The Meaning of Academic Honesty and How to Uphold It



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Changing Times and changing practices

Sharing Knowledge

Research ethics



Higher education

- many goals with no single focus
 - •Prepares students for work as a Professional
 - Provides economic opportunities
 - •Attempts to inculcate "values", "general knowledge" and "character"
 - Provides specialized skills
 - •Provokes young people to look at the world a new, more complex way

Today, the new i-generation students stand at the crossroads of a new way of conceiving texts and the people who create them and who quote them.



-Susan Blum "My Word!: Plagiarism and College Culture"

Where do students learn ethical decision making?

- 1. Mentor, advisor
- 2. Fellow graduate students
- 3. Family
- 4. Friends not in graduate school
- 5. Other faculty
- 6. Religious beliefs
- 7. Discussions in courses, labs, seminars
- 8. Professional organizations
- 9. Courses dealing with ethical issues
- 10. Social Network!!!





J. P. Swazey, K. S. Louis, and M. S. Anderson, "The ethical training of graduate students requires serious and continuing attention," *Chronicle of Higher Education 9 (March 1994):B1–2; J. P. Swazey, "Ethical* problems in academic research," *American Scientist 81(Nov./Dec.* 1993):542–53.

Three sets of obligations of a researchers to adhere to professional standards.

- 1. An obligation to honor the trust that their colleagues place in them.
- An obligation to themselves.
 Irresponsible conduct in research can make it impossible to achieve a goal.



3. An obligation to act in ways that serve the public.

On Being Scientist http://www.nap.edu/catalog/12192.html Available free for one download

SHARING RESEARCH KNOWLEDGE



Scientific Knowledge

The object of research is to extend human knowledge beyond what is already known.

But an individual's knowledge enters the domain of science only after it is presented to others in such a fashion that they can independently judge its validity

(NAP, "On Being a Scientist" 1995)

Sharing Scientific Knowledge

"Science is a shared knowledge based on a common understanding of some aspect of the physical or social world"

(NAP, "On Being a Scientist" 1995)

Presentations

- Social conventions play an important role in establishing the reliability of scientific knowledge

Publications in peer reviewed journals

- Research results are privileged until they are published

Thesis



Why Publish?

- "A paper is an organized description of hypotheses, data and conclusions, intended to instruct the reader. If your research does not generate papers, it might just as well not have been done" (G.Whitesides, Adv. Mater., 2004, 16, 1375)
- **"if it wasn't published, it wasn't done" -** in E.H. Miller 1993



Authorship

- The list of authors establishes <u>accountability</u> as well as <u>credit</u>.
- Policies at most research journals state that a person should be listed as the author of a paper only if that person made a direct and substantial intellectual contribution to the design of the research, the interpretation of the data, or the drafting of the paper.
- The acknowledgments section can be used to thank those who indirectly contributed to the work.

Including "honorary," "guest," or "gift" authors dilutes the credit due the people who actually did the work, inflates the credentials of the added authors, and makes the proper attribution of credit more difficult. ("On Being a Scientist", NAP)



(From ORI http://ori.dhhs.gov/education/products/R CRintro/c02/0c2.html)



The demise of the lone author

Mott Greene

As the average number of contributors to individual papers continues to rise, science's credit system is under pressure to evolve.

Any issue of *Nature* today has nearly the same number of Articles and Letters as one from 1950, but about four times as many authors.

The lone author has all but disappeared. In most fields outside mathematics, fewer and fewer people know enough to work and write alone.



Nature 450, 1165 (2007) | doi:10.1038/4501165a

Author Responsibilities

- Preparation and Submission of Manuscripts:

Follow General Rules:

- Ensure work is new and original research
- All Authors are aware of submission and agree with content and support submission
- Agree that the manuscript can be examined by anonymous reviewers.
- Provide copies of related work submitted or published elsewhere
- Obtain copyright permission if figures/tables need to be reproduced
- Include proper affiliation



What is publishable....

Journals like to publish papers that are going to be widely read and <u>useful to the readers</u>

- Papers that report "original and significant" findings that are likely to be of interest to a broad spectrum of its readers
- Papers that are **well organized and well written**, with clear statements regarding how the findings relate to and advance the understanding/development of the subject
- Papers that are concise and yet complete in their presentation of the findings



What is not acceptable...

- Papers that are routine extensions of previous reports and that do not appreciably advance fundamental understanding or knowledge in the area
- Incremental / fragmentary reports of research results
- Verbose, poorly organized, papers cluttered with unnecessary or poor quality illustrations
- Violations of ethical guidelines, including plagiarism of any type or degree (of others or of oneself) and questionable research practices (QRP)

Publication in the Modern Era

The submission of manuscripts via the Web, transmission of articles to reviewers, especially between continents, and delivery of reviews and galley proofs to authors has revolutionized the speed of publication.

Linking is now ubiquitous in electronic journals, principally in HTML versions. The ACS Web journals have links from bibliographic references directly to the primary source in ACS journals

ChemPort provides linking to 3723 journals from 197 publishers (as of July 11, 2003).

CrossRef, which serves across all scholarly research, provides links to 8156 journals from 221 participating publishers. CrossRef uses the **DOI** (digital object identifier)

Users have a strong preference for articles in PDF format over HTML.

RESEARCH ETHICS

Who Owns the Research Data?

If you are working for an institution or organization, you have to follow the rules set by your organization.

You do not own the intellectual rights! Your institution does!!



(From ORI http://ori.dhhs.gov/education/products/RCRintro /c02/0c2.html)





July 26, 2010 Volume 88, Number 30 Scientist Held For Trade Secret Theft Ann M. Thayer

The FBI has arrested Ke-xue Huang, a former Dow AgroSciences employee, on charges that include 12 counts related to the theft of trade secrets to benefit a foreign government and five counts of foreign transportation of stolen property.

As discussed at a July 19 public hearing, Huang's attorney, James P. Duggan, tells C&EN, the case centers on the disclosure of confidential Dow information on spinosyn insecticide biosynthesis in a review article first published online in late 2008 (*Appl. Microbiol. Biotechnol.* 2009, *82*, 13).

Huang is the lead author and his affiliation is given as China's Hunan Normal University; his coauthors include three HNU scientists and a U.S. scientist also believed to have previously worked at Dow



http://ori.dhhs.gov/misconduct/definition_misconduct.shtml

Research Misconduct

Research misconduct means Fabrication, Falsification, or Plagiarism (FFP) in proposing, performing, or reviewing research, or in reporting research results.

(a) <u>Fabrication</u> is making up data or results and recording or reporting them.

(b) <u>Falsification</u> is manipulating research materials, equipment, or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.

(c) <u>Plagiarism</u> is the appropriation of another person's ideas, processes, results, or words without giving appropriate credit.

(d) Research misconduct does not include honest error or differences of opinion.

Data Manipulation or Fabrication

Data Manipulation

- Researchers who manipulate their data in ways that deceive others are violating both the basic values and widely accepted professional standards of science. failure to fulfill all three obligations.
- They mislead their colleagues and potentially impede progress in their field or research.
- They undermine their own authority and trustworthiness as researchers.

Misleading data can also arise from poor experimental design or careless measurements as well as from improper manipulation.

When a mistake appears in a journal article or book, it should be corrected in a note, erratum (for a production error), or Additions/Corrections





Addition/Correction pubs.acs.org/NanoLett

Chopstick Nanorods: Tuning the Angle between Pairs with High Yield

Rajasekhar Anumolu,* Benjamin J. Robinson, and Leonard F. Pease, III

Nano Letters 2013 ASAP

This article is being retracted due to concerns over the integrity of the data. The originally published PDF of this article is available as Supporting Information.

Other Types of Ethical Violations

- Failure to inform the editor of <u>related</u> papers that the author has under consideration or "in press"
- Unrevealed conflicts of interest that could affect the interpretation of the findings
- Misrepresentation of research findings use of selective or fraudulent data to support a hypothesis or claim

Plagiarism and Duplication



Definitions:

- Plagiarism: using the ideas or words of another person without giving appropriate credit (Nat. Acad. Press document)
- Self-Plagiarism: The verbatim copying or reuse of one's own research (IEEE Policy statement)

Both types of plagiarism are considered to be unacceptable practice in scientific literature



Plagiarism Lines Blur for Students in Digital Age

http://www.nytimes.com/2010/08/02/education/02cheat.html?pagewanted=1

New York Times By TRIP GABRIEL Published: August 1, 2010

"....many students simply do not grasp that using words they did not write is a serious misdeed.

Digital technology makes copying and pasting easy, of course. But that is the least of it.

The Internet may also be redefining how students — who came of age with music file-sharing, Wikipedia and Web-linking understand the concept of authorship and the singularity of any text or image. "

"A University of Notre Dame anthropologist, Susan D. Blum, disturbed by the high rates of reported plagiarism, set out to understand how students view authorship and the written word, or "texts" in Ms. Blum's academic language. (See "My Word!: Plagiarism and College Culture,")"

"Our notion of authorship and originality was born, it flourished, and it may be waning," Ms. Blum said. "Students who plagiarize, who improperly incorporate someone else's text into their own without giving credit, may be committing a grave academic misdeed. Some really don't know how to avoid it, because the rules are terribly subtle and take many years to master. Some deliberately do so to get the job done."

-Susan Blum "My Word!: Plagiarism and College Culture"





A tale of two citations

Mounir Errami & Harold Garner *Nature* **451**, 397-399 (24 Jan 2008) doi:10.1038/451397a

"It is the best of times, it is the worst of times". Scientific productivity, as measured by scholarly publication rates, is at an all-time high. However, high-profile cases of scientific misconduct remind us that not all those publications are to be trusted — but how many and which papers?

The most unethical practices involve substantial reproduction of another study (bringing no novelty to the scientific community) without proper acknowledgement. If such duplicates have different authors, then they may be guilty of plagiarism, whereas papers with overlapping authors may represent self-plagiarism.

Simultaneous submission of duplicate articles by the same authors to different journals also violates journal policies.

Example of Duplication

Original Paper Oriented Assembly of Fe3O4 Nanoparticles into Monodisperse Hollow Single-Crystal Microspheres Yu et al, J. Phys. Chem. B 2006, 110, 21667-21671 (Figure 3)







Plagiarized paper:

Fabrication of Monodisperse Magnetic Fe3O4-SiO2 Nanocomposites with Core-Shell Structures Hua Fang,* Chun-yang Ma, Tai-li Wan, Mei Zhang, and Wei-hai Shi J. Phys. Chem C 2007, 111, 1065-1070

Original paper:

Ultra-large-scale syntheses of monodisperse nanocrystals, Park et al. Nature Materials, 2004, 3, 891 (Figure 3C)



Mounir Errami & Harold Garner *Nature* **451**, 397-399 (24 Jan 2008)



China and Japan, have estimated duplication rates that are roughly twice that expected for the number of publications they contribute to Medline. Perhaps the complexity of translation between different scripts, differences in ethics training and cultural norms contribute to elevated duplication rates in these two countries.

Sooner or later ethical violations get exposed

Some famous examples

Pioneering Physics Papers Under Suspicion for Data Manipulation

Recent discoveries at Bell Laboratories-the research arm of Lucent Technologies in Murray Hill, New Jersey-said to be of Nobel quality suddenly became mired in questions last week. Outside researchers presented evidence to Bell Labs management on 10 May suggesting possible manipulation of data involving five papers published in Science, Nature, and Applied Physics Letters over 2 years. In response, Bell Labs officials said that they are forming a committee of independent researchers to investigate. Their conclusions may not be known for months, but scientists who have seen the data are already saying that the potential fallout from the investigation could be devastating.

The Bell Labs papers describe a series of different experiments with organic conducAngeles, and director of the California NanoSystems Institute: "It's hard to understand. I know these people. Most of them are good, careful scientists." "It's a little overwhelming," adds Lydia Sohn, a Princeton University physicist who helped bring some of the discrepancies to light. "It's just disturbing, and disappointing, and sad." The noise pattern is particularly disturbing, says Charles Lieber, a chemist and nanoscience expert at Harvard University in Cambridge, Massachusetts: "It's virtually impossible for me to believe that some of this wasn't made up."

Schön himself acknowledges that the similar noise pattern is "difficult to explain." But others affiliated with Bell Labs suggest privately that a systematic artifact in the measurement equipment might account for

24 MAY 2002 VOL 296 SCIENCE, p 1376



Striking resemblance. Published data from studies of different devices revealed a similarity in recorded "noise." Schön says the bottom figure was sent to *Science* by mistake (see correction, p. 1400). 27 JULY 2007 VOL 317 SCIENCE www.sciencemag.org

Science

Retraction

WE WISH TO RETRACT OUR REPORT "CDX2 GENE EXPRESSION AND TROPHECTODERM LINEAGE specification in mouse embryos" (1). Allegations of research misconduct were received by the University of Missouri-Columbia (MU) Provost, and an investigation found that the first author (K.D.) engaged in research misconduct by intentionally falsifying and fabricating digital images in the preparation of Figs. 4I; 4N; 4S; 2G; 3, J to L; S2, V to X; and S6, I to K accompanying the *Science* article. In addition, the original raw image files for the majority of the figures in the paper have not been located (the exceptions being the confocal scanning images in Figs. S1, S3, S4, S5, and S6), raising the possibility that the data they represent may also be suspect. We have decided to withdraw the article in its entirety in view of the fact that the paper was founded at least in part on falsified or fabricated images.

The corresponding author (R.M.R.) takes responsibility for placing excessive trust in his coworker and for not assuring that a complete set of raw data existed at the time the questions first arose about the paper. We deeply regret any scientific misconceptions that have resulted from the publication of this article.

The first author resigned from MU shortly after the allegations of research misconduct were received and could not be found to sign the retraction.

R. MICHAEL ROBERTS,¹ M. SIVAGURU,² H. Y. YONG³

¹Division of Animal Sciences, University of Missouri, Columbia, MO 65211, USA. ²Institute for Genomic Biology, University of Illinois, Urbana-Champaign, IL 61801, USA. ³BK21 Dental Research Institute, College of Dentistry, Seoul National University, 28 Yongun-dong, Chongno-gu, Seoul 110-749, Korea.

Reference

1. K. Deb, M. Sivaguru, H. Y. Yong, R. M. Roberts, Science 311, 992 (2006).

Reactome Array Paper May Be Withdrawn Lead author's own institution recommends report be retracted

William Schulz & Carmen Drahl Chemical & Engineering News August 10, 2010

An ethics panel of the Spanish Council for Scientific Research (CSIC) has recommended that the journal *Science* withdraw a paper on which one of its own researchers, Manuel Ferrer, was the lead author. Ferrer's paper describes a reactome array, a sensitive metabolite array for obtaining detailed quantitative profiles of a cell's metabolic networks (*Science* 2009, *326,* 252).

When the paper was published last year, it generated significant controversy because of the chemistry it described. Prof. Laura L. Kiessling (UW, Madison), characterized the paper's chemistry as "unlikely," while other experts raised the possibility that its data were fraudulent. Ferrer posted additional data on the reactome array on the CSIC website in an attempt to clarify his work, but that has apparently not quelled critics' concerns.

Reactome Array: Forging a Link Between Metabolome and Genome

9 OCTOBER 2009 VOL 326 SCIENCE www.sciencemag.org


The Chronicle of Higher Education, August 11, 2006 Also in Wall Street Journal –today's issue (40% students use materials downloaded from internet!)

The Plagiarism Hunter

When one graduate student went to the library, he found copycats — lots of them By PAULA WASLEY, Athens, Ohio

In Ohio University's Library, Thomas A. Matrka takes just 15 minutes to hit pay dirt. Scattered before him on a table are 16 chemical-engineering master's theses on "multiphase flow." Identical diagrams in two theses from 1997 and 1998 strike him as suspicious. Turning a few more pages, he confirms what he suspected......

Most of the plagiarism found at Ohio occurred in introductory chapters describing research methods and reviewing the previous literature in the field, for which there is little expectation of originality. And all but a few cases involved international students who, he says, whether through ignorance, laziness, or cultural misunderstanding, may have either not known correct citation practices or, struggling to write in a foreign language, been tempted to borrow another student's words.

How Journals Detect and Handle Problem Papers

- Information received from reviewers or other editors
 Literature search for related papers by the author
- Withdrawal of a paper from publication
- Banning authors from publication in the journal for 3-5 years and informing the co-authors and editors of related journals of our action
- For less serious cases, placing the author on a "watch list" for careful examination of their submissions prior to requesting reviews

RETRACTED: Fluorescence lifetime increase by introduction of F⁻ ions in ytterbium-doped TeO₂-based glasses

Journal of Alloys and Compounds, Volume 393, Issues 1-2, 3 May 2005, Pages 279-282 Guonian Wang, Shixun Dai, Junjie Zhang, Shiqing Xu and Chonghong Jiang

RETRACTED: Effect of F- ions on spectroscopic properties of Yb³⁺-doped zinc-tellurite glasses • *Journal of Physics and Chemistry of Solids, Volume 66, Issue 6, June 2005, Pages 1107-1111* Guonian Wang, Junjie Zhang, Shixun Dai, Jianhu Yang and Zhonghong Jiang

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Home » Science & Technology » A Massive Case Of Fraud SCIENCE / TECHNOLOGY

FEBRUARY 18, 2008 VOLUME 86, NUMBER 07 PP. 37-38

A Massive Case Of Fraud

Journal editors are left reeling as publishers move to rid their archives of scientist's falsified research

William G. Schulz

A CHEMIST IN INDIA has been found guilty of plagiarizing and/or falsifying more than 70 research papers published in a wide variety of Western scientific journals between 2004 and 2007, according to documents from his university, copies of which were obtained by C&EN. Some journal editors left reeling by the incident say it is one of the most spectacular and outrageous cases of scientific fraud they have ever seen.

The culprit, sources say, is chemistry professor Pattium Chiranjeevi of <u>Sri Venkateswara University</u> in Tirupati, India. SVU conducted an investigation into Chiranjeevi's work after a journal editor presented evidence to university officials that the professor had plagiarized and possibly falsified several manuscript submissions. Chiranjeevi, who communicates through a wide variety of e-mail addresses, has not responded to multiple requests for comment by C&EN.



Chiranjeevi retains his teaching position at SVU, according to a university source who has requested anonymity. "He is a permanent employee of the university, and the administration cannot fire him easily," the source says. Instead, Chiranjeevi has been barred from research and research supervision and from holding any administrative post at the university.

A CHEMIST IN INDIA has been found guilty of plagiarizing and/or falsifying more than 70 research papers published in a wide variety of Western scientific journals between 2004 and 2007, according to documents from his university, copies of which were obtained by C&EN. Some journal editors left reeling by the incident say it is one of the most spectacular and outrageous cases of scientific fraud they have ever seen.

Can Stem Cells Become Sperm Cells?

A Potential New Hope for Infertile Men

By RADHA CHITALE

ABC News Medical Unit

July 9, 2009



Professor Karim Nayernia, is seen at Newcastle University



Health

Now, new research may provide a glimmer of hope that infertile men may one day be able to contribute to the gene pool.

"We have a system which enables us for the first time to produce human sperm from stem cells," said Dr. Karim Nayernia, a professor of stem cell biology at Newcastle University in the United Kingdom and the lead researcher on this study, published July 8 in the journal Stem Cells and Development.

"Studying sperm maturation is not accessible in vivo [in a body]. You cannot follow the system," Nayernia said. "Now we have a system to monitor the stages of male infertility."



ScienceInsider

Breaking news and analysis from the world of science policy



Journal Editor Retracts Paper on Sperm Made From Stem Cells

The paper, published online by *Stem Cells and Development* on 8 July with Karim Nayernia of Newcastle University in the United Kingdom as the corresponding author, had already received some criticism from other experts; Dr Allan Pacey of the University of Sheffield in the United Kingdom, for example, was quoted by <u>The</u> <u>Independent</u> as saying: "As a sperm biologist of 20 years' experience, I am unconvinced from the data presented in this paper that the cells produced ... can be accurately called 'Spermatozoa.' "

The paper's problems soon got much worse. Graham Parker, editor-in-chief of *Stem Cells and Development*, told *Science*Insider that he received an email on 10 July from the editors of another journal, *Biology of Reproduction*, claiming that **two paragraphs from Nayernia paper's introduction were copied without attribution from a** <u>2007 review article</u> by Makoto Nagano of McGill University in Montreal, Canada, that was published in their journal.

Parker says Nayernia told him the offending text was inserted by a postdoctoral fellow. But Parker says the explanation he received was not consistent with an innocent mistake. "Once I had established that the suggested reason for the text's inclusion was not being substantiated I decided to retract the paper" on 21 July, Parker says.

RETRACTION WATCH

Daily updates on retractions at *retractionwatch.com*

Misconduct dissolves paper on possible clot-busters

with one comment

Drug researchers in India have lost their 2013 paper in <u>ACS Medicinal Chemistry Letters</u> because the first author fabricated findings.

The article, by a group from the <u>Maharaja Sayajirao University of Baroda</u>, Vadodara, in Gujarat, was attempting to synthesize and screen novel clot-busting drugs; <u>one compound</u> <u>exhibited the same activity as aspirin or warfarin</u>, but without increasing bleeding time.

Sadly, it appears as if this potential medical advance was not to be. Here's the retraction <u>notice</u> for "Novel 2-Aminobenzamides as Potential Orally Active Antithrombotic Agents": <u>Read the rest of this entry »</u>



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What are the reasons for plagiarism?



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http://www.indiana.edu/~wts/pamphlets/plagiarism.shtml

Responding to Possible Plagiarism

SCIENCE VOL 323 6 MARCH 2009, p1293

Documenting reactions from authors and journal editors to plagiarism may help others address the problem.

Tara C. Long,¹ Mounir Errami,² Angela C. George,¹ Zhaohui Sun,² Harold R. Garner^{1,2*}

212 pairs of articles with signs of potential plagiarism were chosen for this study

86.2% -similarity between an original article and its duplicate

73.1%. the average number of shared references

Only 47 (22.2%) duplicates cited the original article as a reference.

71.4% of the manuscript pairs shared at least one highly similar or identical table or figure.

42% also contained incorrect calculations, data inconsistencies, and reproduced or manipulated photographs.

....The increasing availability of scientific literature on the World Wide Web has proven to be a double-edged sword, allowing plagiarism to be more easily committed, while simultaneously enabling its simple detection through the use of automated software.

SCIENTIFIC INTEGRITY

Responding to Possible Plagiarism

SCIENCE VOL 323 6 MARCH 2009, p1293

Documenting reactions from authors and journal editors to plagiarism may help others address the problem.

Tara C. Long,¹ Mounir Errami,² Angela C. George,¹ Zhaohui Sun,² Harold R. Garner^{1,2*}

The responses from duplicate authors were more varied;

- 28% denied any wrongdoing,
- 35% admitted to having borrowed previously published material
- 22% were from coauthors claiming no involvement in the writing of the manuscript.
- 17% claimed they were unaware that their names appeared on the article

93% of the original authors were not aware of the duplicate's existence.

The journal editors primarily confirmed receipt and addressed issues involving policies and potential actions.

Selected Responses from the authors

"There are probably only 'x' amount of word combinations that could lead to 'y' amount of statements. ... I have no idea why the pieces are similar, except that I am sure I do not have a good enough memory

"I was not involved in this article. I have no idea why my name is included."

"This article was mainly done by a young fellow Dr. []. I made the corrections in text and completed the article Unfortunately Dr. [] has died in January this year, so we can't ask him for the reasons....."

"I am not a native English speaker so I do have problems in expressing my ideas... You and other English language speakers are lucky from this point of view...."

"To be honest with you, I was not aware of the fact that I need to take prior permission of the authors of the original article. As such I am facing many difficulties and hardships in my personal life. ..."

The corresponding author has been my teacher (and a very good one at that) from whom I have learned many things. My respect for him was of the utmost level until I found that he had been plagiarizing papers from all over the world....."

Plagiarism Is Not a Big Moral Deal

By <u>STANLEY FISH</u>

August 9, 2010

http://opinionator.blogs.nytimes.com/2010/08/09/plagiarism-is-not-a-big-moral-deal/?hp

"The rule that you not use words that were first uttered or written by another without due attribution is less like the rule against stealing, which is at least culturally universal, than it is like the rules of golf."

" If you're a professional journalist, or an academic historian, or a philosopher, or a social scientist or a scientist, the game you play for a living is underwritten by the assumed value of originality and failure properly to credit the work of others is a big and obvious no-no...."

But if you're a musician or a novelist, the boundary lines are less clear (although there certainly are some) and if you're a politician it may not occur to you "

"Plagiarism is breach of disciplinary decorum, not a breach of the moral universe."

Good Record Keeping

It is your fundamental obligation to create and maintain an accurate, accessible, and permanent record of data.



From ciaralira.wordpress.com

Record sufficient detail for others to check and replicate the work.

Depending on the field, it will require entering data into bound notebooks with sequentially numbered pages using permanent ink, using a computer application with secure data entry fields, identifying when and where work was done, and retaining data for specified lengths of time.

Every scientific result must be carefully prepared, submitted to the peer review process, and scrutinized even after publication.

Summary

COMMUNICATION: Be creative and effective in communicating your research

ACADEMIC HONESTY AND ETHICS: These are the pillars of research.

COURAGE:

Once you get your courage up and believe that you can do important problems, then you can. If you think you can't, almost surely you are not going to. Look for the positive side of things instead of the negative

DRIVE and COMMITMENT

According to Edison, "Genius is 99% perspiration and 1% inspiration."

DISCIPLINE:

- Follow dress code and work hours
- Be respectful and helpful
 - You should follow and cooperate rather than struggle against the system



For more research tips

See http://www.nd.edu/~pkamat/researchtips.html