

# Image Integrity in Research Publication

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# **Image Integrity in research publication**

- Types of image problems in biomedical papers
- Prevalence
- Identifying and understanding image integrity issues
- Paper mills
- What is the way forward?

# Why is appropriate image preparation so important?

- **Illegitimate figure preparation is an indicator for potentially illegitimate scientific conduct**
- Clear need to **avoid misunderstanding, misinterpretation, and allegations** from readership
- Publications are the **most important medium for introducing research results** to the scientific community
- Cope: Editors have a **duty to be vigilant** and are **ethically obliged to act if they suspect misconduct**

# Prevalence

## **Analysis and Correction of Inappropriate Image Duplication: the *Molecular and Cellular Biology* Experience.**

[Bik EM](#)<sup>1</sup>, [Fang FC](#)<sup>2,3</sup>, [Kullas AL](#)<sup>4</sup>, [Davis RJ](#)<sup>5</sup>, [Casadevall A](#)<sup>6</sup>.

[Mol Cell Biol.](#) 2018 Sep 28;38(20).

Analyzed 960 papers  
published in Molecular and Cellular Biology (MCB) from 2009 to 2016

Found 59 papers (6.1%) to contain inappropriately duplicated images.

~10% of papers with inappropriate image duplications in MCB were  
retracted (~0.5% of total).

The 59 instances of inappropriate image duplication led to:  
41 corrections  
5 retractions

## Results from image screening pilots

eLife (2017)

Number of mss screened 100

Figures/legends amended  
before publication: 26

Duplications 18

Over-contrasting 7

Manipulated images 6  
(e.g. eraser tool, rotation, cloning)

Missmatch of corresponding images 6  
(e.g. magnified in inset panel)

Splicing 5

Empty panels 3

## Results from image screening pilots

eLife (2017)      RSOB (2019)

Number of mss screened      100      100

Figures/legends amended  
before publication:      26      32

Duplications      18      12

Over-contrasting      7      5

Manipulated images  
(e.g. eraser tool, cloning)      6      8

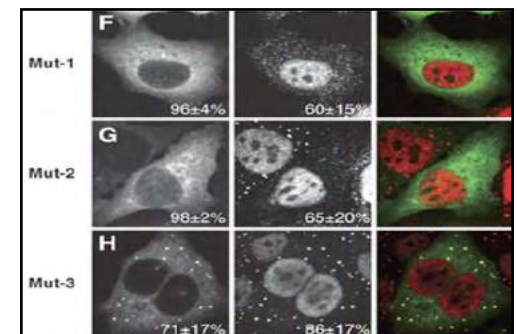
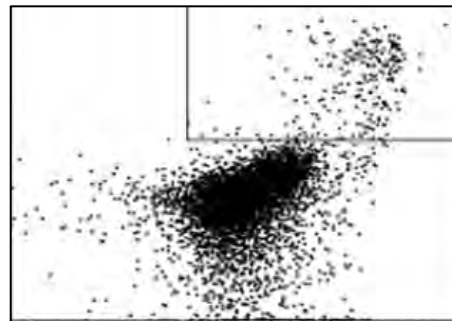
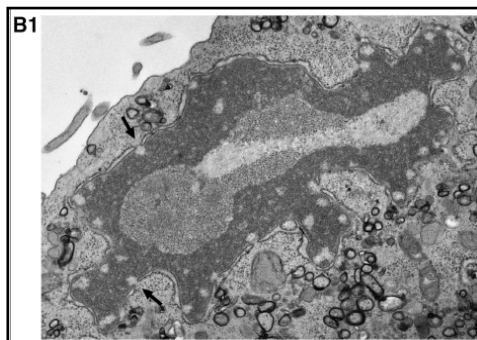
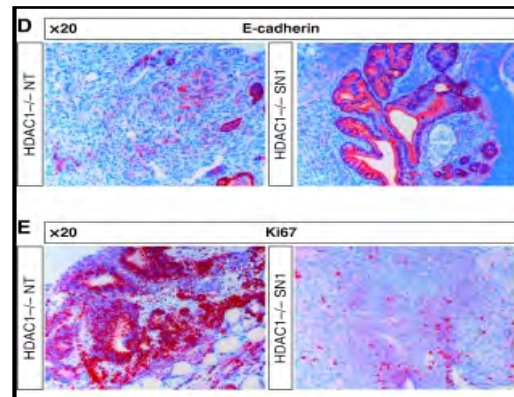
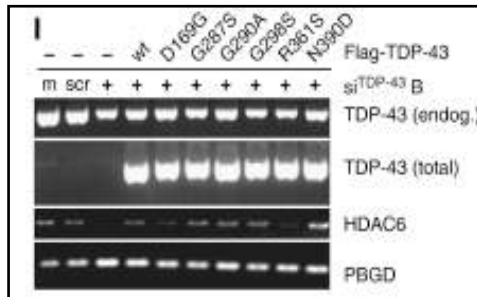
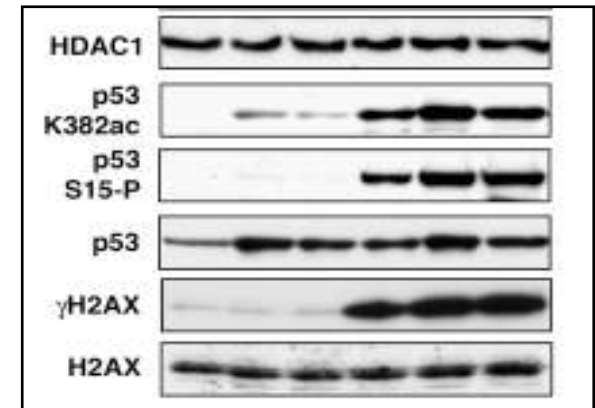
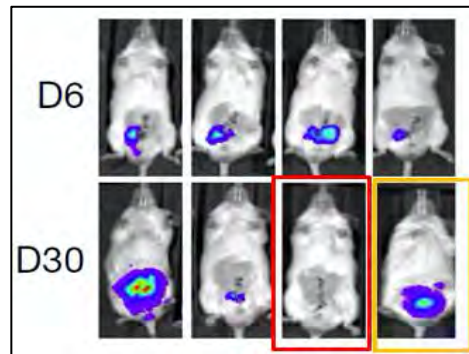
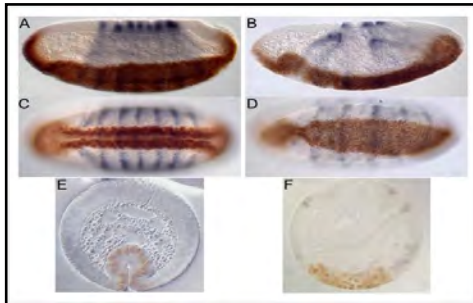
Missmatch of corresponding images  
(e.g. magnified in inset panel)      6      2

Splicing      5      7

Empty panels      3      3

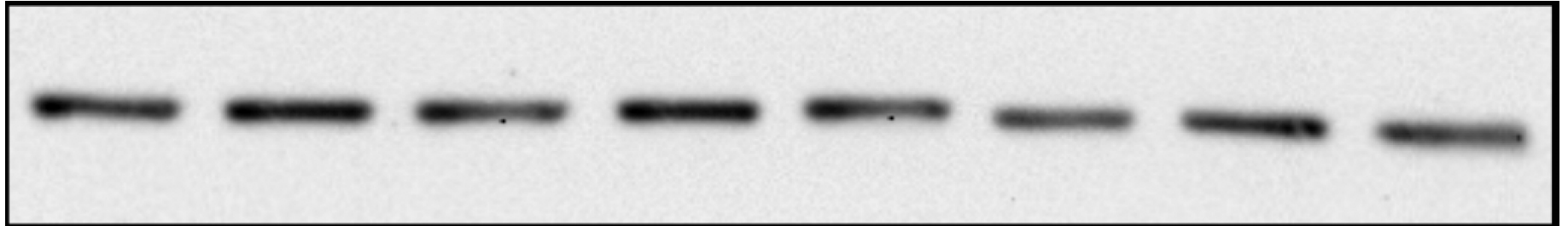
	Image integrity issues found/ figures amended before publication    %	Manipulation with intent, fabrication, other serious problems Manuscript not published                    %
Journal of Cell Biology	20	1
EMBO Press	20	1
eLife	25	1
RSOB	31	1
FEBS Press	26,7	2,1

# Image types

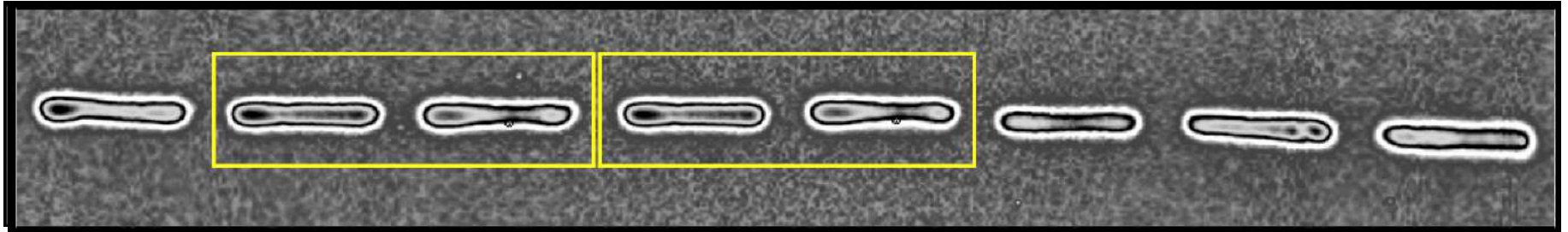




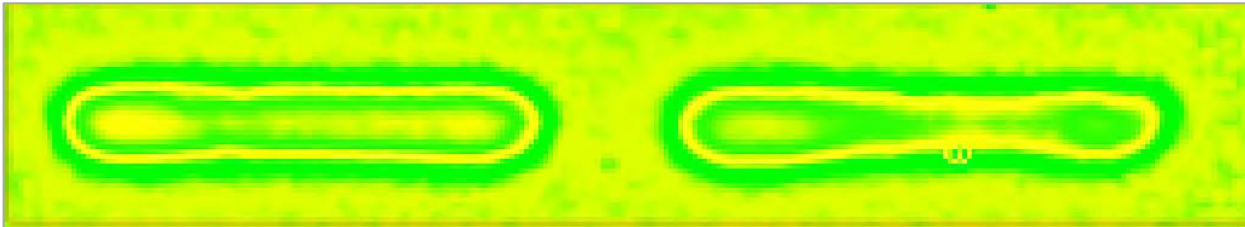
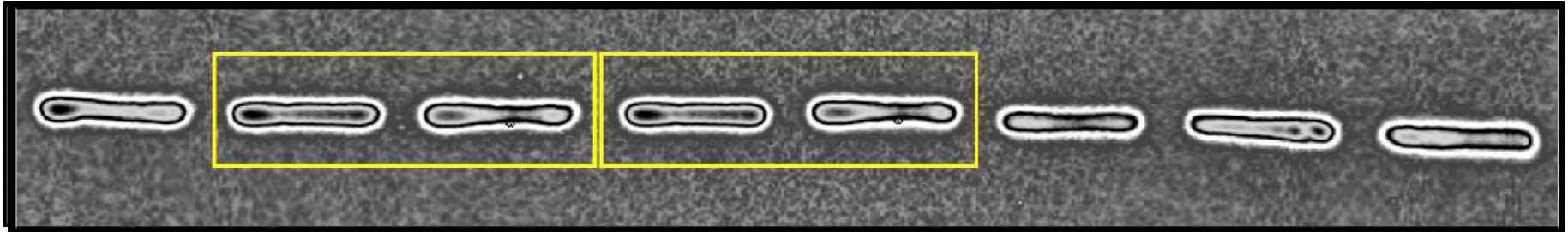
# Image screening



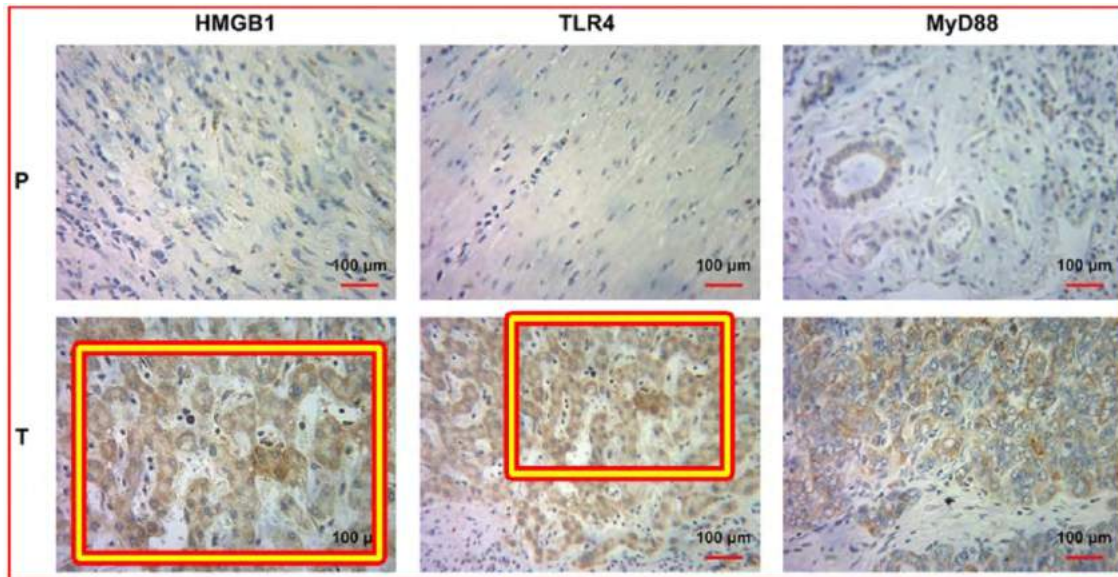
# Image screening



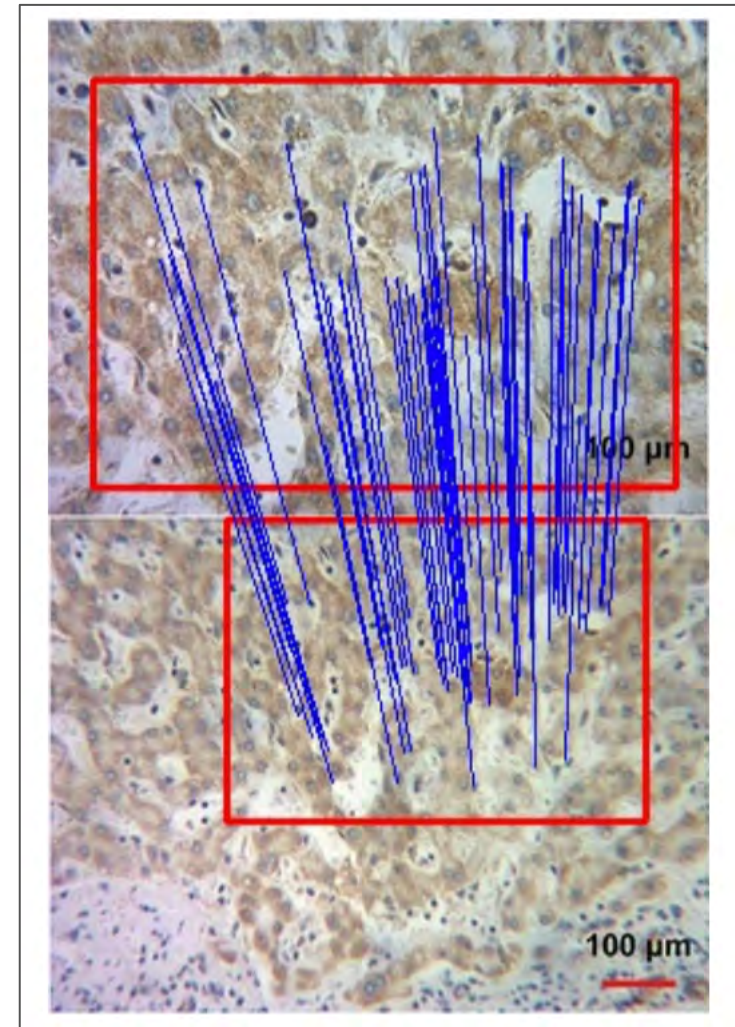
# Image screening



# Automated screening tools

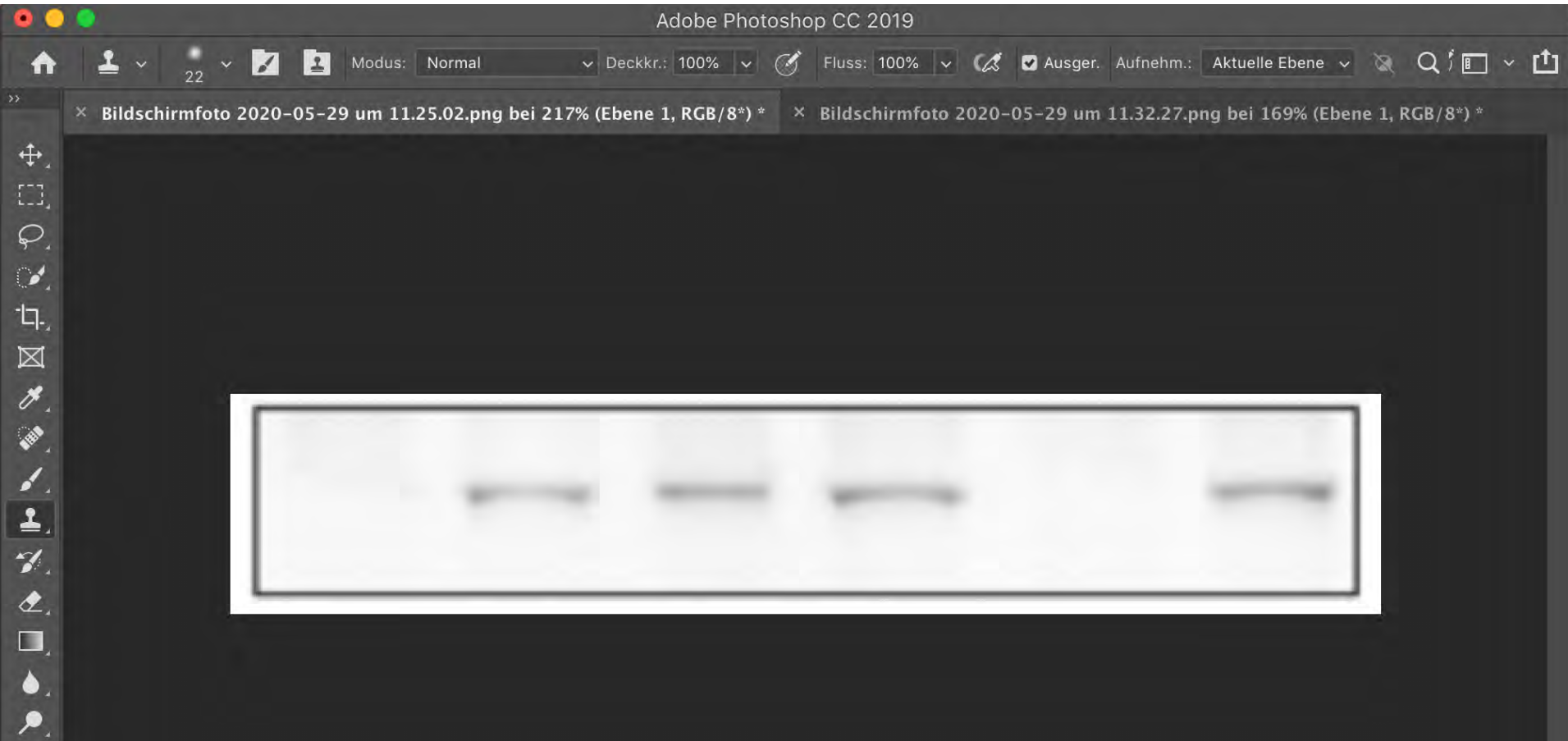


Using an algorithm to extract and screen images searching for duplicate images.

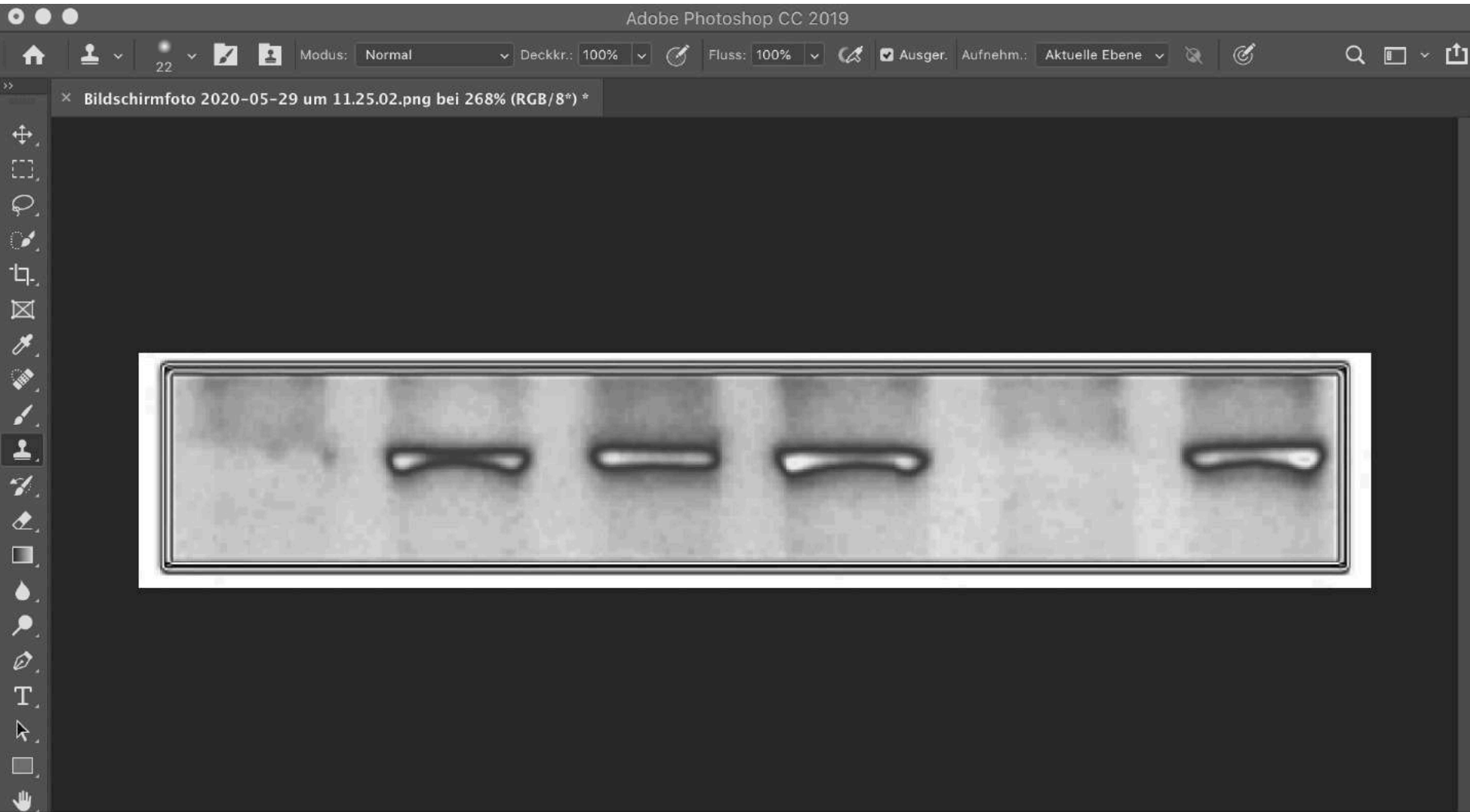




# Image manipulation in Photoshop



# Image manipulation in Photoshop



# Paper mills



<https://science.sciencemag.org/content/342/6162/1035>

- Companies that produce and sell scientific papers at demand
- Whether or not the experiments have been performed is not clear
- Images might be sold to multiple authors to represent different experiments.
- Data included in these papers is often falsified or fabricated.

## The Possibility of Systematic Research Fraud Targeting Under-Studied Human Genes: Causes, Consequences, and Potential Solutions

Jennifer A Byrne , Natalie Grima , Amanda Capes-Davis , Cyril Labbé

First Published February 5, 2019 | Review Article |  Check for updates

DOI: (10.1177/1177271919829162)

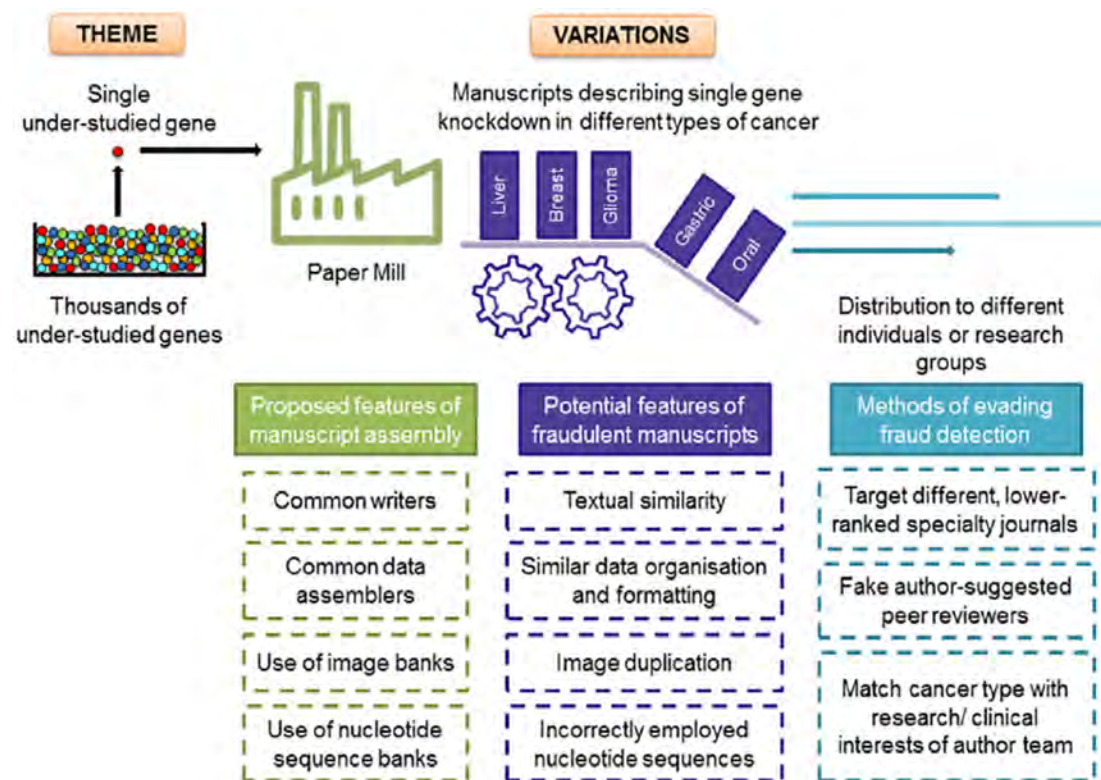


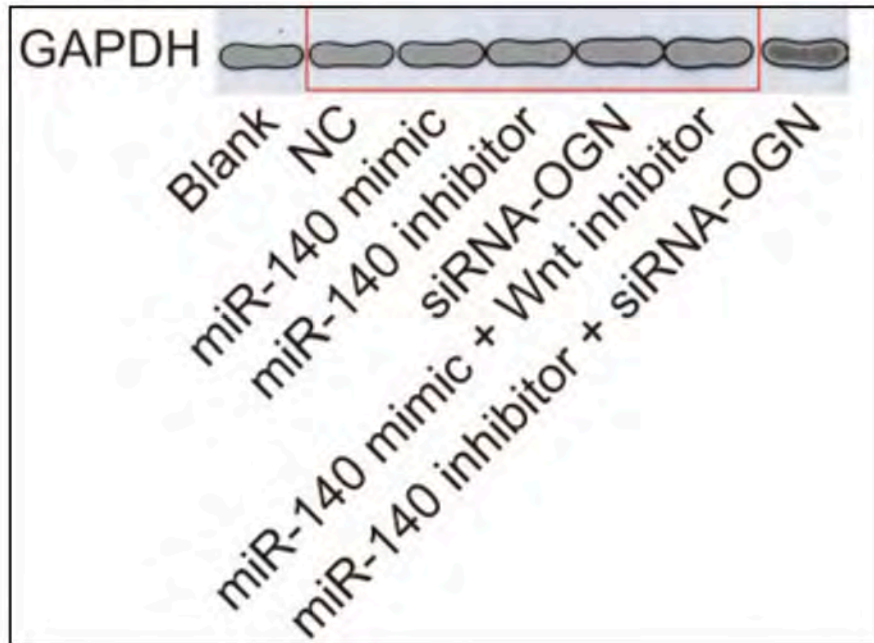
Figure 5. Overview of the proposed key features of the construction of fraudulent manuscript series by paper mills using a 'theme and variations' approach. The 'theme' shown is an under-studied human gene which is examined in different cancer types to produce a number of manuscript 'variations'. The existence of thousands of under-studied human genes means that this process could be repeated many times to produce large numbers of fraudulent manuscripts and ultimately publications.



## FEBS Journal Manuscript A

Figure 6

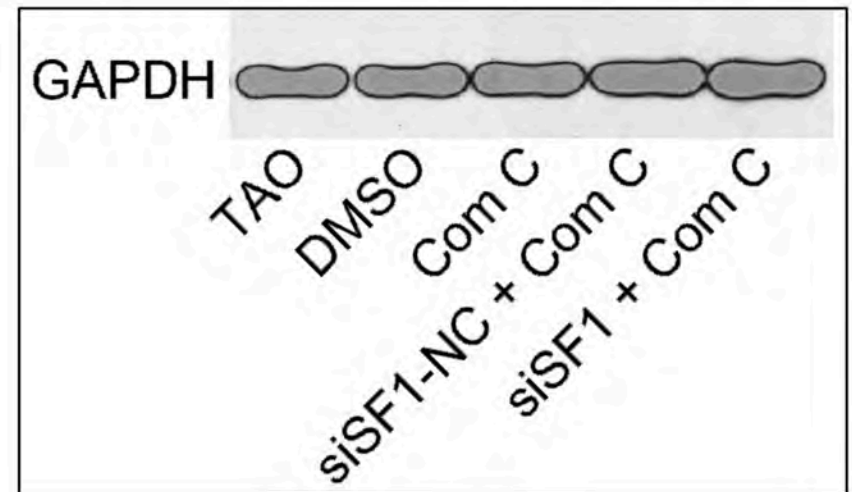
MicroRNA-140 in pulmonary fibrosis



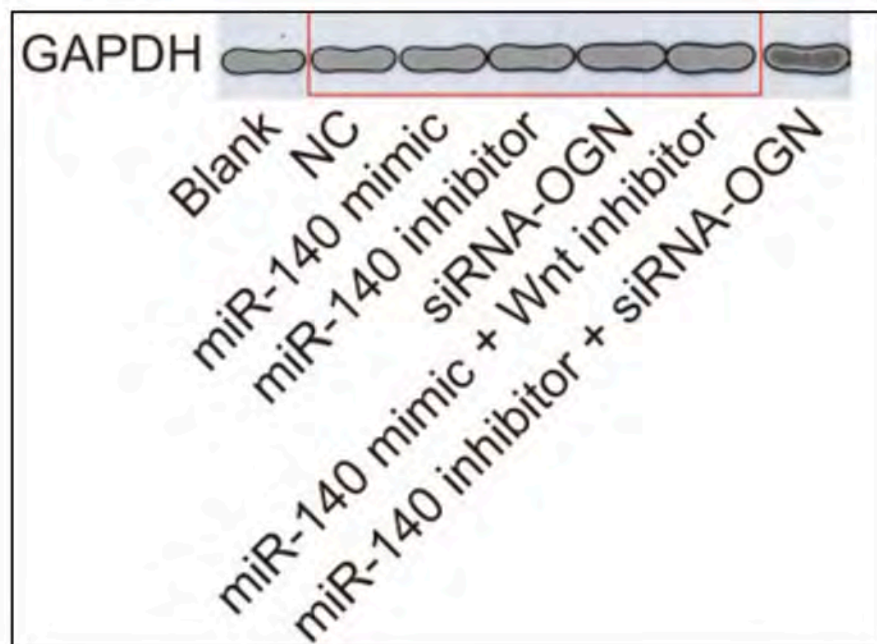
## FEBS Letters Manuscript B

Figure 5

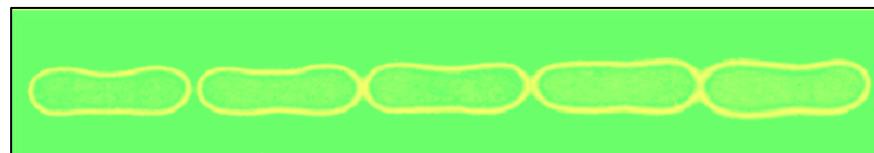
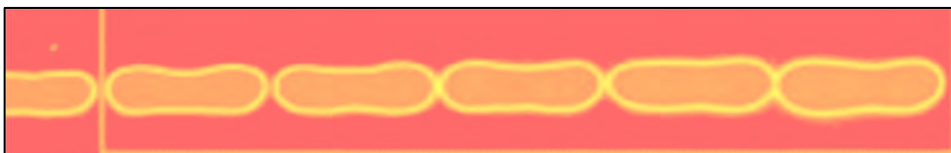
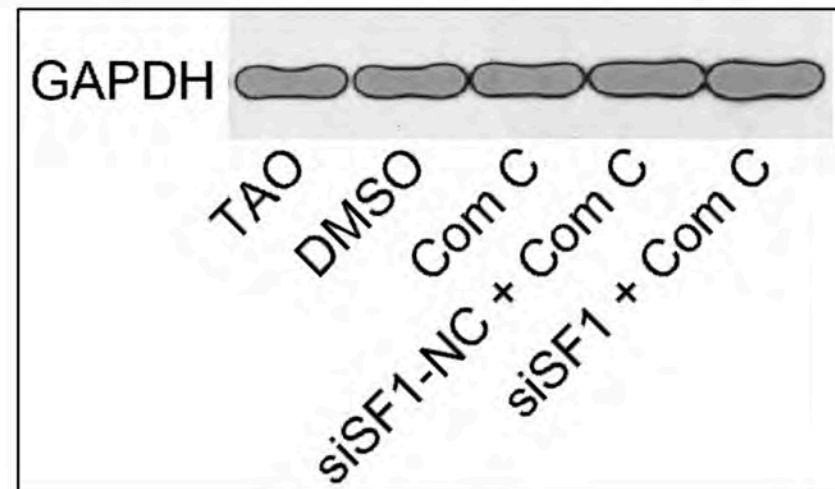
Role of SF1 in thyroid-associated TED



Ms A, fig 6



Ms B, figure 5



**Table 1.** Association between clinicopathological features and IL-38 protein expression.

	N	IL-38 expression			p-value
		strong (n = 194, %)	weak (n = 108, %)	negative (n = 82, %)	
age, years					0.393
<65	171	34.0	37.0	45.0	
≥65	213	66.0	63.0	55.0	
gender					0.521
male	181	48.4	40.7	39.1	
female	203	51.6	59.3	60.9	
T stage					0.016*
T1	6	3.2	5.5	3.0	
T2	21	16.1	13.0	5.7	
T3	173	46.9	42.5	29.1	
T4	184	33.8	39.0	62.2	
N stage					0.005*
N0	93	67.7	48.1	40.7	
N1	159	25.7	33.3	34.7	
N2	132	6.6	18.6	24.6	
M stage					0.002*
M0	267	96.8	96.3	81.3	
M1	117	3.2	3.7	18.7	
AJCC stage					0.001*
I	73	17.7	11.0	7.2	
II	118	46.8	37.0	31.9	
III	125	32.2	48.0	42.0	
IV	68	3.3	4.0	18.9	
differentiation					0.001*
high	89	66.0	50.0	32.0	
moderate	167	27.4	36.0	41.0	
low	128	6.6	14.0	27.0	

rsob.royalsocietypublishing.org Open Biol. 8: 180132

Reduced interleukin-38 in non-small cell lung cancer is associated with tumor progression

Open Biol. 8: 180132. <http://dx.doi.org/10.1098/rsob.180132>

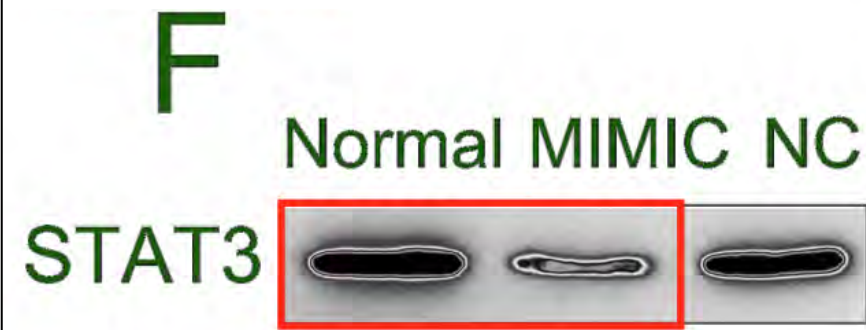
**Table 1.** Association between clinicopathological features and miR-125a-5p expression.

	n	miR-125a-5p expression in tumour		p-value
		high (n = 292, %)	low (n = 92, %)	
age, years				0.393
<65	170	34.0	45.0	
≥65	214	66.0	55.0	
gender				0.521
male	180	48.4	39.1	
female	204	51.6	60.9	
T stage				0.008*
T1	6	3.2	3.0	
T2	21	16.1	5.7	
T3	172	46.9	29.1	
T4	185	33.8	62.2	
N stage				0.005*
N0	94	67.7	40.7	
N1	158	25.7	34.7	
N2	132	6.6	24.6	
M stage				0.001*
M0	268	96.8	81.3	
M1	116	3.2	18.7	
AJCC stage				0.008*
I	72	17.7	7.2	
II	119	46.8	31.9	
III	125	32.2	42.0	
IV	68	3.3	18.9	
differentiation				0.002*
high	88	66.0	32.0	
moderate	168	27.4	41.0	
low	128	6.6	27.0	
vascular invasion				0.002*

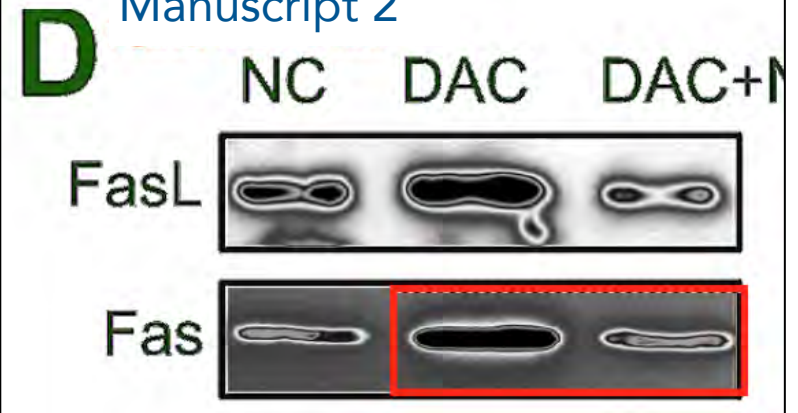
Reduced miR-125a-5p level in non-small- cell lung cancer is associated with tumour progression

Open Biol. 8: 180118. <http://dx.doi.org/10.1098/rsob.180118>

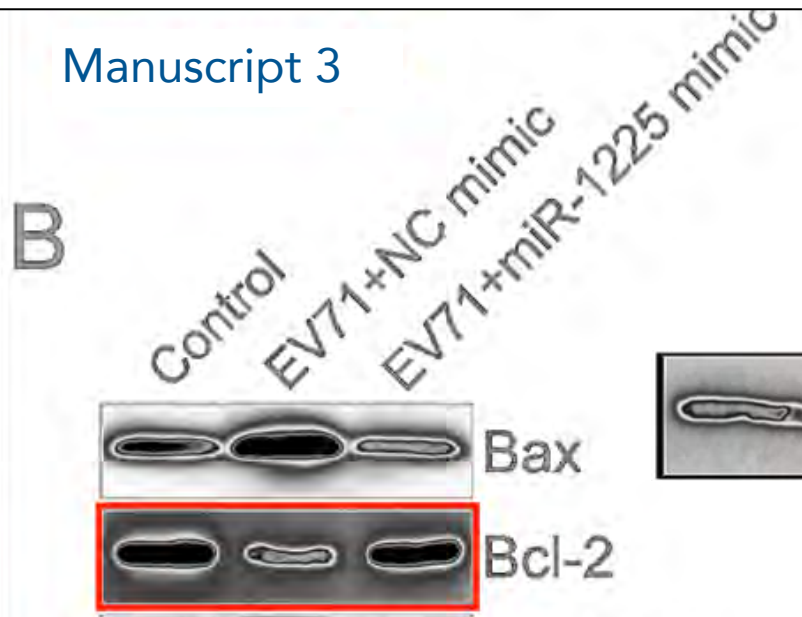
Manuscript 1



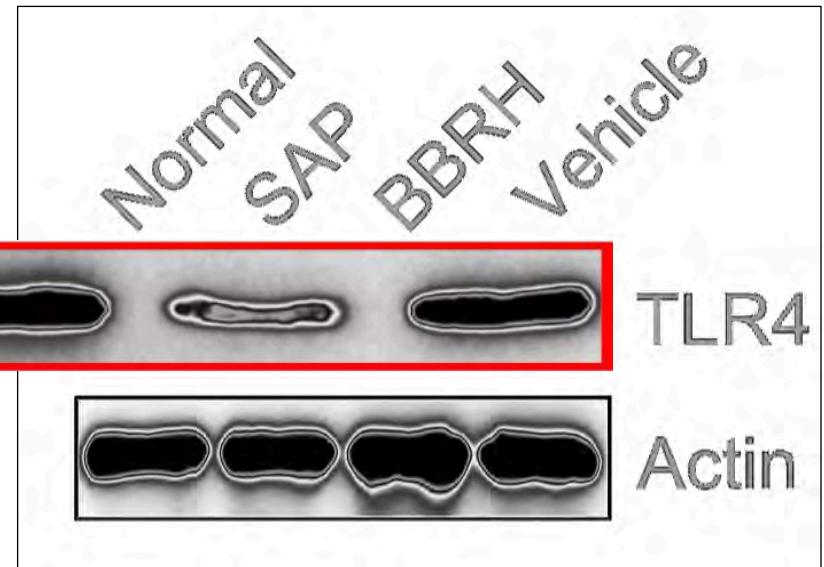
Manuscript 2



Manuscript 3



FEBS Openbio





**C**

Nuclear p65

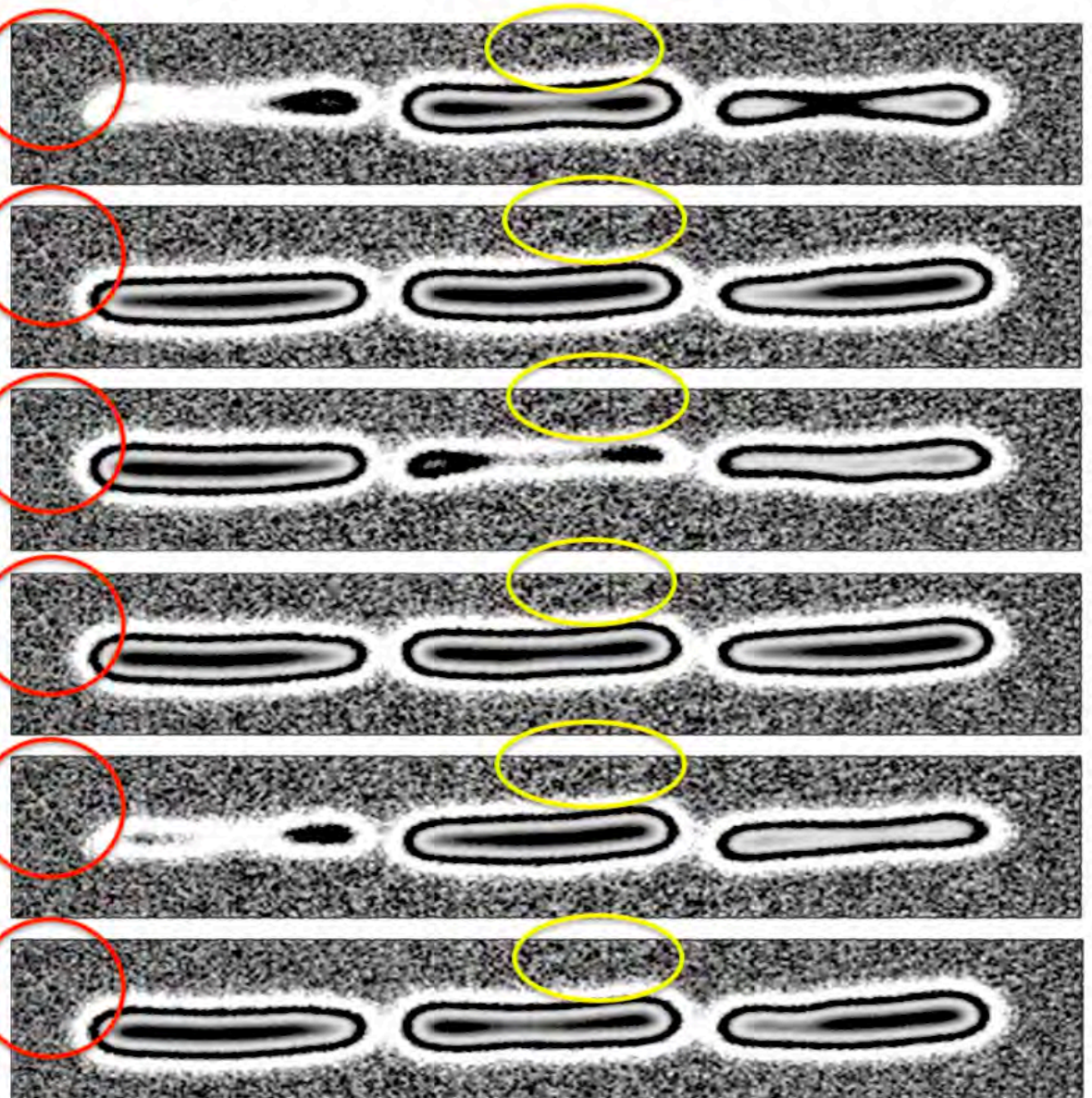
Lamin B

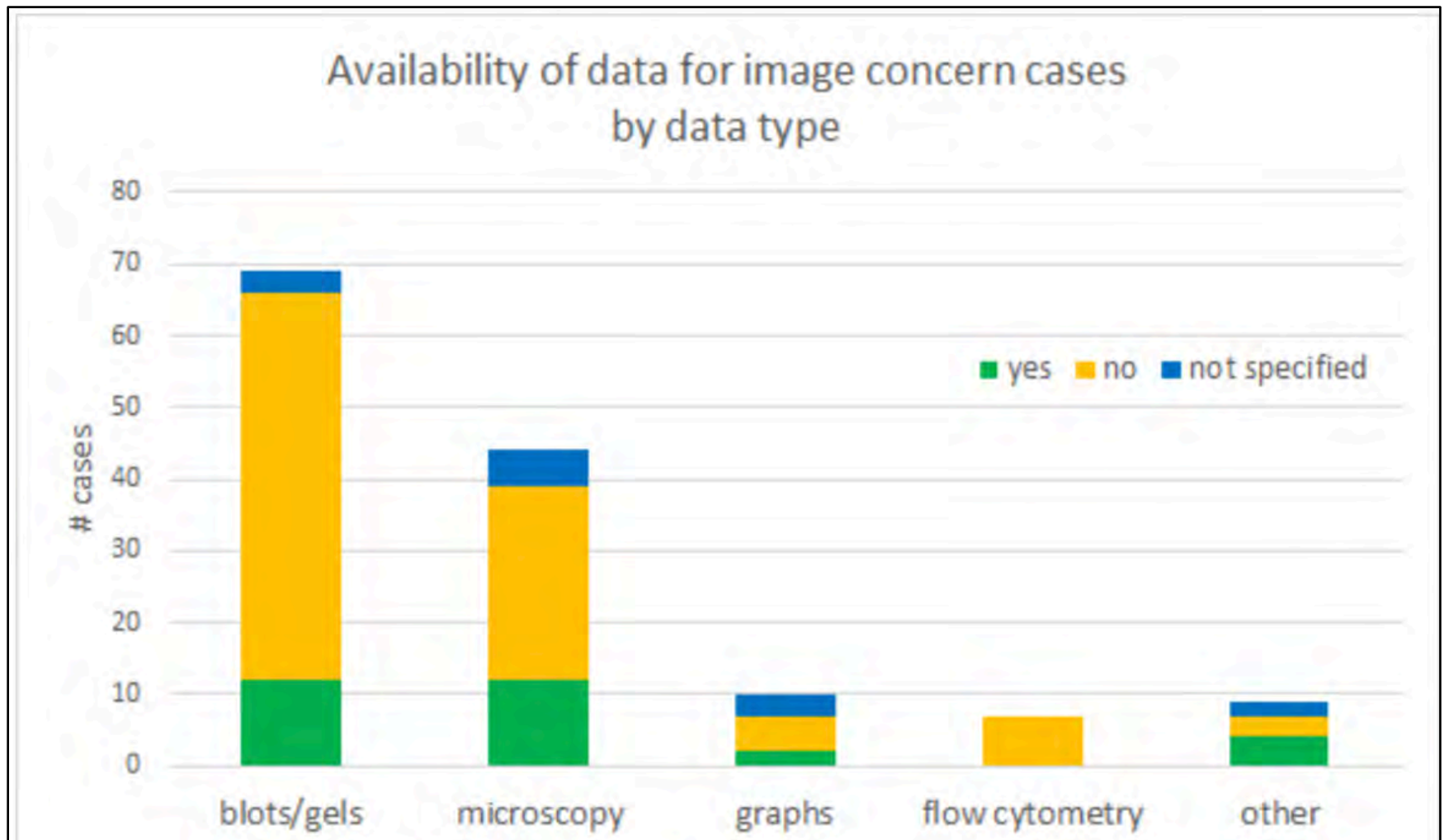
Cytoplasmic p65

I $\kappa$ B $\alpha$

p-I $\kappa$ B $\alpha$

GAPDH





The original data play an essential role in clarifying image integrity issues when raised, but unfortunately authors are often unable to provide these data after publication

# RAW DATA

I reply to your letter with regret. The three main researchers in the study died in a plane crash last week. The computers they were carrying containing a large amount of research data were also destroyed, including the data from this article  
(...)

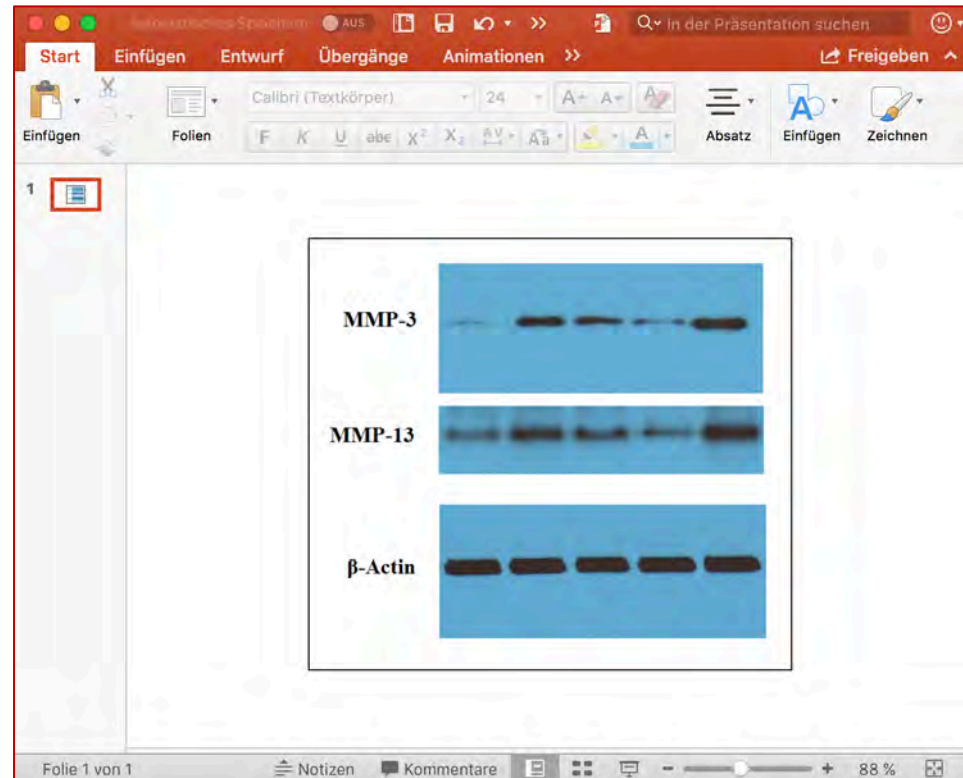
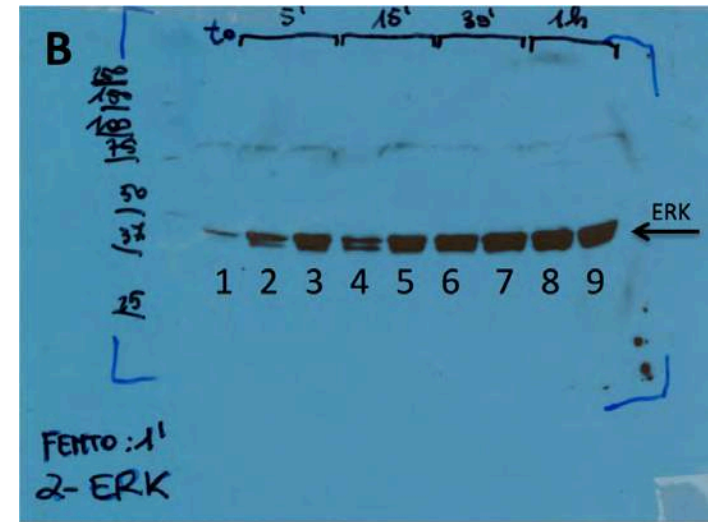
If there is a real problem with the data from this study, we will also arrange to re-test.

Alternative/replacement images are **not a substitute for missing raw data**

Many journals now strongly encourage authors to supply RAW DATA for blots and micrographs at submission stage.

Need to specify clearly what will be accepted as raw data:  
**Uncropped, unprocessed images for photomicrographs, blots, and gels including weight markers**

**Alternative/replacement images are not a substitute for missing raw data**





## Summing up:

- Image problems are a potential indicator of illegitimate scientific conduct.
- Editors have a duty and are ethically obliged to act if they suspect misconduct
- We are dealing with a vast variety and scope of possible problems
- in a considerable proportion of submissions and published papers
- There is evidence of systematically fabricated submissions using fake or stock images (paper mills)

# We need to

- Remain vigilant
- Tidy up the literature transparently
- Journals should have screening routine in place (also automated systems)
- Work out an infrastructure and a common framework for detecting image problems within and between journals
- Establish a culture of honesty in the labs, work closely with primary data
- Educate young scientists – training, supervision, mentoring

Integrity is doing the right thing,  
even when no one is watching.

*C. S. Lewis*

# Reading list

## Prevalence of Image duplications

**Analysis and Correction of Inappropriate Image Duplication: the Molecular and Cellular Biology Experience.**  
Bik EM1, Fang FC2,3, Kullas AL4, Davis RJ5, Casadevall A6 (2018). Mol Cell Biol. 2018 Sep 28;38(20).

## Ethics:

### **What is Ethics in Research & Why is it Important?**

David B. Resnik (2015) NIH, <https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm>

### **On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition (2009)**

Committee on Science, Engineering, and Public Policy

<https://www.nap.edu/catalog/12192/on-being-a-scientist-a-guide-to-responsible-conduct-in>

**COPE code of conduct** <https://publicationethics.org/resources/code-conduct>

**Avoiding Twisted Pixels:** Ethical Guidelines for the Appropriate Use and Manipulation of Scientific Digital Images.  
DW Cromey (2010). Sci Eng Ethics. 2010 Dec; 16(4): 639–667. <https://link.springer.com/article/10.1007/s11948-010-9201-y>

## Automated screening:

### **Researchers have finally created a tool to spot duplicated images across thousands of papers**

<https://www.nature.com/articles/d41586-018-02421-3>

## Paper mills:

### **China's Publication Bazaar**

<https://science.sciencemag.org/content/342/6162/1035>

### **Elisabeth Bik**

<https://scienceintegritydigest.com/2020/02/21/the-tadpole-paper-mill/>

### **Systematic fabrication of scientific images revealed**

Jana Christopher (2018) FEBS Letters <https://doi.org/10.1002/1873-3468.13201>

### **Digital magic, or the dark arts of the 21st century—**

### **how can journals and peer reviewers detect manuscripts and publications from paper mills?**

Jennifer A Byrne, Jana Christopher (2020) FEBS Letters <https://doi.org/10.1002/1873-3468.13747>

### **The Possibility of Systematic Research Fraud Targeting Under-Studied Human Genes:**

### **Causes, Consequences, and Potential Solutions**

Jennifer A Byrne 1 2, Natalie Grima 1, Amanda Capes-Davis 3, Cyril Labbé 4, [doi: 10.1177/1177271919829162](https://doi.org/10.1177/1177271919829162)

## Framework:

### **Publishers launch joint effort to tackle altered images in research papers**

<https://www.nature.com/articles/d41586-020-01410-9>

### **STM Working Group**

<https://www.stm-assoc.org/standards-technology/working-group-on-image-alterations-and-duplications/>