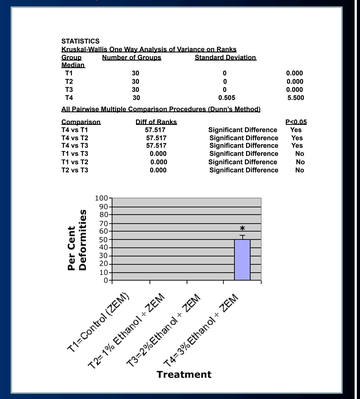
2. Embryos were then treated with one of four different treatment solutions (ZEM, ZEM containing 1%, 2%, and 3% ethanol). These were inverted twice to ensure mixing.

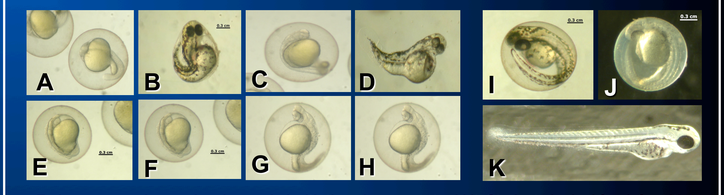
3. The subsequent solution and embryos were relocated to Petri dishes and incubated for 3hr at 28˚C. The number of embryos with abnormalities were counted every 24 hours for two days.

RECORDING RESULTS. Students were required to observe and record the number of deformities and dead embryos at 24 and 48hr intervals. They then graphed their data (examples below) and interpreted their results in the lab report.

30% Epiboly	24hr	48hr
Control	95%	90%
1% Ethanol	95%	80%
2% Ethanol	80%	60%
3% Ethanol	40%	40%







Embryos were observed and recorded with the microscopy tool kit. Students looked for deformities in the eyes (cyclopia), trunk or tail (smaller or shorter embryos). Embryos often displayed abridged development so the students were directed to compare the morphology in the experimental treatments to the controls (wild type). The results were photographed for each of the trials and after 24 and 48 hours; the digital images were stored on memory sticks so the students could take away the information to be used in their lab reports.. Some of the deformed phenotypes (A to H) and wild type (I to K) are shown above.

SUMMARY. Because we are working with live, 3-dimensional organisms, the animal can be viewed and demonstrated easily with the "tool kit". The entire class can view any or all aspects of what one feels is important. Techniques can be demonstrated while showing important live structures or processes, in contrast to static images. Further, students can take away their own data as compared to "canned" information. Finally, having the material at hand lends itself to immediate direct quantitative analysis as compared to more limited qualitative observations.