Kirsten Miles
P.I. Outcomes

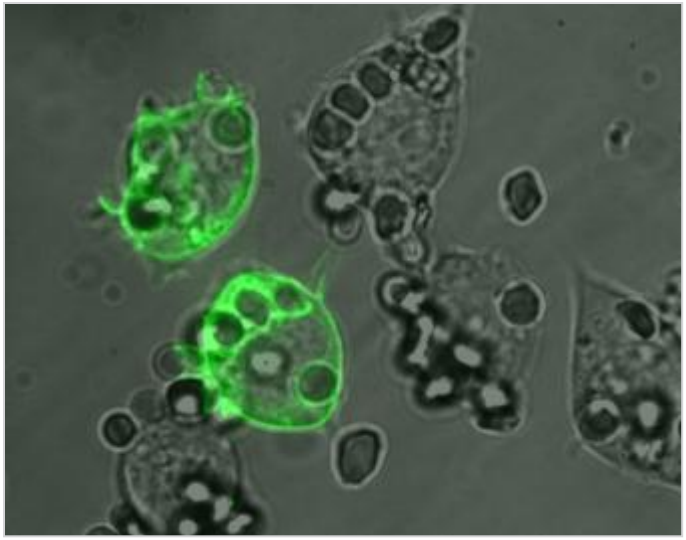
Integrity of Science Image Data Issues and emerging standards

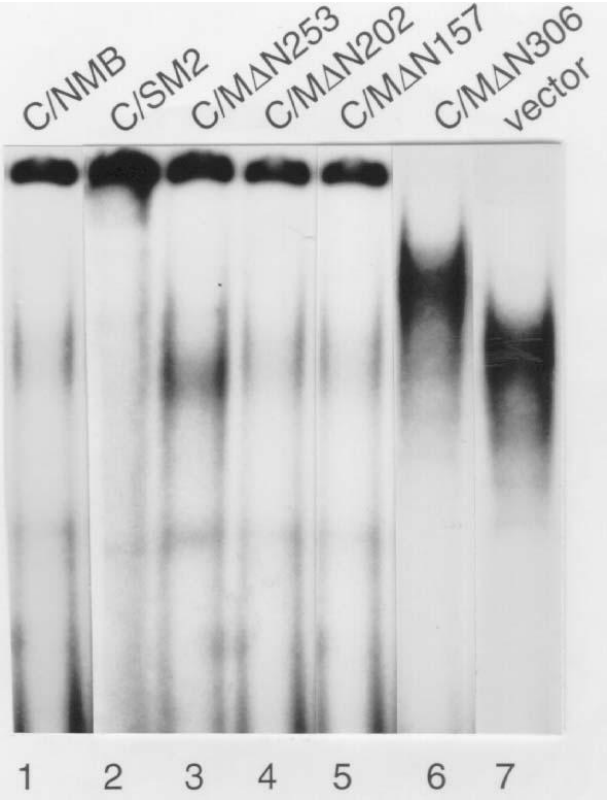
Special thanks to:

- **Robert A. Bloodgood, PhD**, Professor, Department of Cell Biology, SOM
- **Addeane S. Caelleigh**, UVA School of Medicine, Curriculum Design
- **Sherry Lake,** Metadata Specialist, Charles L. Brown Science and Engineering Library
- **Jan A. Redick, CEMT**, Associate Director, Advanced Microscopy Facility, SOM
- **John Krueger, PhD**, U.S. Office of Research Integrity
- **David Castle, PhD,** Cell Biology, UVA
- for sharing their valuable experience

  and digital images

Data – images in Biomed





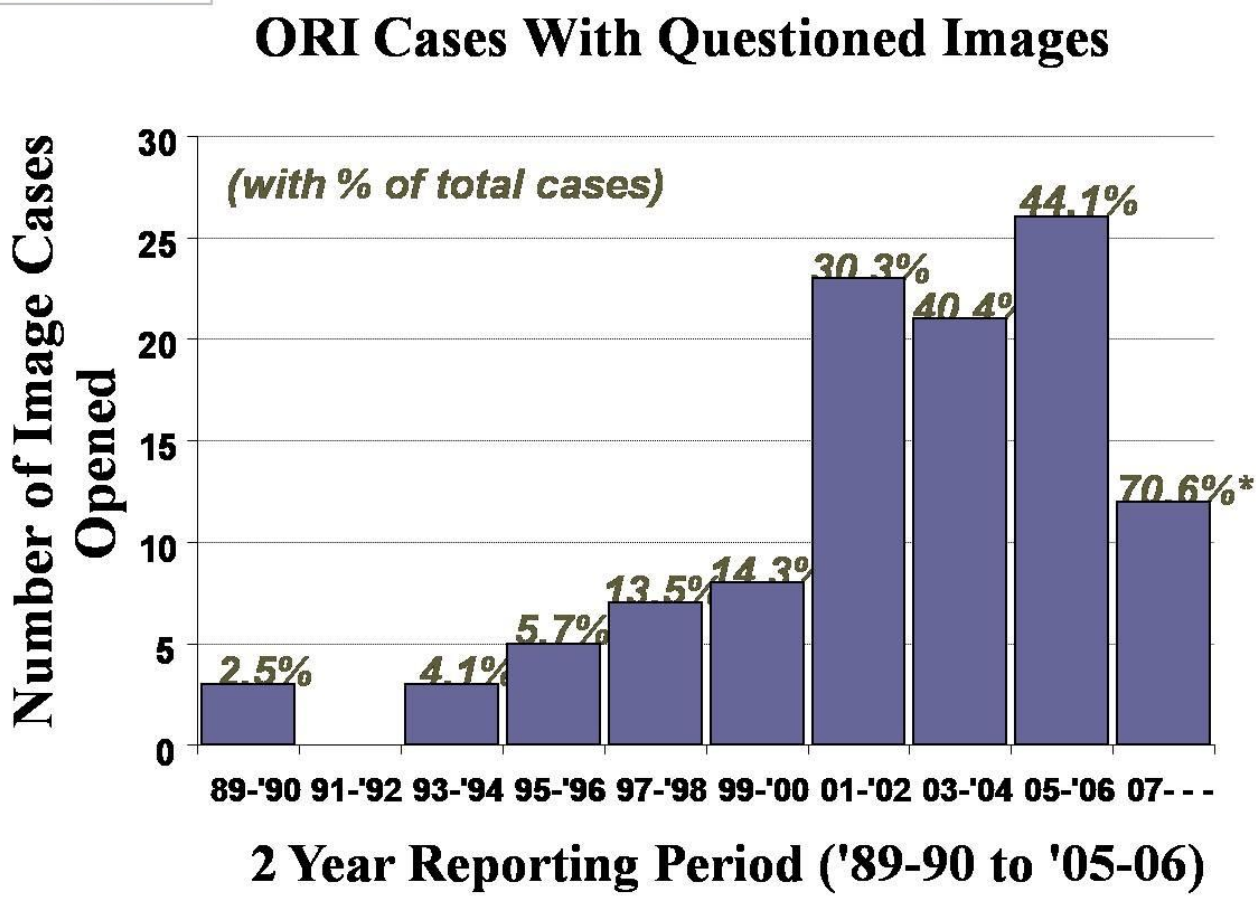
Images as data or illustrations?

Today's Outline

- Images as Data
- What do you need to know?
- What issues are unique to data images?
- What can you do to maintain the integrity of your work?

Technology and Transitions

Why Images?



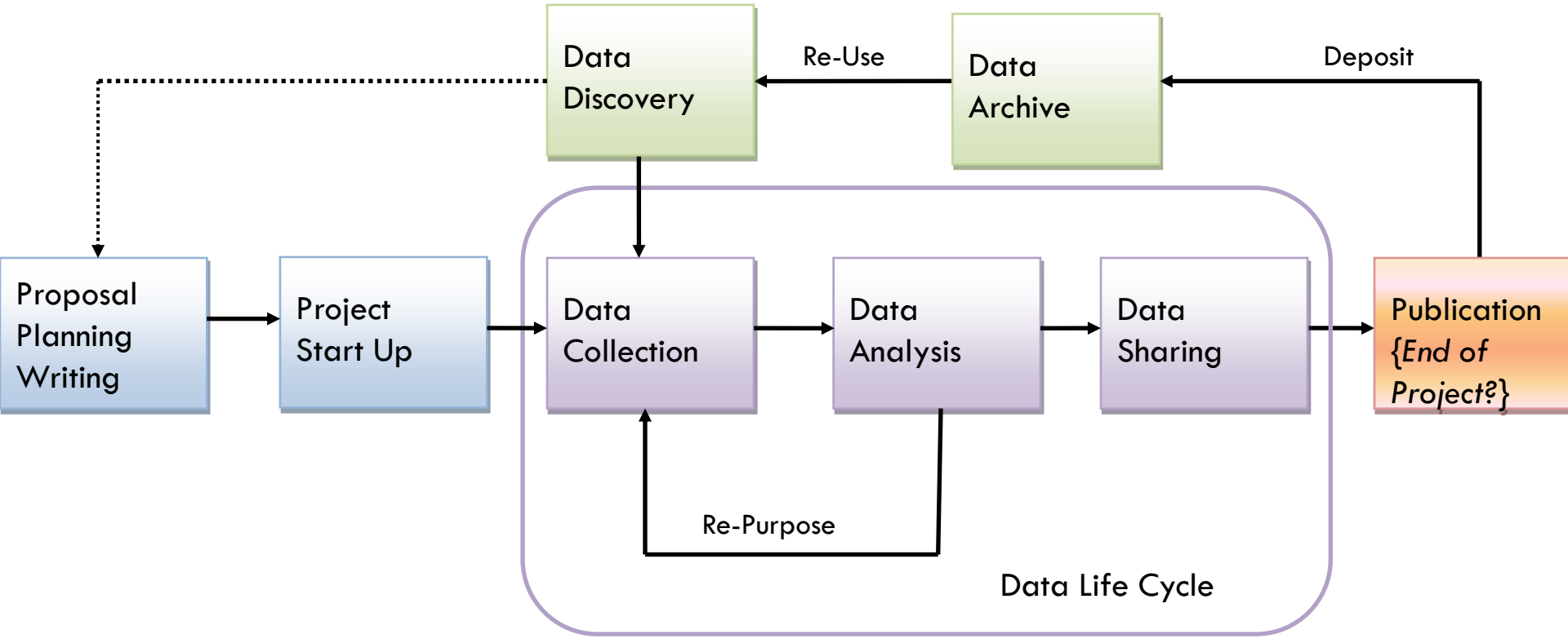
Slide: John Krueger, PhD, Scientist-Investigator, ORI
(from slide presentation at Uniformed Services University, July 23, 2008).

From the Microscope to the Journal, Maintaining Image Data Integrity

Who looks at your data, and when?

The Research process - Your eye
The Editorial process - The editor's eye
The ultimate editor - The Reader's eye

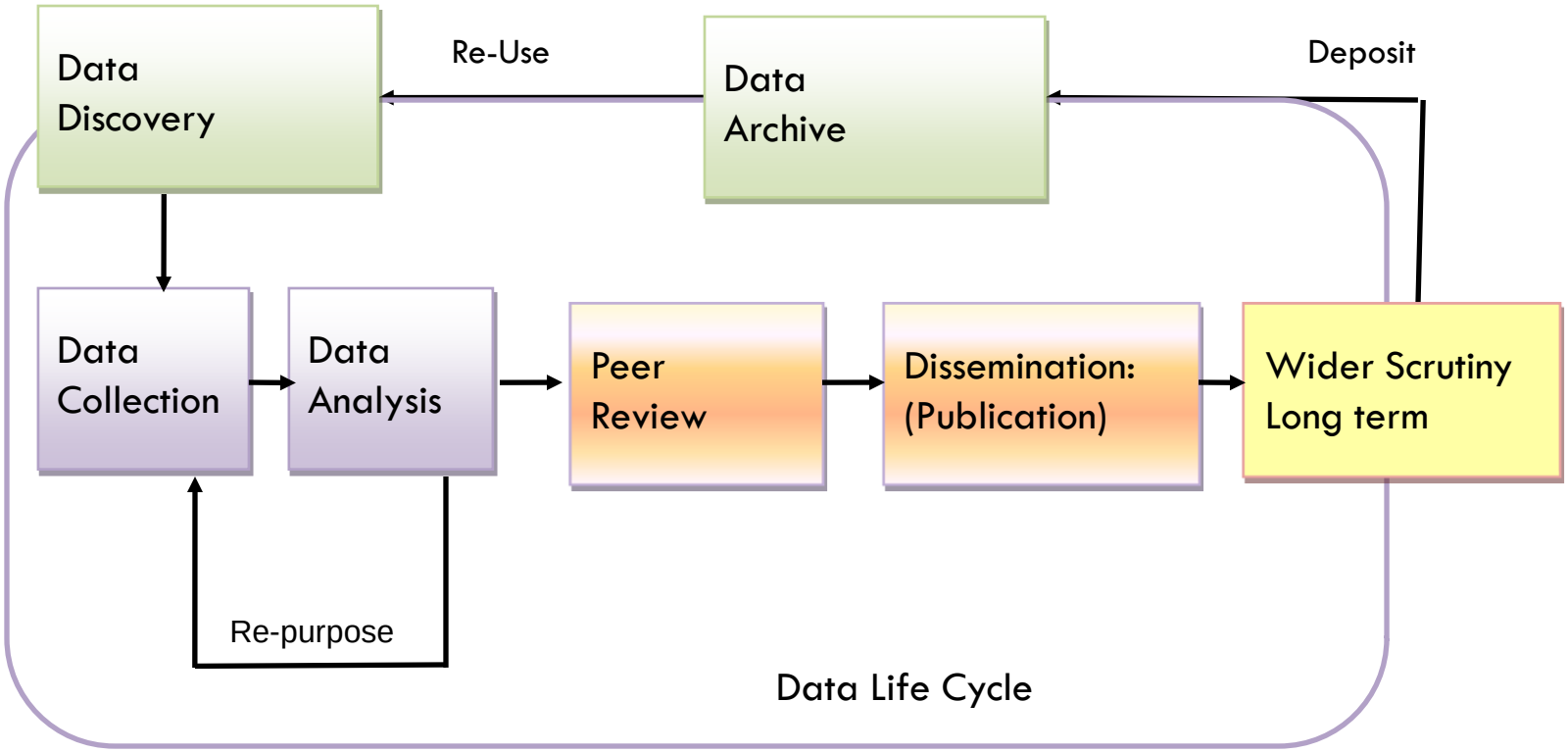
Research Life Cycle



Source: Sherry Lake, Charles L. Brown Science and Engineering Library, UVA

Does the Data Cycle End?

Whose eyes see the data, and when?



Source: Kirsten Miles P.I. Outcomes , Charlottesville, Va

Journals Have Responded

Council of Science Editors - general guidelines
CSE's White Paper on Promoting Integrity in Scientific Journal Publishing (2006) (www.CouncilScienceEditors.org)

Nature Publishing Group (34 journals)
– set guidelines and standards in 2007

Some journals have set guidelines
Journal of Cell Biology developed first set
some journals are adopting or adapting *JCB*'s guidelines

Digital Access
The Ultimate Editor

Woo-Suk Hwang and team published about stem cells and cloning

- two papers in *Science* (March 2005; June 2005)
- one in *Nature* (August 2005)

In 2005, Post Doc bloggers raised questions about images; investigations revealed pervasive fraud
In 2006, journals retracted the articles; national scandal for Korea; Hwang stripped of positions

Data Viewer

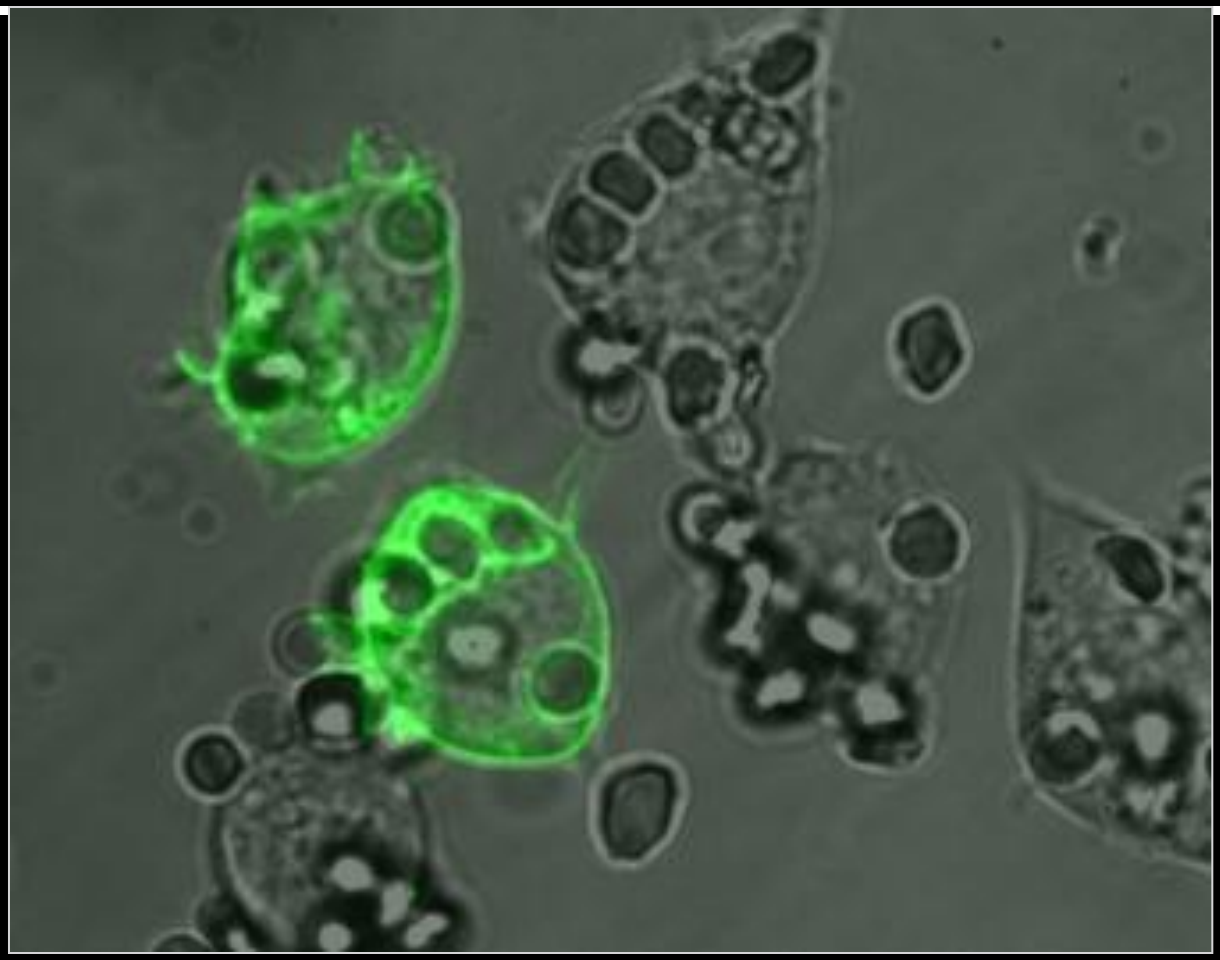
JCB Data Viewer

The concept of providing public access to supporting data has arrived.

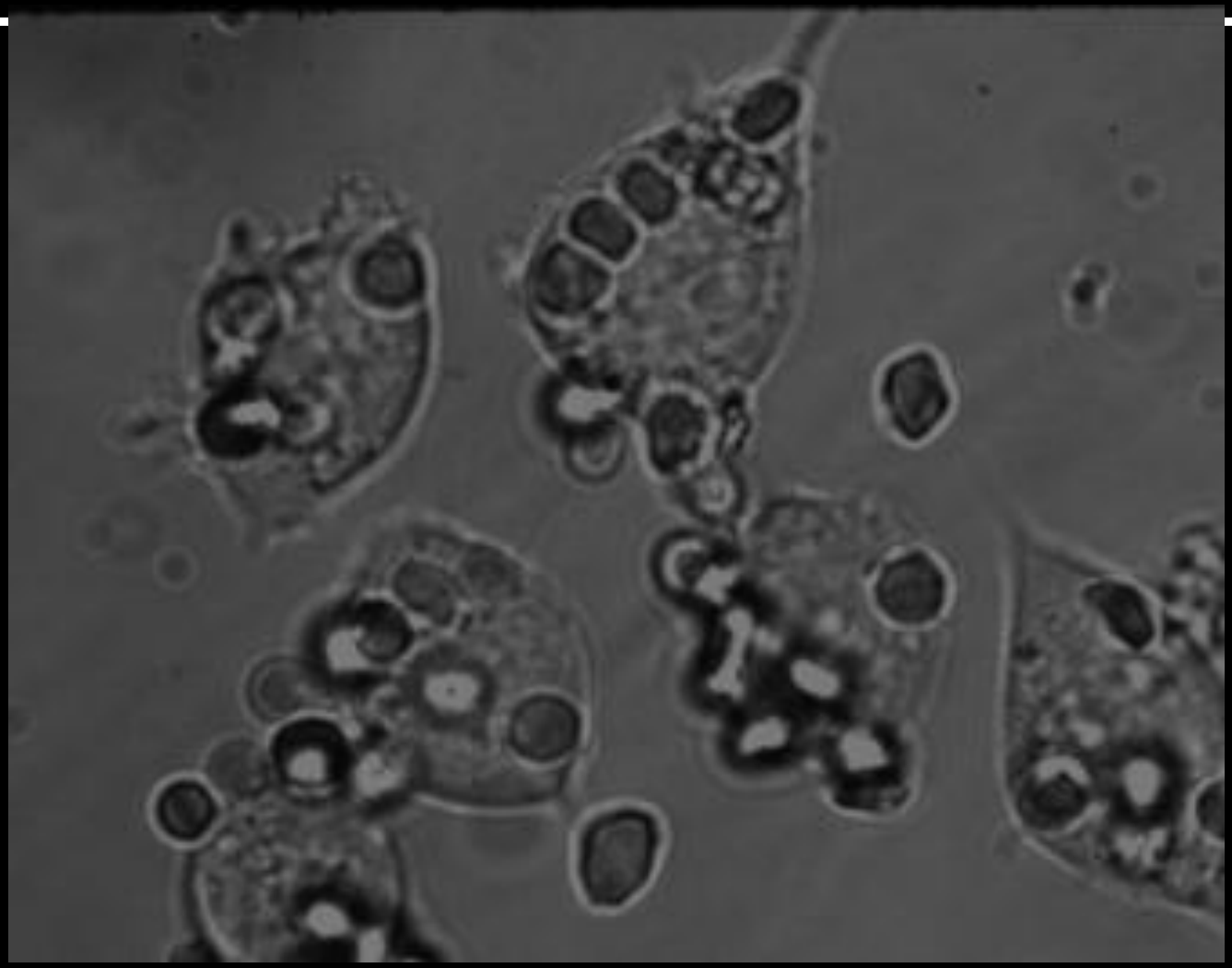
Where it will go, remains to be seen. Be prepared!

Data Viewer Examples

Channel Controls



Access to Original



Which is true?

1.	Everyone manipulates data for publication, it isn't a big deal	0%
2.	I am only making my image "pretty" for the editor, who expects it	0%
3.	It is ok to use a representative image from a different study if it is mine	0%
4.	Manipulating images to make figures more convincing may deprive your colleagues of seeing other information that is often hidden in a picture or other primary data.	0%

Image Data Manipulation

Best Practices in managing Image Data:

Discuss image data issues with your P.I. early on to establish procedures

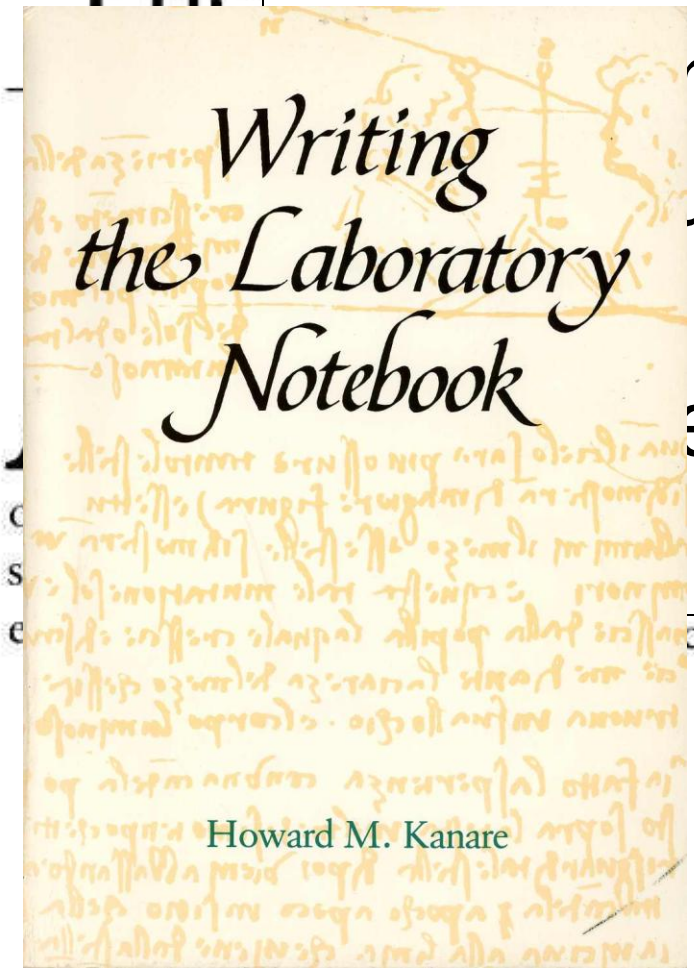
Preserve the original for future access

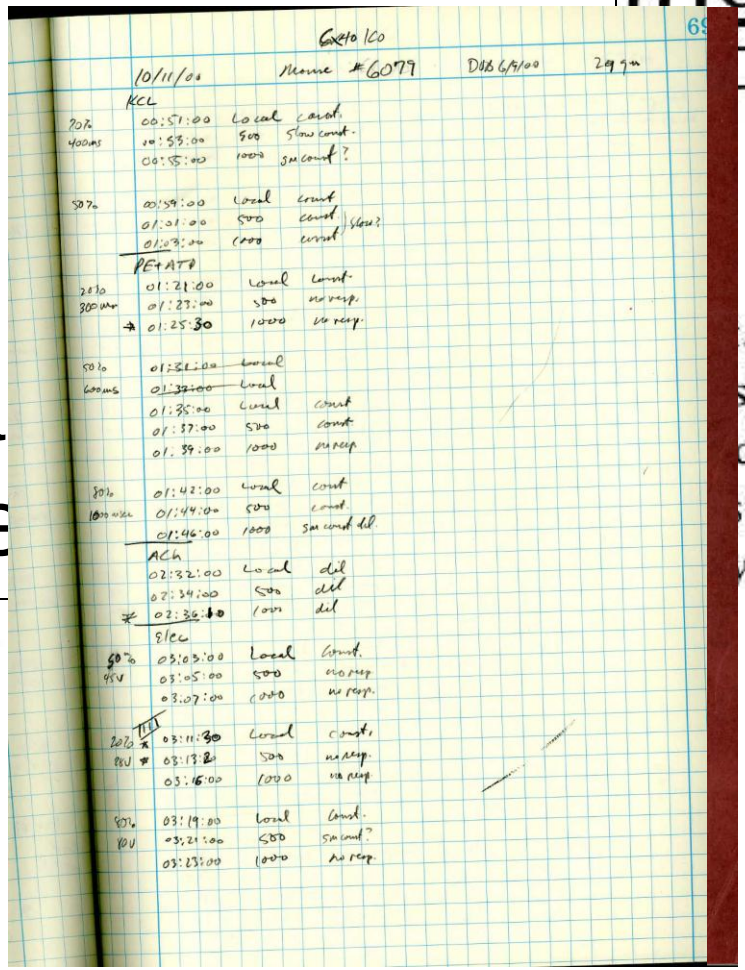
Record/document all changes to image, be able to *replicate* your actions

Creating Primary Data

- You are creating primary data.
- Your integrity hinges on having a plan!
- How will you insure its integrity?
- Do you have a plan?

The Beginnings of a Solution





How might you keep track of your original data in the 21st century?

Write original data to a weekly CD

↓

Finalize the CD, i.e. it can no longer be modified

↓

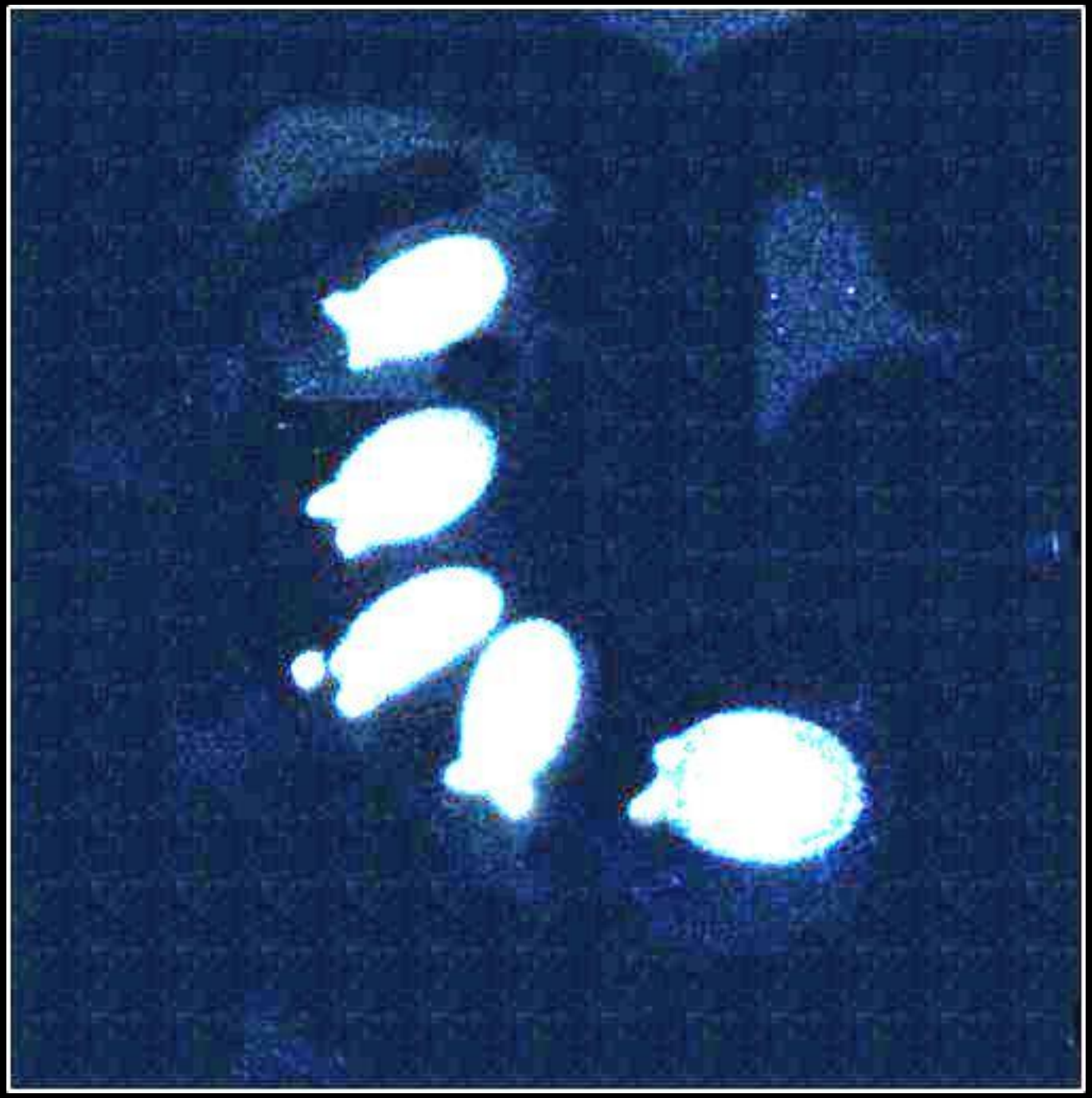
Implement a system for linking lab notebook and ALL data

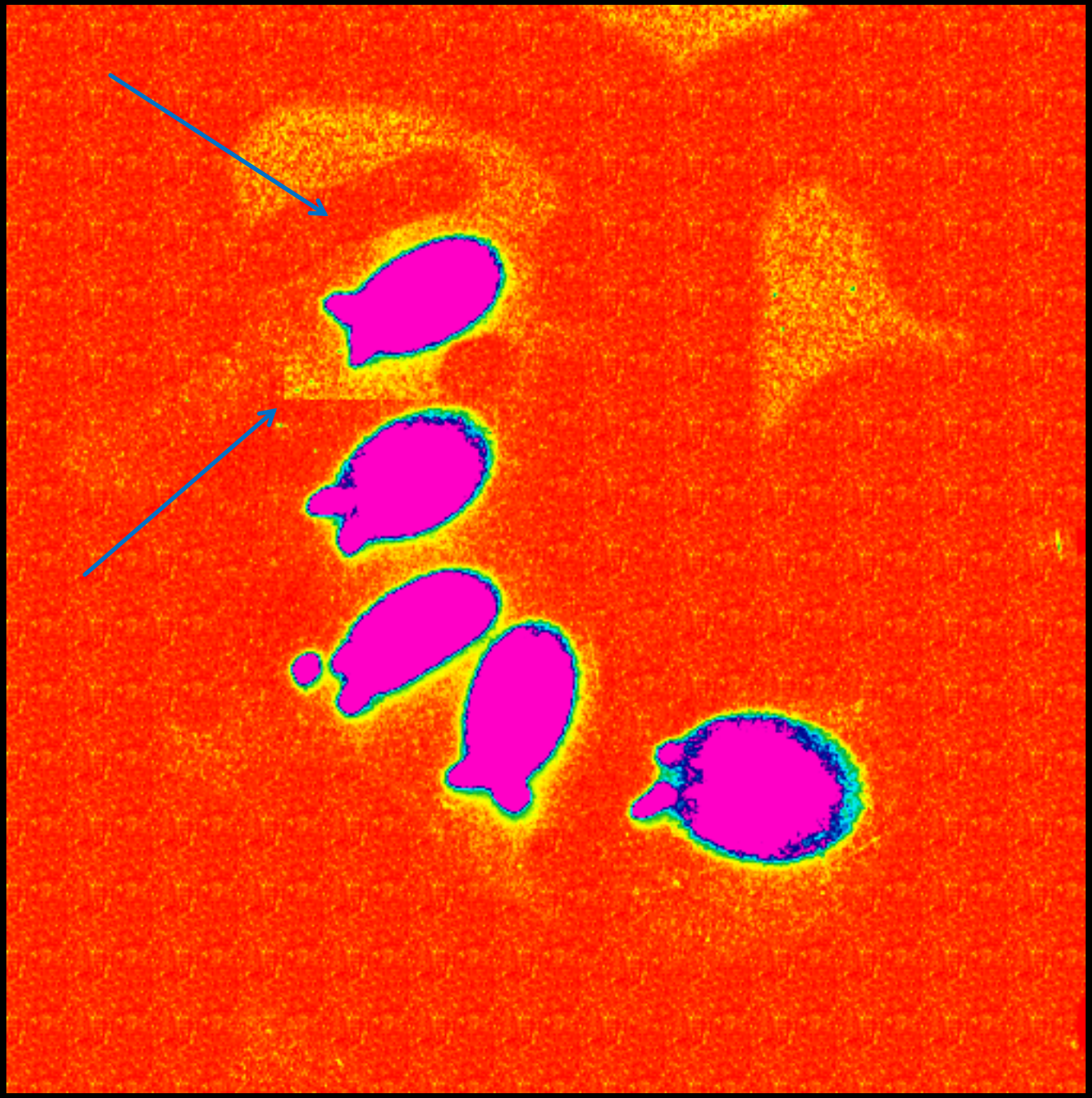
↓

Store CD in your laboratory notebook → Lab copy

Screening Examples

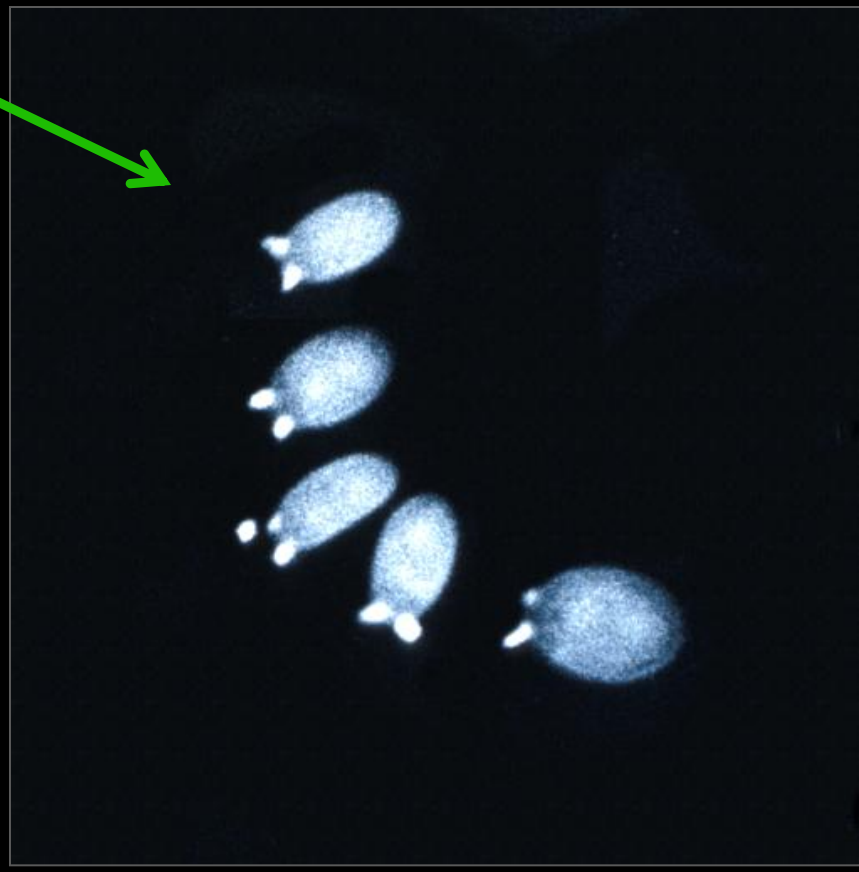
The following images were prepared by UVA colleagues expressly to demonstrate screening tools and are not research material.



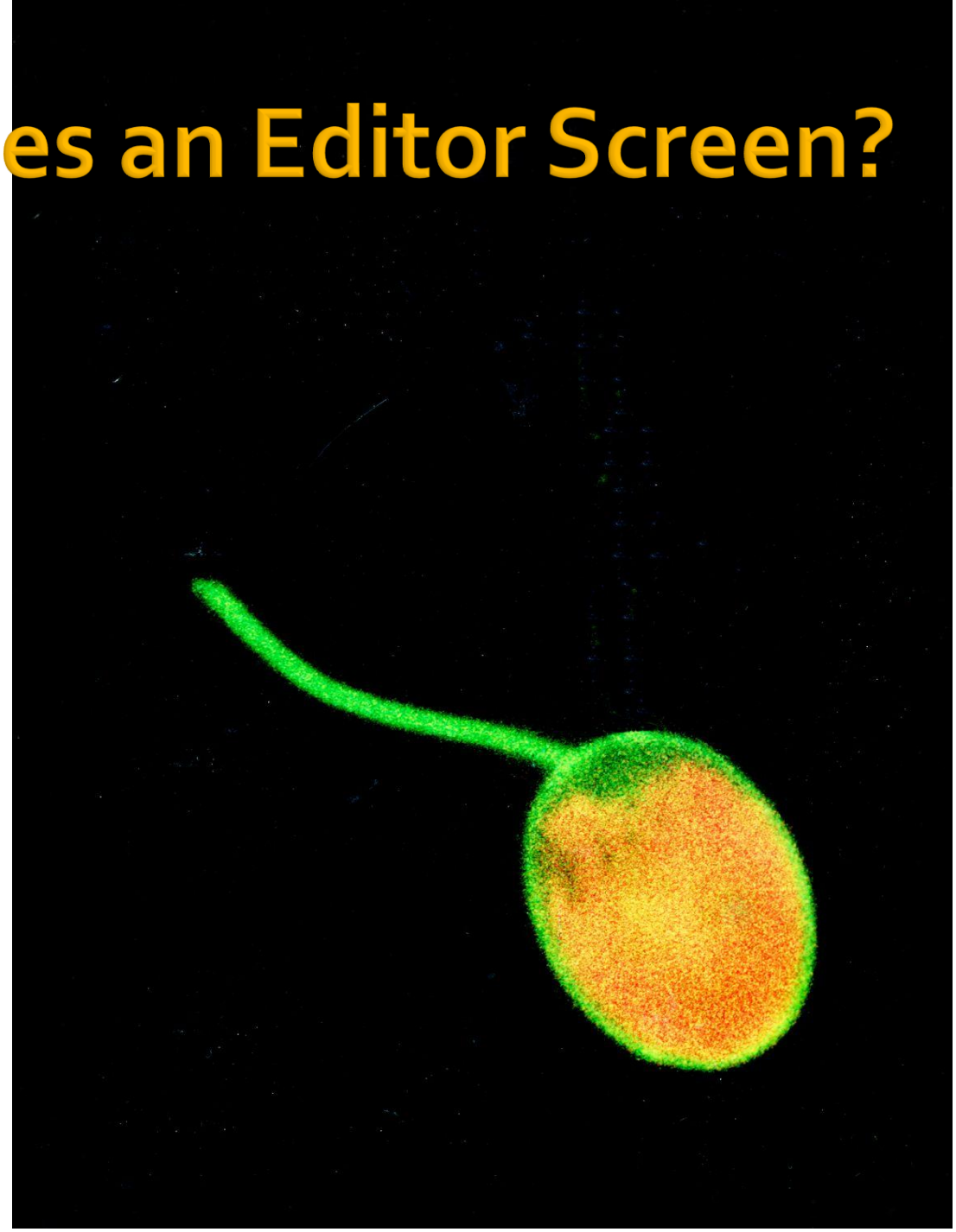


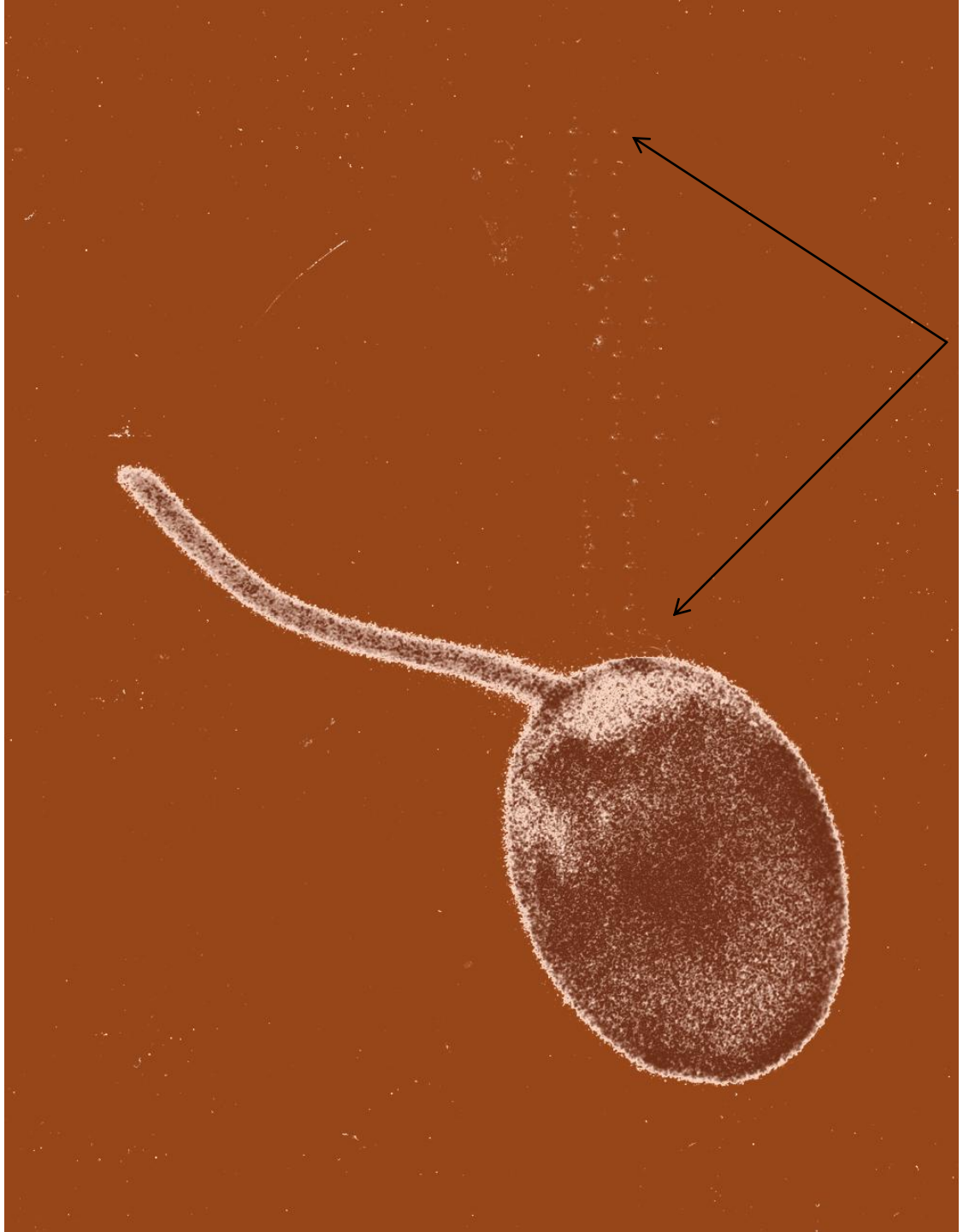
Original and Alteration

Tidying the image?



When Does an Editor Screen?





Images as Data

Safeguarding your images and credibility in a world of emerging standards.

What do you need to know in order to preserve your image as a faithful representation of the original?

Intent of Image

- Understanding the context in which the image will be used is critical in determining what sort of boundaries exist
  - What is the purpose of the image?
  - What limits apply?

Intent of Image

Image purposes fall into three areas

Densitometry

Representation

Quantification

Densitometry

- Is a large field, involving measuring brightness to darkness levels
- Sensitivity to changing the relationship between the lightest and darkest categories, for instance with the midtone-slider in Photoshop.
- Very little manipulation is acceptable

Representative Images

- Not entirely representative
- Informal agreements exist that usually best image is selected
- Intention is to be descriptive, to "represent" what you saw in the microscope
- Greater scope for using tools to modify in order to create "representation"

Quantitative Images

- Computer image analysis techniques have decreased effects of observer biases
- These are the quantitative characterization of two dimensional or three dimensional digital images

Maintain your image integrity

- Collect all the data and do it honestly
- Document any changes you make to the image
- Don't exclude observations that disagree with the momentary hypothesis – if your science is any good the hypothesis can change
- Make sure that the conditions as well as the data are recorded: gains, temperatures, sample rate, etc
- Interpretations change with time, *the data do not*

Crafting a Data Plan

- NSF began requiring data plans for all grant applications beginning in October 2010
- Their goal is to encourage data sharing
- What is your plan?
- Develop a template for digital image data
- Identify on-campus resources

SCiDaC at UVA

- Andrea S. Horne, MILS

Research and Data Services Management
Claude Moore Health Sciences Library
horne@virginia.edu 434-924-9985

- Andrew Sallans

Head of Strategic Data Initiatives
Charles Brown Engineering Library
als9q@virginia.edu 434-243-2180

The Audit Trail – a powerful tool:

An Audit Trail Log can be enabled to track each step in a manipulation process, in Adobe Photoshop, ImageJ, and in ImagePro.

- It *must be enabled* in each of the software packages in order to record replicable steps used to process images prior to publication.

The Audit Trail

The Edit History Log can be enabled to track each step in a manipulation process, in Photoshop.

- It must be enabled in the General Panel of Photoshop Preferences
- To read the history log for an image *that is open and active, or from the File menu in Bridge when the image is selected*, choose:

>File > File Info > History
>File > File Info > Advanced*

*If detailed was not selected when the image was created, limited information can be gained here

Adobe Edit History Log

Ec Log

Ch

Adobe Photoshop CS3 Extended

File Edit Image Layer Select Filter Analysis View Window Help

Sample Size: Point Sample

Workspace

Navigator Histogram Info

Preferences

General
Interface
File Handling
Performance
Cursors
Transparency & Gamut
Units & Rulers
Guides, Grid, Slices & Count
Plug-Ins
Type

Color Picker: Adobe

Image Interpolation: Bicubic (best for smooth gradients)

UI Font Size: Small

Changes will take effect the next time you start Photoshop.

OK
Cancel
Prev
Next

Options

- Automatically Launch Bridge
- Auto-Update Open Documents
- Beep When Done
- Dynamic Color Sliders
- Export Clipboard
- Use Shift Key for Tool Switch
- Resize Image During Paste/Place
- Zoom Resizes Windows
- Zoom with Scroll Wheel

History Log

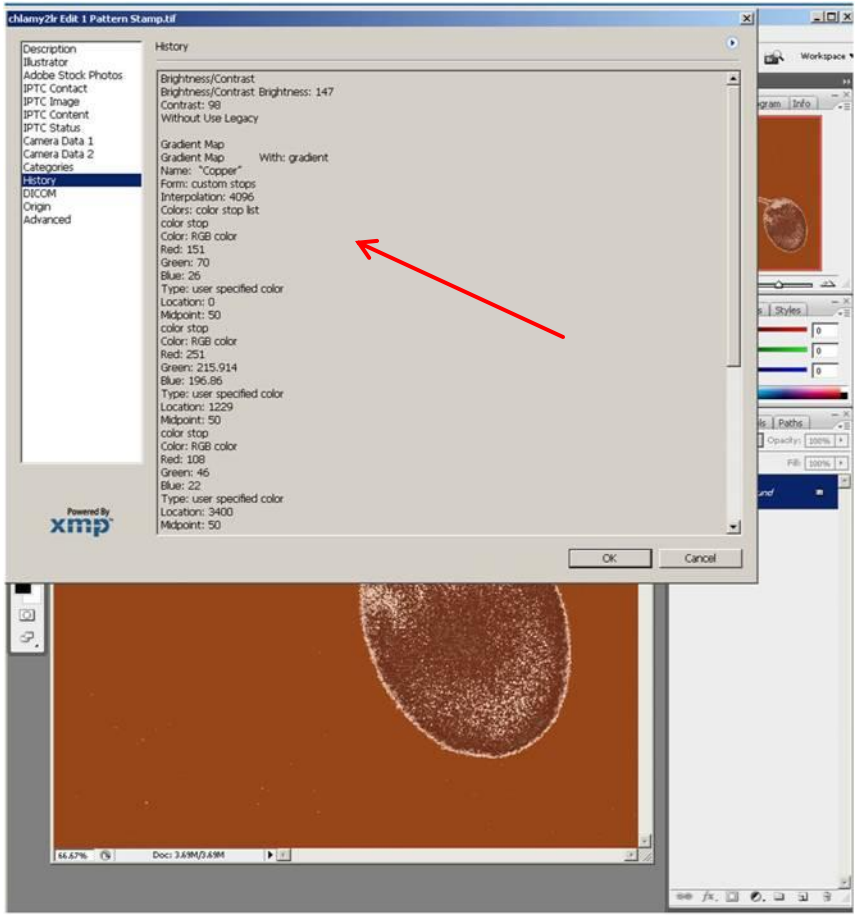
Save Log Items To:
- Metadata
- Text File — Choose...
- Both

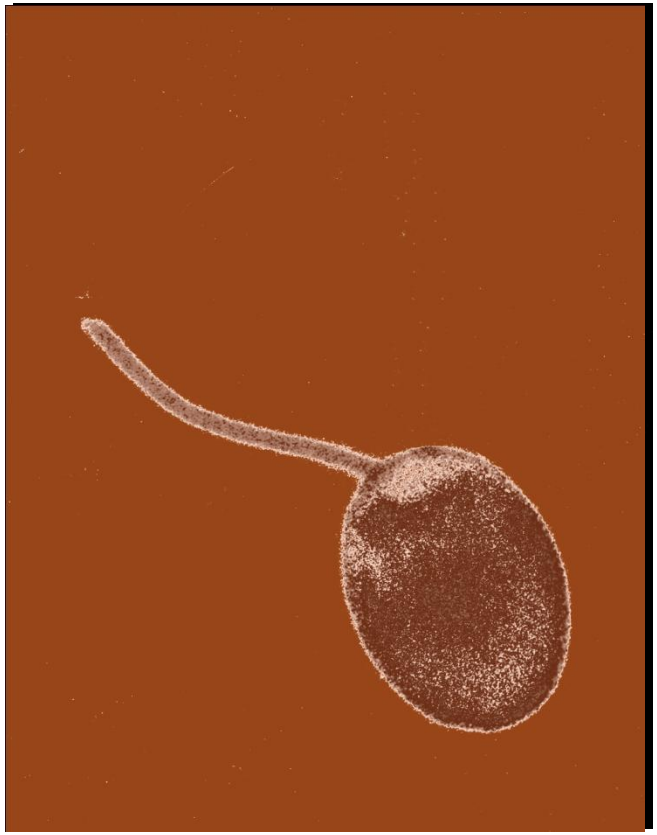
Edit Log Items: Detailed

Sessions Only
Concise
Detailed

Warning Dialogs

EHL examples

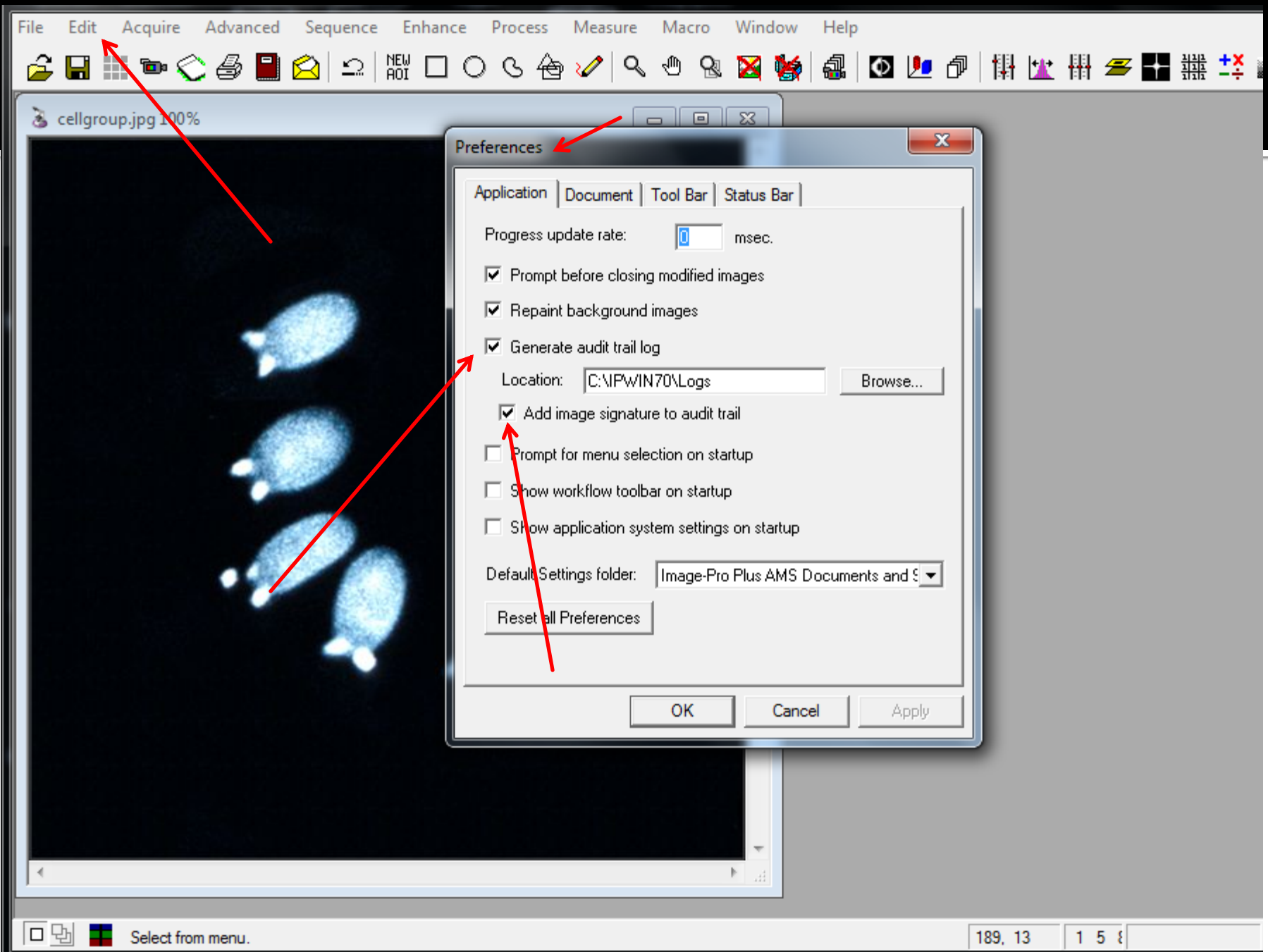




The Audit Trail in ImagePro

The Audit Trail Log can track each step in a manipulation process, in ImagePro.

It must be enabled in the Preferences Panel of the ImagePro Edit drop down menu.


File Edit Acquire Advanced Sequence Enhance Process Measure Macro Window Help
cellgroup.jpg 100%
Preferences
Application Document Tool Bar Status Bar
Progress update rate: 0 msec.
Prompt before closing modified images
Repaint background images
Generate audit trail log
Location: C:\IPWIN70\Logs
Browse...
Add image signature to audit trail
Prompt for menu selection on startup
Show workflow toolbar on startup
Show application system settings on startup
Default Settings folder: Image-Pro Plus AMS Documents and S
Reset all Preferences
OK
Cancel
Apply
Select from menu.
189, 13

Audit Trail L

testlog - Notepad

File Edit Format View Help

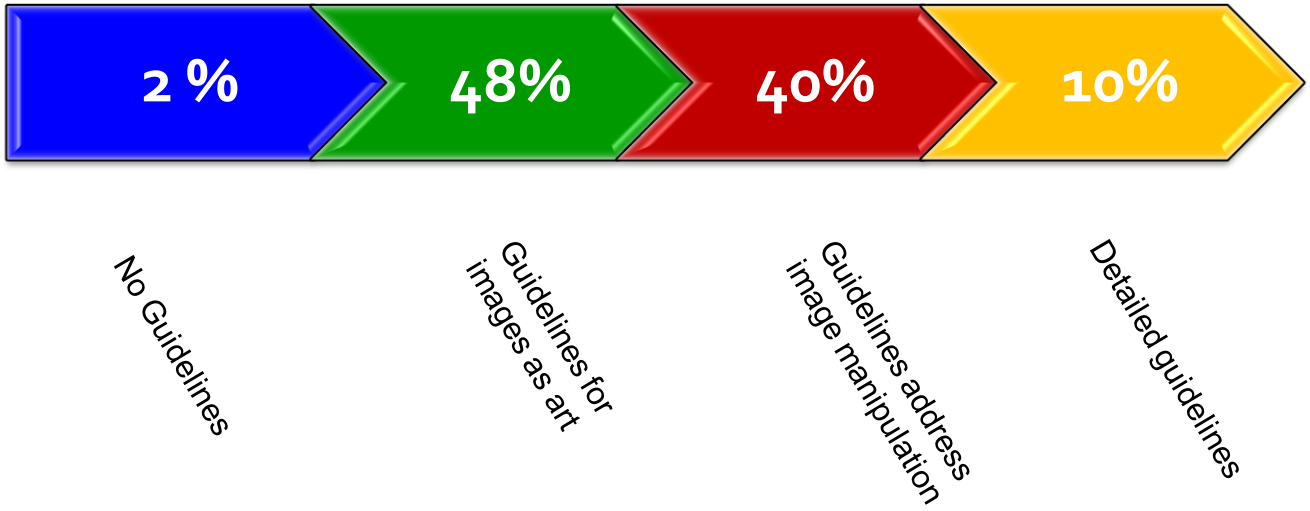
```
2010/12/03 00:48:37.200 Image-Pro Plus AMS version 7.0.0.591 logging started by
user Gateway Customer.
2010/12/03 00:48:42.388 ret = IpLutShow(1)
2010/12/03 00:48:47.770 ret = IpLutSetAttr(LUT_BRIGHTNESS, 92)
2010/12/03 00:48:53.957 ret = IpLutSetAttr(LUT_CONTRAST, 89)
2010/12/03 00:49:18.611 ret = IpLutSave("C:\Users\Gateway Customer\Documents
\Image Integrity\Images\cellgrouplog.lut", "")
2010/12/03 00:49:20.358 ret = IpLutShow(0)
2010/12/03 00:49:37.757 ret = IpDrShow(1)
2010/12/03 00:49:44.710 ipLArray(0) = 0
2010/12/03 00:49:44.710 ipLArray(1) = 255
2010/12/03 00:49:44.710 ret = IpDrSet(DR_RANGE, 0, ipLArray(0))
2010/12/03 00:49:47.596 ret = IpDrShow(0)
2010/12/03 00:49:58.603 ret = IpLutShow(1)
2010/12/03 00:50:02.144 ret = IpLutSetAttr(CHANNEL, 1)
2010/12/03 00:50:10.428 ret = IpLutSetAttr(LUT_BRIGHTNESS, 57)
2010/12/03 00:50:19.632 ret = IpLutSetAttr(LUT_CONTRAST, 11)
2010/12/03 00:50:24.686 ret = IpLutSetAttr(LUT_GAMMA, 62)
2010/12/03 00:50:31.238 ret = IpLutSetAttr(LUT_BRIGHTNESS, 42)
2010/12/03 00:50:31.269 ret = IpLutSetAttr(LUT_BRIGHTNESS, 42)
2010/12/03 00:50:32.549 ret = IpLutSetAttr(CHANNEL, 2)
2010/12/03 00:50:39.159 ret = IpLutSetAttr(LUT_CONTRAST, 56)
2010/12/03 00:50:42.304 ret = IpLutSetAttr(LUT_CONTRAST, 49)
2010/12/03 00:50:46.370 ret = IpLutSetAttr(LUT_BRIGHTNESS, 55)
2010/12/03 00:50:51.950 ret = IpLutSetAttr(LUT_GAMMA, 121)
2010/12/03 00:51:14.227 ret = IpLutSetAttr(LUT_GAMMA, 133)
2010/12/03 00:51:23.337 ret = IpLutSetAttr(LUT_CONTRAST, 51)
2010/12/03 00:51:30.908 ret = IpLutSetAttr(CHANNEL, 2)
2010/12/03 00:51:32.118 ret = IpLutSetAttr(CHANNEL, 3)
2010/12/03 00:51:36.557 ret = IpLutSetAttr(LUT_CONTRAST, 60)
2010/12/03 00:51:44.510 ret = IpLutSetAttr(LUT_BRIGHTNESS, 49)
2010/12/03 00:51:48.613 ret = IpLutSetAttr(LUT_GAMMA, 133)
2010/12/03 00:51:56.843 ret = IpLutSave("C:\Users\Gateway Customer\Documents
\Image Integrity\Images\cellgrouplog.lut", "")
2010/12/03 00:52:01.002 ret = IpLutShow(0)
2010/12/03 00:52:25.799 ret = IpWsSaveAs("C:\Users\Gateway Customer\Documents
\Image Integrity\Images\cellgroupIPlog.jpg", "jpg")
2010/12/03 00:52:25.815 ' The file signature for C:\Users\Gateway Customer
\Documents\Image Integrity\Images\cellgroupIPlog.jpg is: B35B-E031-3FD9-746F-
C1FC-4E6E-BCDB-D38B
2010/12/03 00:55:02.067 ret = IpDocClose()
2010/12/03 00:55:02.067 ret = IpIOvrShow(0)
2010/12/03 00:55:02.067 ret = IpAnShow(0)
2010/12/03 00:55:35.115 ret = IpAppCloseTools()
2010/12/03 00:55:35.115 ret = IpSMShow(SM_HIDE)
2010/12/03 00:55:35.115 ret = IpAppExit()
2010/12/03 00:55:35.318 Image-Pro Plus AMS session ended by user Gateway
Customer.
```

The Audit Trail in ImageJ

ImageJ is a public domain image processing program developed at the National Institutes of Health, designed with an open architecture.

Metadata has to be created using the macro to "Record", which records all activity , and cut and pasted into a text file for a session log. Instruction are at this link and in the notes of this slide.

Spectrum of Guidelines
What does your publication require?



Print and online aids

1. Examples of journal guidelines

- Rockefeller University Press (*Journal of Cell Biology* & 3 other journals) http://jcb.rupress.org/misc/ifora.shtml
  > scroll to Image Manipulation
- *Nature* journals (34 journals)
  http://www.nature.com/authors/editorial_policies/image.html
- Web resource:
  http://mend.endojournals.org/misc/itoa.shtml#digital

Print and online aids

2. **Professional guidelines**

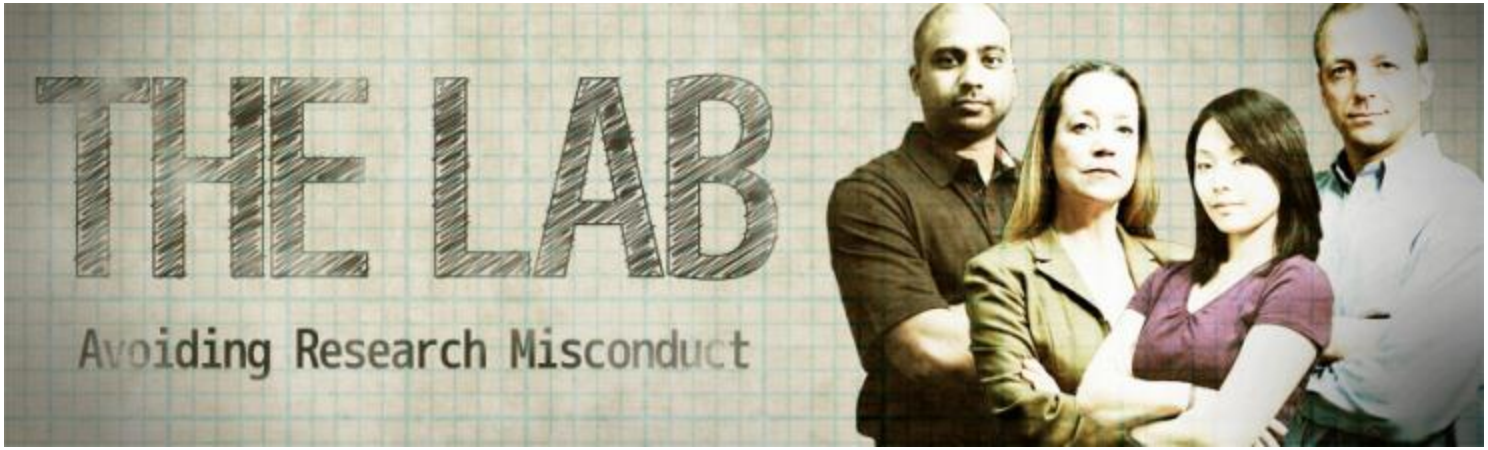
- Council of Science Editors, *CSE's White Paper on Promoting Integrity in Science Journal Publications* — see "3.4 Digital Images and Misconduct" http://www.councilscienceeditors.org/editorial_policies/whitepaper/3-4_digital.cfm

Print and online aids

- Office of Research Integrity http://ori.dhhs.gov/
  - Guidelines for data management http://ori.dhhs.gov/education/products/RCRintro/co6/oc6.html
  - tools for examining images and other digital data (see "Forensic tools") http://ori.dhhs.gov/tools/ > "Forensic Tools" in left menu on home page
  - guidelines for conducting inquiries

    http://ori.dhhs.gov/misconduct/ > "Handling Misconduct" in left menu on home page

ORI's Interactive Case Study



In "The Lab: Avoiding Research Misconduct," you become the lead characters in an interactive movie and make decisions about integrity in research that can have long-term consequences. The simulation addresses Responsible Conduct of Research topics such as avoiding research misconduct, mentorship responsibilities, handling of data, responsible authorship, and questionable research practices.

Print and online aids

- Microscopy Society of America

Policy on digital image data:

All parameters of the production and acquisition of the original uncompressed file, as well as any subsequent processing steps, must be documented and reported to ensure reproducibility.

Print and online aids

- **John Russ:**
- "The heart of the scientific method is replicability. If adequate information is provided on the processing steps applied, and the original image data are preserved, then the validity of the results can be independently verified." http://www.drjohnruss.com/downloads/ethics.pdf

Print and online aids

- **Jerry Sedgewick**:
- "The sole means for determining the extent of the existence of alteration or additions lies in looking at the original."

- Scientific Imaging with Photoshop, Methods, Measurements, and Output - Check your Library
- Adobe Photoshop tutorials

Final Words

- Inform yourself thoroughly about the image data guidelines of your:
  - Journal, institution, lab, and adviser
  - Follow proactive guidelines even if your journal doesn't expect them yet!
- The onus is on you to know the boundaries in your field, institution, and publication venues.
- Be prepared to respond to a wider scrutiny.

Contact information

Please contact me with any questions, comments, or requests to repeat this seminar:

Kirsten D. Miles

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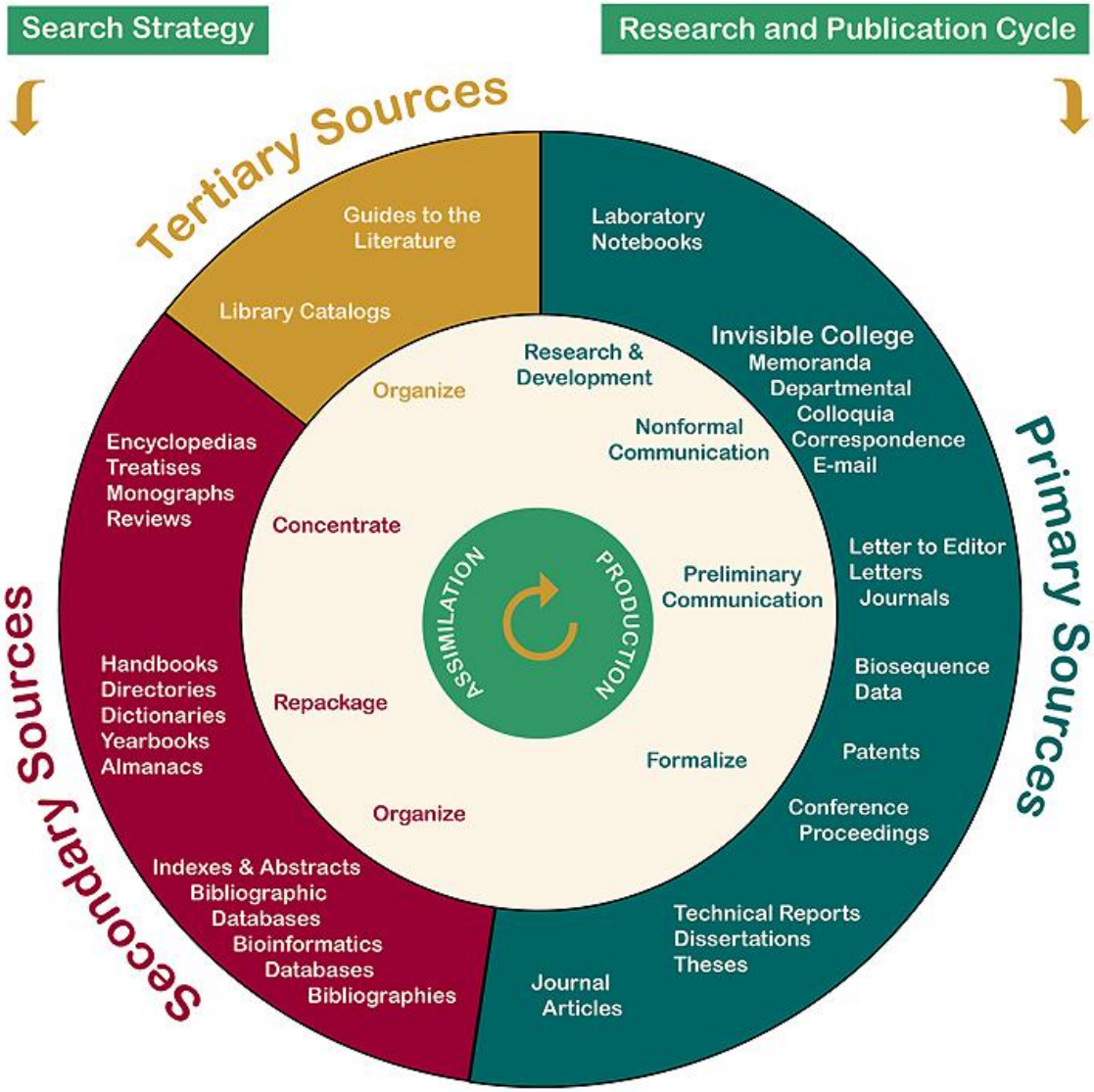
sirole.uva@gmail.com / 434-960-5193

www.scienceimageintegrity.org


Search Strategy
Research and Publication Cycle
Tertiary Sources
Guides to the Literature
Library Catalogs
Laboratory Notebooks
Invisible College
Memoranda
Departmental
Colloquia
Correspondence
E-mail
Research & Development
Organize
Nonformal Communication
Encyclopedias
Treatises
Monographs
Reviews
Concentrate
ASSIMILATION
PRODUCTION
Preliminary Communication
Letter to Editor
Letters
Journals
Handbooks
Directories
Dictionaries
Yearbooks
Almanacs
Repackage
Biosequence Data
Formalize
Patents
Organize
Conference Proceedings
Indexes & Abstracts
Bibliographic Databases
Bioinformatics Databases
Bibliographies
Technical Reports
Dissertations
Theses
Journal Articles
Primary Sources
Secondary Sources