Chapter 9

Ethical Conduct in Science

9.1 What are scientific ethics?

Ethics are systematic norms of behaviour that are acceptable to a community, profession or organization. In the conduct of science, the practices conducive to collective enquiry into natural phenomena that have developed through ages constitute ethical practices in science.

Scientific ethics have the following components.

Honesty: One has to strive for honesty in all scientific communications. Honestly report data, results, methods and procedures, and publication status. Do not fabricate, falsify, or misrepresent data. If you do not know something, admit it clearly (after all, science starts with the realization that we do not know something). If you are probing a question and your data are inconclusive, state it unambiguously. Do not deceive colleagues, granting agencies, or the public.

Objectivity: Strive to avoid bias in experimental design, data analysis, data interpretation, peer review, personnel decisions, grant writing, expert testimony, and other aspects of research where objectivity is expected or required. Minimize chances of experimental results being influenced by personal bias. Avoid self-deception.

Integrity: Keep your promises and agreements; act with sincerity; strive for consistency of thought and action. Disclose personal or financial interests that may affect research.

Carefulness: Avoid careless errors and negligence. Carefully and critically examine your own work and the work of your peers. Keep good records of research activities, such as data collection, research design, and correspondence with agencies or journals.

Openness: Share data, results, ideas, tools, resources. Be open to criticism and new ideas.

Remember, your learning through the educative process could be possible because knowledge was openly available to you. Whatever you have learned owes to past generations of scientists who have made their findings openly available to everybody. Therefore scientific ethics demands that you should also make your findings openly available to others.

Respect for Intellectual Property: However there are situations where some ideas may be patented with the hope that the idea may be used by some company to make a product or to improve an industrial process. Copyrights of books and research papers are owned by the publishers.

A scientist should honour patents, copyrights, and other forms of intellectual property. Do not use unpublished data, methods, or results without permission. If you are writing a book or an article and intend to use a figure, table, or other forms of scientific information that have been published by others, seek permission from the person or company that owns the copyright. If you intend to use a figure or a table from your own published work, then also you have to seek permission from the publisher of the journal where your paper earlier appeared.

Give credit where credit is due. Properly acknowledge all contributions to the research you are publishing. Never plagiarize, i.e., never copy chunks of text from the writings of others without mentioning where it is from.

Confidentiality: Protect confidential communications, such as papers submitted for publication, grants applications, personnel records, trade or military secrets, and patient records. If you are reviewing a paper, it should be treated as a confidential document, and you should not divulge information from that manuscript to others.

Responsible Publication: Publish in order to advance research and scholarship, not to advance just your own career. Avoid wasteful and duplicative publication.

Social Responsibility: Strive to promote social good and prevent or mitigate social harms through research, public education, and advocacy. You should not apply your knowledge in ways that can cause harm to the society and destruction of humanity. You should also propagate scientific temper among the people around you and should try to free them from various unscientific beliefs and superstitions.

Non-Discrimination: Avoid discrimination against colleagues or students on the basis of sex, race, caste, language, region or other factors that are not related to their scientific competence and integrity.

Competence: You should constantly try to improve your own professional competence and expertise through lifelong learning. Take steps to promote competence in science as a whole.

Animal Care: Show proper respect and care for animals when using them in research. Do not conduct unnecessary or poorly designed animal experiments.

Human Subjects Protection: When conducting research on human subjects, minimize harms and risks and maximize benefits. Respect human dignity and privacy. Take special precautions with vulnerable populations; and strive to distribute the benefits of research fairly.

[Adapted from Shamoo A and Resnik D. 2009. Responsible Conduct of Research, 2nd ed. (New York: Oxford University Press).]

9.2 Research misconduct

Research misconduct means and includes fabrication, distortion, or plagiarism in proposing, performing, or reviewing research, or in reporting research results, breach of confidentiality, and interference with other researchers' works.

The terms above have the following meanings.

Fabrication means wilful making up fake data or results, and recording or reporting them. Scientists sometimes take recourse to such unethical practices to earn recognition, fame, and sometimes, simply promotion. Some such cases are cited in Section 9.12.

Distortion means purposefully 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. Such malpractice often happens when a scientist's research results contradict his/her personal beliefs and assumptions.

Plagiarism means the appropriation of another person's ideas, processes, results (including formulas and computer codes) or expressions without giving appropriate credit. Copying and pasting passages from another paper, book, or homepage without acknowledgement amounts to plagiarism. Publishing or communicating the same content to multiple journals/conferences amounts to 'self-plagiarism', which is also considered an offence.

Breach of confidentiality means making public data of confidential nature, which are listed in the last section under the head 'Confidentiality'.

Interference means unnecessarily creating hurdles for another researcher's work by wilfully damaging or concealing materials, processes, hardware, data, text, or similar research objects.

Research misconduct does not include honest error or honest differences in interpretations or judgements of data. Inadvertent errors, experimental mistakes, or programming bugs are not considered to be research misconduct. But one should try by all means to avoid these.

A finding of research misconduct means that there is a significant departure from accepted practices followed by the relevant research community, that the misconduct is committed intentionally, or knowingly, or recklessly, and the allegation is proven by a significant volume of evidence.

9.3 Maintenance of research data

All researchers must keep a record of all experiments conducted by them and data thereof in a laboratory log-book with date, and get them duly authenticated by their corresponding supervisors periodically. This is required because, in the event of a dispute regarding the reported results, the Editor of the journal, or a scientific ethics committee (either at the national level or at the Institute level) may demand to see the raw data.

When a student completes the requirements of a degree and leaves the Institute, he (or she) can take a copy of the data/results obtained through his (or her) own work; and, can use these for his (or her) future research only if they are not needed to be kept confidential under contractual obligation with the sponsors of the research project. The original data should be maintained by the concerned faculty members also, and can be used for their future work.

In a research project, the principal investigator (PI) is responsible for the collection, management and retention of research data. PIs should adopt an orderly system of data organization and should communicate the chosen system to all members of a research group. For long-term research projects, in particular, PIs should establish and maintain procedures for the protection of essential records in the event of a natural disaster or other emergency.

In case of research conducted without external funding (including research by master's and doctoral students) the responsibility of the maintenance of research data lies with the scholar as well as his/her supervisor. Research data must be archived for a minimum of three years after the final project close-out, with original data retained wherever possible. If any charges regarding the research arise, such as allegations of scientific misconduct or conflict of interest, data must be retained until such charges are fully resolved. Data should be retained long enough because such disputes may arise years after the work is reported.

9.4 Dissemination of research results

The scientific community has established specific procedures for making one's research results known to the rest of the research community and to the general public. For a research work that does not involve secrecy or intellectual property (IP) protection requirements, the output is normally expected to be first published in a reputed, peer-reviewed scientific journal, thus exposing it to the scientific community at large, for their critical evaluation and subsequent use for new work. If the piece of work passes this test, it is recognized as a contribution to the body of human knowledge.

Many ethical issues arise out of authorship of scientific papers. So it warrants a detailed discussion.

9.4.1 Academic authorship

A majority of research is carried out by groups, each comprising a faculty member and his (or her) supervised students. In some cases more than one faculty member may guide a student. The principle governing the order of authorship of papers that result from such a work should be to recognize the relative weightage of the contribution from the individuals participating in a specific piece of work.

In a multi-authored paper, two of the authors assume prominent roles.

The first author: Except for experimental physics papers that involve hundreds of authors, in most papers the first author is considered to be the one who has maximum contribution both in terms of generating the idea and carrying out the work.

The corresponding author: The person who communicates the paper to the journal, and is responsible for answering all queries regarding the paper (including responses to the reviewers' comments).

In the initial stage of research association with a faculty member, a student normally undergoes the phase of becoming familiar with the broad research area, learning the methodology of research, doing literature survey, identifying the problem, learning the operation of any relevant equipment, and absorbing the 'culture' of the discipline. In this phase, the student's contribution may be in the form of simulating systems, writing programs, collecting data, or helping in the execution of experiments formulated by the faculty member. The student's contribution in this phase may be recognized through co-authorship in papers resulting from the work. After the end of that phase, it is expected that the greater share of the intellectual contribution comes from the student, so that the student can logically become the first author. But if the supervisor still has to generate the ideas and the student carries out the procedures as per instruction, the supervisor should be the first author of the paper resulting from such work.

A research work that leads to the PhD (or master's) degree of a student is supposed to be the joint work of the student and the supervisor. Naturally they should be co-authors of papers coming out of such work. However, if a student carries out a part of the research work independently without any intellectual support from his (or her) supervisor, the supervisor may allow him/her to communicate the work as a single-authored paper. But in such a case, prior written consent of the thesis supervisor(s) must be taken. If such a work needs to be considered for inclusion in the student's dissertation/thesis, it can only be done with the approval of the concerned supervisor(s). Publication of a piece of work as a single authored paper without the knowledge of the supervisor is considered to be scientific malpractice.

All the members of any research group should have access to the experimental/observational/computational results and should be able to check if the manuscript does adequately and accurately reflect the same. After a paper is published, if any dispute arises regarding the validity of the results, all the authors of the paper have to take responsibility.

The data generated by any earlier work may be used in any subsequent work with due reference and acknowledgement. But such data should not be reported in a dissertation/thesis in a manner implying to have been generated by the student's own research.

9.4.2 Interdisciplinary and collaborative research

Multi-investigator research teams may consist of people from different disciplines who perform different, specialized functions in an integral research plan. It is possible that the participants do not have full knowledge or understanding of parts of the work performed by their colleagues. In such situations, the following guidelines apply.

- The Principal Investigators involved in the project have special responsibilities to ensure the overall cohesiveness and validity of the work and the resultant publications on which they appear as co-authors. The PIs shall be accountable in case of disputes regarding the validity of the results.

- All authors in a group effort have a shared responsibility for the veracity and the originality of the published result and the methodology as well as the data acquisition and analysis procedures.

- Each author in a group should have access to the manuscript prior to its submission for publication, and should agree to his or her inclusion as a co-author. It is the responsibility of the corresponding author to ensure that all the participants in the programme know that the paper is being prepared for publication in a target journal.

- Early in the project, each research group should define appropriate practices for the maintenance of data after publication of the papers.

- If a student researcher participates in an interdisciplinary collaborative work (in which some parts of the work are carried out by others), he (or she) can include it in his (or her) PhD dissertation/thesis only after clearly demarcating his (or her) own contribution from the others', and with due acknowledgment of the contribution of the others.

In collaborative work with other institutions, one or more faculty members of an Institute, along with their students, carry out research work jointly with one or more faculty members and/or researchers of another organisation. In such situations, the guidelines listed in the last section should apply, and have to be interpreted accordingly.

In case of collaborative research, researchers are obliged to acknowledge or include (as co-author) the contribution of his/her collaborator in an appropriate manner.

9.5 Openness in research

Scientific research depends heavily on ready availability of knowledge created by earlier researchers. If some research has been conducted earlier, and a researcher in the present generation does not have access to the information, there is a risk of repeating the same work, and possibly repeating the mis-steps in that process—thus losing valuable research time. A researcher in the present generation has to remember this issue and so has to make every effort to make the results of his/her work available to anyone interested in it, so that future research can benefit from the knowledge he/she created. All interested persons should have access to the data, the processes, and to the final results of the research. In science there is no place for secrecy.

Sometimes scientists tend to be secretive, unwilling to share ideas and information, because they fear someone might 'steal' their ideas. But in general, scientists gain much more if they discuss ideas freely with others, because then others will also share their ideas. Science thrives in such atmosphere of free exchange of ideas and information.

But research conducted in companies and university research financially supported by private companies often demand such secrecy, where the result of the research would be known only within that company and not outside. This is often protected by Intellectual Property Rights (IPR). The results of such research are typically not disseminated through research journals or conference publications, and are protected by patents.

Students aspiring for degrees that involve thesis/dissertation work as a part of the curriculum should not normally take up research programmes involving secrecy. This is because a PhD student is expected to publish in scientific journals prior to submission of a thesis, and if a research programme demands secrecy, that may stand in the way of the student's research career. How would the student know if the project he/she is involved in demands secrecy? Normally, such sponsored research is initiated through a contract or some such document. A sponsored or contractul research programme can be regarded as requiring secrecy if any document pertaining to the sponsorship or contract establishes that any part of data, processes, or final results of such work is not freely publishable or can only have restricted access.

However, exception to this can be made at the discretion of the Institution or university on a case-to-case basis, and after signing the non-disclosure agreement with the Institute.

Confidentiality, however, may be maintained while making provision to protect

(a) the rights of privacy of individuals in research projects involving human subjects,

(b) the secrecy of input data where the research programme has to depend on information that is otherwise classified as sensitive by the State or is so perceived, and

(c) the secrecy of private papers, documents, diaries, and other analogous materials, both in writing and in digital form, which might be provided to the members of the research project, if deemed necessary.

9.6 Copyright issues

Since the IP policy protects against unauthorized reproduction of copyrighted materials and the law directly impinges upon the activities of researchers, it is important that all researchers are aware of the pertinent law and acquaint themselves with the IP Policy of the land.

It may be noted that the doctrine of "fair use," permits certain limited copying for educational or research purposes without the permission of the owner. Under this interpretation, the researchers are permitted to photocopy and distribute limited portions of copyrighted works purely for academic use only if conditions for "fair use" are met.

Note that providing copies from copyrighted materials as study materials is not a “fair use".

9.7 Unethical publishing practices

Sometimes scientific workers fall prey to the lure of quick career advancement and indulge in wrong practices when publishing their work. Some of the situations that are recognized as unethical are listed below.

1. Submitting the same paper to different journals without telling the editors
2. Not informing a collaborator of your intent to file a patent in order to make sure that you are the sole inventor
3. Including a colleague as a co-author in a paper in return for a favour, even though the colleague did not make a serious contribution to the paper
4. Trimming outliers from a data set without discussing your reasons in the paper
5. Using an inappropriate statistical technique in order to enhance the significance of your research
6. Conducting a review of the literature that fails to acknowledge the contributions of other people in the field or relevant prior work

The following situations are also treated as research misconduct:

1. Any researcher publishes another co-researcher’s work without including him (or her) as coauthor or even acknowledging him (or her).

2. A student communicates a paper containing the work carried out as part of the thesis/project/dissertation without the supervisor's consent.

3. A supervisor communicates a paper out of the work carried out by a student, without including the student as a co-author.

9.8 Ethics in reviewing

After a paper is submitted to a journal, the Editor identifies a few important researchers in the field and requests them to review the paper. The reviewers have to check whether scientific procedure has been followed in formulating the hypotheses, in testing the hypotheses, in reporting the results, etc. For example, if an experiment is being reported, the reviewer has to check whether all the conditions involved in the experiment, and all the parameters are properly reported, so that anyone can repeat the experiment. The following ethical issues are involved in the process of reviewing.

1. The review has to be based solely on the scientific merit of the paper, and not on the reviewer's perception about the authors' past work or his/her personal equation with the authors.

2. The recommendation should not be biased by whether or not the paper has cited the reviewer's own papers.

3. One should not discuss the confidential data from a paper that one is reviewing, with colleagues or collaborators.

Sometimes researchers tend to refuse review requests even if the concerned paper is directly in his/her area—because participating in a review does not have any impact on one's career advancement. That is why some people consider it a waste of time. But one has to remember that whenever he/she submits a paper to a journal, the Editor has to get at least three reviewers to process the paper. The system would not work unless each researcher agrees to review at least three papers for each paper he/she expects to get published. Therefore agreeing to review a paper (when the researcher has the necessary background to make informed comment about a piece of work) is also a part of scientific ethics.

9.9 Citation and impact of a paper

After a paper is published, the scientists in the relevant area repeat the work or use it for further work. If the scientific community finds the work important, they would cite the paper in their own papers. That is why the number of citations a paper gets is often treated as an indicator of the impact of that paper.

A good, lucid, and concise presentation style normally attracts more citations than clumsily prepared papers. The more people will read your paper, the more will be the chance of it being cited. That is why brevity matters (people have a natural propensity to read short papers). If the title and the abstract (people read these two to decide which papers they would actually read) can attract the attention of a large number of researchers, the paper stands a better chance of being cited by some of them. But ultimately what matters is the technical content of the paper, and whether or not it is useful to others.

Since the citation of a paper is often considered to be an indicator of the worth of a paper, the citations attracted by a researcher is often taken as an indicator of the scientific productivity of the researcher. It is used in various decision making exercises, e.g., the promotion of academic personnel. Similarly, the citations received by papers published in a journal indicate the quality of the journal, which is quantified by an "impact factor".

This has led to many unethical practices that have come to light over the past few years. Enough has been written about the unsuitability of impact factors in judging the quality of papers and journals. I will not delve upon that issue here. Rather, I will enumerate the ethical practices that one is expected to follow.

1. One should cite all the earlier work that have contributed to the knowledge-base that has formed the background of the paper.

2. One should not cite papers whose results are not directly or indirectly used in a paper, or which are not really relevant to the paper. One should not use citation as mark of gratitude for a favour received earlier.

3. One should not induce others to cite one's papers that are not really relevant to a given piece of work.

9.10 The lure of easy publicity

The process of submission of a research paper in a reputed journal, the review process, the revisions in response to the reviers' comments, the acceptance and its final publication take time. That too is only the first step. After the paper is published, researchers working in related fields worldwide come to know about it. Sometimes they repeat the work to check the reproducability of the results, sometimes they use the results of the work to do further research and the outcome of those researches validate your work. In their publications they cite your paper. This process takes time, and recognition comes only after researchers, worldwide, accept your results.

Sometimes there is a strong lure to sidestep this process to gain publicity. Some researchers issue press statements regarding their research results on their own. Sometimes they write articles in newspapers to publicize their own work. These practices should be conscientiously avoided. Until a piece of work goes through scientific scrutiny to gain acceptance, it must not be disseminated among the lay public who cannot distinguish between a first tentative step at finding the answer to a question and the stage at which science has found a definitive answer to that question.

If any researcher feels the need to make public announcement of an important development in view of the urgency of the situation, he or she should contact the concerned functionaries of the Institute or university. The decision to publicise a discovery should be taken by the university / institution after carefully checking if concerned work has gone through the peer review process of a reputed journal.

There are certain areas of research which are not very relevant to scientific journals, but are highly relevant in the Indian context. These are related to the scientific issues directly affecting the Indian people's lives (such as environmental degradation, change in rainfall pattern, falling groundwater table, etc.). The outcome of studies on these issues can be brought to the notice of the general public through print and electronic media only after a thorough discussion on the same at the respective academic units.

9.11 Environmental safety and experiments with living organisms

Researchers conducting any research work have to take all precaution against safety-hazards especially when the research work involves experiment using explosives, dangerously hazardous chemicals and environmentally hazardous and non-biodegradable waste materials. Permission or clearance must be taken from the Institute / university authorities regarding the use of these.

There are a few unavoidable steps to be taken for environmental safety and for maintaining safe and healthy working conditions among users and laboratory conditions when handling

- Chemical and biochemical waste
- Living organism growth with/without rDNA techniques and transgenomics
- Radioisotope and heavy metal toxicity

- Radiation like X-ray, Gamma ray, UV etc.
- Flammable solvents and super-cooled liquid,
- Broken glass
- Odour and fire
- Pathogen and air/blood borne diseases
- Inhalation of poisonous gas.

The lead researcher of a group has to keep constant personal care to minimize the risk of accident and occurrence of hazards.

Most universities/institutes have committees concerning research works involving the above. Research proposals that involve these should be placed before the respective committee for approval.

To protect safety of the individuals and of the environment, periodical compulsory health and safety trainings programmes should be conducted. All students, faculty, and staff should participate in health and safety training programmes and learn the basic precautions and preventive measures to avoid accidents, and the steps to be taken in the event of accidents. Each laboratory that involves such procedures and practices should have a safety manual, and all students working in the lab should read and follow the manual. The students and staff should report to their supervisor immediately in case of any accidents and report all unsafe conditions, accidents, and work related injuries and illnesses (every occupational accident or injury) immediately.

9.12 Cases of scientific misconduct

We shall now discuss some cases of scientific misconduct, so that the reader can take lessons from these. In the cases of living scientists, I will avoid naming the scientists involved. But the reader should understand that these are not imaginary situations; these are real and well-documented cases.

9.12.1 Causal link between MMR vaccine and autism

In 1998 a paper was published in a famous biology journal 'Lancet' reporting that the children who are vaccinated against Measles, Mumps, and Rubella (MMR) in early childhood, have a higher propensity to develop the cognitive disorder called autism. Following the report, there was a serious debate about the desirability of this vaccination, and many parents refused to get their children vaccinated.

It was revealed later that the work was seriously flawed. The work was apparently done by collecting data on children who had received MMS vaccination. But since the scientist *wanted* to establish a relationship, he selectively chose the cases who took the vaccination and also had symptoms of autism. The sample size was small ($n = 12$), and there was no control group used in the experiment. Since both the events (administration of the vaccine and detection of autism) happen in early childhood, it is easy to show a correlation between the two if the sample selection is not blind and random.

9.12.2 Creating human stem cells by cloning

A South Korean scientist, who had made his name by cloning different farm animals like cows and pigs, made an announcement in two papers published in 2004 and 2005 in the famous journal *Science* that he has succeeded in creating human embryonic stem cells by cloning. This came as a surprise to scientists because this was the first reported success in human somatic cell cloning. Nobody had yet succeeded in creating a human stem cell by cloning due to the complexity of primates.

Initially there was allegation of misconduct regarding the way he obtained the human eggs. But later investigations revealed that most of his results were fabricated. Characteristic of his style was to announce achievements in press conferences instead of presenting verifiable information to the scientific community. As a result, he was a celebrity, considered a 'Pride of Korea' before his exposure in late 2005.

9.12.3 Fraudulent fossil finds in the Himalayas

In 1989 it was revealed that a series of fossil finds from the Himalayas reported in reputed journals over a period of two decades were not from the Himalayas at all: they were sourced from other places. The long period of time during which the fraud went undetected caused a major problem, because by then many scientists worldwide had based on these observations in their own work, resulting in confusing theories. These theories, in turn, found their way into textbooks. It proved extremely difficult to expunge the wrong ideas from the current body of knowledge.

9.12.4 Brain repair with metallothionein

A Danish researcher had published nearly 100 peer-reviewed papers, had climbed in the university hierarchy by reporting path-breaking research on brain repair mechanisms and the role of a metal-binding protein called metallothionein.

The allegations of research misconduct surfaced when two of her students noticed that the data they obtained in their experiment were not the same as that reported in her paper. Investigations were conducted by the Danish Committees on Scientific Dishonesty, which concluded that not only the data for her recent papers, but also those for her Ph.D. thesis were fabricated. As a consequence, she had to leave the university.

9.12.5 The Piltdown man

At a meeting of the Geological Society of London on 18 December 1912, an amateur archaeologist named Charles Dawson claimed that people working at a gravel pit in a place called Piltdown found a fragment of a skull. Revisiting the site on several occasions, Dawson claimed to have found further fragments of the skull and half of the lower jaw bone. Using these fragments the skull was reconstructed, and for a long time (about 45 years), it was believed to be one of the 'missing links' in the evolution from ape to humans. Dawson was showered with honours and laurels for this discovery.

The fossil perplexed the experts, because the skull was similar to that of a modern human in many ways—but only smaller, but the jaw-bone the canine teeth had ape-like features. Due to this 'evidence' it was believed for a long time that in the evolutionary pathway the skull and cranium evolved into the modern form before the jawbones and teeth. Some regarded it as an enigmatic aberration inconsistent with the path of hominid evolution as demonstrated by fossils found elsewhere.

In 1953, scientists examined the fossil carefully and concluded that three fragments of the fossil came from different sources: It consisted of a human skull of medieval age, the lower jaw of an orangutan and fossil teeth of a chimpanzee. Dawson had created the appearance of age by staining the bones with an iron solution and chromic acid. Microscopic examination revealed file-marks on the teeth, and it was deduced from this that he had also modified the teeth to a shape more suited to a human diet.

9.12.6 Stem cells from body cell

The next case concerns a Japanese scientist who shot to prominence when she published two seminal papers in *Nature* in January 2014. She and her colleagues had demonstrated a surprisingly simple way of turning ordinary body cells—she used mouse blood cells—into stem cells. Her procedure was simply to soak them in a weak bath of citric acid for half an hour. She claimed that this simple procedure erases their developmental past and renders them capable of developing into any type of body cell. Back in 2006, another Japanese scientist Shinya Yamanaka had developed a more difficult method of achieving that and had got the Nobel Prize. Naturally many people started considering the new invention as a candidate for another Nobel Prize.

But soon other researchers in that field started doubting her results. An investigation within her Institute followed, which concluded that her results were fabricated. Further investigation revealed that genetic markers of the claimed STAP ('stimulus-triggered acquisition of pluripotency') cells did not match those of the mice from which they were apparently obtained. The investigators concluded that the STAP cells were nothing but ordinary embryonic stem cells that someone had taken from a freezer and relabelled.

Following such damning evidence, her supervisor committed suicide, and she lost her job.

9.12.7 Transuranic element 118

In the late 20th century, many nuclear physicists were concerned with discovering transuranic elements (elements with atomic number greater than 92). These elements did not occur naturally. They could only be discovered by creating them in a laboratory via collisions between light nuclei and neutrons, alpha particles or other light nuclei. These were unstable nuclei, and decayed fast into other smaller nuclei. The way to confirm their existence was to look at the decay chains, which enabled one to conclude that a specific nucleus had been created for a fraction of a second.

The elements 93 to 103 were discovered at the Lawrence Berkeley National Laboratory (LBNL) in the USA, elements 104 and 105 were discovered at the Flyorov Laboratory of Nuclear Reactions (FLNR) in the Soviet Union, element 106 was discovered at both these laboratories at the same time, and then the Gesellschaft für Schwerionenforschung (GSI) in Darmstadt, Germany surged ahead by discovering the next 6 elements. During the cold war, the American laboratory was under presure to beat the other two in discovering newer transuranic elements.

In 1999, the LBNL announced that they have found evidence of the formation of element 118. They used a 88-inch diameter cyclotron to accelerate krypton nuclei (atomic number 36) to bombard uranium nuclei, and then used a Berkeley-Gas-Separator (BGS) to analyse the products. The data were then analysed with a software called Goosy. They reported three instances of a decay chain from element 118 to element 116 and then to element 114 and so on until element 106.

After the paper was published in Physical Review Letters, other groups tried to replicate the results and failed. In 2000, the researchers at LBNL also failed to replicate their own results. An enquiry was started. After eliminating all sources of error one by one, the investigators noticed something bizarre: A log file in the computer's database showed that some of the raw data files had been tampered with from a particular scientist's user account. Some parts of the raw data had been rearranged to make it appear as if decay chains had occurred.

LBNL retracted the paper from PRL, and the scientist in question lost his job.

9.12.8 Transistors from crystalline organic materials

A young scientist from the AT&T Bell Labs, USA, published a series of papers reporting transistor-like on-off behaviour from crystalline organic materials. The discovery was sensational, because he reported even single-molecule semiconductors—which was believed to be heralding the days of microsopic computers. But other scientists noticed something peculiar in his papers: the graphs reporting behaviour of the transistor contained fluctuations due to random noise (as expected), but the noise components at different temperatures were identical. An investigation was started, which found nine examples of data substitution, nine examples of unrealistic precision and six examples of results that contradict known laws of physics in papers authored by that scientist.

9.12.9 The skin-grafting case

In 1974, a scientist working at Sloan-Kettering Institute for Cancer Research, reported that he could transplant tissue from genetically unrelated animals without rejection by the recipient animal if he kept the tissue from the donor in organ culture for four to six weeks. Such a finding would have been valuable for transplant medicine, and so it caused quite an excitement in the research community.

However, other scientists had trouble replicating the work. As doubts were growing, the concerned scientist was asked to repeat the experiment. He claimed to have grafted patches of skin from black mice onto white mice, and 'demonstrated' success of the procudure. However, a laboratory assistant noticed that the dark color could be washed away with alcohol, which implied that the scientist had simply coloured a patch of skin with a felt-tipped pen! When charged, the scientist admitted deception.

9.12.10 Obesity and ageing

The researcher in this case was a very famous professor at the University of Vermont College of Medicine, who commanded huge resources and had a dozen research workers working on his projects. His team was investigating how the lipid content in human blood changed with ageing. The professor had in mind a hypothesis, which he wanted to test by obtaining blood samples from people over a long period of time.

One of his assistants assigned the job had obtained data which apparently was not supporting the hypothesis. He showed the results to the Professor. He took home the electronic data-sheet to check and returned it the next day after having done a few 'corrections'. The assistant ran the statistical analysis and found that now the data supported the hypothesis. Suspicious, he discussed the incident with his lab-mates who also said that they had similar experiences in different situations. The assistant then informed the incident to the university authorities. An investigation ensued, which revealed numerous cases of scientific wrongdoing stretching over decades. The scientist had to face a jail sentence.

9.12.11 Prayer helps fertility!

In the year 2001, a paper published in the Journal of Reproductive Medicine (JRM) by researchers at the prestigious Columbia University Medical Center in New York reported a finding that infertile women who were prayed for by Christian prayer groups became pregnant twice as often as those who did not have people praying for them.

In vitro fertilization (IVF) is the most advanced form of infertility treatment currently available and represents the last hope for women with severe infertility. Therefore, any technique that could increase the efficacy of IVF by even a few percent would be a medical breakthrough. Yet the Columbia University study claimed to have demonstrated, in a carefully designed randomized controlled trial, that distant prayer by anonymous prayer groups increased the success rate of IVF by an astounding 100 percent! It was later exposed that the whole paper was a case of fraud. Both the Columbia University and the journal JRM were severely criticized, Columbia for submitting a profoundly flawed and absurd article and JRM for erroneously publishing it. According to a report published in *The Guardian* on May 30, 2004, one of the study's authors is a conman obsessed with the paranormal who has admitted to the multi-million-dollar scam. The other two authors acted as his accomplice in order to get name, fame, and of course, grant money.

9.12.12 Canal rays

In the 1920s, during the heady days of the development of quantum mechanics, much attention of physicists were focused on the interaction between matter and radiation. In 1926, the German physicist Emil Rupp published startling results on the behaviour of "canal rays" which seemed to corroborate Einstein's theories on wave-particle duality. The results were later proved to be fabricated, though further experiments vindicated Einstein's theory.

Canal rays were produced in little glass tubes. On one side of a tube is an anode (a positively charged electrode) and at the center of the tube is a cathode (a negatively charged electrode). The cathode had holes drilled in it. Most of the positive ions shooting from the anode would be captured by the cathode, but some would pass through the holes. These would continue travelling to the far side of the tube, and along the way they would emit light. Rupp studied these rays, particularly their interference patterns and coherence. His work showed that hydrogen atoms emerging from a discharge tube could emit a coherent beam of light up to 15 centimeters long.

Einstein noticed the result, and based on it proposed an experiment to find out if waves emitted by atoms were emitted over time, or emitted instantaneously. But the scientist Robert Atkinson noticed something strange in Rupp's results: the fast-moving Hydrogen atoms seemed to be more observable than ones having only random thermal motion. Still the scientific community at that time did not suspect a foul play.

But in 1935 he crossed the limit. He claimed to have accelerated beams of positrons in ways that no one had done before. Eyebrows were raised, and people asked him how exactly did he achieve the feat. That's when it was revealed that he did not even have the apparatus to produce positron beams. All the results he had reported so far were fabricated.