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A Review of the Types of Scientific Misconduct in Biomedical Research

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Abstract Biomedical research has increased in magnitude over the last two decades. Increasing number of researchers has led to increase in competition for scarce resources. Researchers have often tried to take the shortest route to success which may involve performing fraudulent research. Science suffers from unethical research as much time, effort and cost is involved in exposing fraud and setting the standards right. It is better for all students of science to be aware of the methods used in fraudulent research so that such research can be detected early. Biomedical research is one area that seems to have attracted maximum numbers of fraudulent researchers; hence this article devotes itself to biomedical research scenario.

Keywords Research misconduct · Unethical research · Biomedical research · Scientific misconduct · Fabrication · Falsification · Plagiarism

It is essential for all people of science to keep abreast of the problems faced by scientific research so that solutions can also be thought of to maintain continued salubrity of science and its methods. Baconian philosophy advocates that the scientific researcher should free his mind from preconceptions and prejudices that distort the truth. It views the scientist as a disinterested seeker of truth seeking truth only for the sake of truth (http://www.iep.utm.edu/b/bacon.htm accessed on 20/8/08). However, the present day scientists are having a difficult time in sticking to the Baconian ideals. Rather than being a disinterested seeker of truth, the modern day scientist is often a participant in an intense competition for prestige and the benefits that accrue from that prestige (Wright 1944; Florey 1962). Reasons for carrying out poor quality research or indulging in scientific misconduct include '*publish or perish*' attitude among researchers which compels them to do research for career advancement (Fleet et al. 2006). The number of publications in the curriculum vitae is

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considered to increase its value. Continuation of funding of research depends on the prestige of the scientist and the perceived impact of the study which may force some to undertake fake research. The paradigm of scientific research is changing from that of a 'passion' of a lone genius to that of a 'profession' of group research (Wutchy et al. 2007). Group research means that number of people on the same item of research is more and this leads to increased needs for funds also. *Careerism* is on the rise among researchers. For a careerist nothing else matters apart from the pursuit of professional advancement. The end justifies the means adopted by a careerist and issues like pride and dignity become expendable items. Another reason for flawed research given by David Goodstein is *overconfidence of the researcher* in his or her own hypothesis (David Goodstein at http://www.aaup.org/AAUP/pubres/academe/2002/JF/Feat/good.htm accessed on 24/09/08). A scientist may have a strong belief that a particular phenomenon is true and this may induce them to formulate an article without making efforts to actually verify their own beliefs through experimentation.

Scientific misconduct denotes violation of the standard codes of conduct in professional scientific research (Schachman 1993). Three groups of people can be responsible for scientific misconduct—1) Those actually performing the research (researchers); 2) those who are assessing the research (peer reviewers and editors of scientific journals); 3) those who support (fund) the research.

I) Scientific misconduct by the researchers—The National Science Foundation of the U.S defined scientific misconduct in 1988 as "fabrication, falsification, plagiarism or other practices that seriously deviate from those that are commonly accepted within the scientific community for proposing, conducting and reporting research" (http://www.nsf.gov/oig/session.pdf accessed on 24/09/08). While the 'ffp' portion (fabrication, falsification and plagiarism) of the definition was accepted readily by the scientific community the latter portion of the definition was debated. Members of scientific community felt that enforcing the latter portion of the definition would amount to curbing the independence of thinking and would force scientists to stick to an orthodox mould (David Goodstein at http://www.aaup.org/AAUP/pubres/academe/2002/JF/Feat/good.htm accessed on 24/09/08). Hence, a revised definition was proposed and adopted in 2000 wherein scientific misconduct was defined only as 'ffp'. *It is obvious that the term has defined only to include the deviations committed by the scientists themselves and the deviations committed by others involved in stages of research beyond the conception and conduction stage are not included in this definition.*

Serious scientific misconduct is fortunately uncommon but the biomedical sciences have the dubious distinction of harbouring higher incidence of scientific misconduct than other branches of science such as physics or mathematics (David Goodstein at http://www.aaup.org/AAUP/pubres/academe/2002/JF/Feat/good.htm accessed on 24/09/08). Linus Pauling, who won the Nobel Prize twice, remarked that "most of the cheats in science are MDs" (http://www.whale.to/a/lies_stat_q.html accessed on 24/09/08). Biologists who intend to cheat take cover under 'biologic variability' to explain away the lack of reproducibility of an experiment. Scientists in other branches of science do not have this luxury and are therefore more careful to avoid misconduct.

Fabrication ('dry labbing') is the making up of false research data without actually doing any experiment. Falsification is the manipulation of research data or processes or omitting critical data or results. Experiment is done at least to a certain extent but methodology is falsified to obtain 'desired' results. The 'patchwork mouse' of William Summerlin (1974) at Memorial Sloan Kettering Hospital has almost become synonymous with the term

fabrication (Hixson 1976; Summerlin et al. 1973). Summerlin claimed that he had transplanted tissue successfully from one species of mice (black) to another species of mice (white) by keeping the tissue in culture for 4 weeks to 6 weeks. Investigations revealed that Summerlin had turned some white rats into black rats by drawing black patches on their skin using a black coloured marker pen ('patchwork mouse').

Some researchers like John Darsee of Harvard seem to have made a career out of falsification during 70s and 80s with almost all his research work coming under suspicion and resulting in retractions of articles from journals exceeding 50 to 60 in number (Knox 1983). Dr. Ranjit Chandra's study in Canada published in September 2001 edition of 'Nutrition' claimed that a multivitamin formula that he had patented could reverse memory loss problems in geriatric population (http://www.cbc.ca/national/news/chandra accessed on 4/8/08). This was later found to be a fabricated study with no available data to support the outlandish claim. Dr. Chandra took the art fabrication to a new level by getting another fabricated article authored by one Amrit Jain published in his own journal wherein the findings were supportive of Dr. Chandra's earlier findings. This time, not only the data but even the author 'Amrit Jain' was fabricated as such a person was not traceable at all! South Korean researcher Hwang Woo-Suk published 2 papers in 'Science' in 2004 and 2005 where he reported to have cloned human embryonic stem cells (Hwang et al. 2005). Subsequent investigations revealed that the data was fabricated and no embryonic stem cells were actually found as claimed by the researcher. The papers were later retracted by 'Science' (Kennedy 2006). Norweigean oncologist Jon Sudbø managed to publish a fabricated paper in 'The Lancet' in 2005 in which he claimed that anti-inflammatory drugs such as ibuprofen diminish the risk of oral cancer in smokers. Out of the 908 'patients' in Sudbø's study 250 were noted to have the same date of birth! Subsequent inquiry revealed that as many as 15 of his articles were fraudulent (Couzin and Schirber 2006; http://news.bbc.co.uk/2/hi/health/4617372.stm accessed on 4/8/08).

Plagiarism involves publication of others work as ones own work or copying others articles with minor modifications and publishing it as a new study. One of the definitions of plagiarism quoted by Eugene Garfield is that it is "the act of appropriating the literary compositions of another, or parts and passages of his writings, or the ideas or language of the same, and passing them off as the product of one's own mind" (Black's Law Dictionary 1979; Garfield 1980). Plagiarism in Latin (plagiarius) means theft or kidnapping of one's slave or child and it literally amounts to kidnapping of others ideas ('brain child') and stealing their credit (Greenacre 1978). Iraqi researcher Elias Alsabati's thirst for plagiarism remains unparalled. He seems to have plagiarised more than 50 articles relating to cancer and immunology research getting many of them published in reputed journals (Broad 1980). Websites have been devised to help detect wilful or inadvertent plagiarism. Harold Garner and colleagues developed an open-access database available on the internet in 2006 called 'Déja Vu' to detect plagiarism and autoplagiarism in biomedical literature (www.turnitin.com; http://spore.swmed.edu/dejavu/ accessed on 17/8/08; Errami and Garner 2008).

Plagiarism has been classified into two major types—grand larceny plagiarism and petty larceny plagiarism (Merton 1979). Grand larceny plagiarism involves outright copying of entire texts and petty larceny involves use of ideas without explicit citation of the sources. Petty larceny plagiarism is far more common than grand larceny plagiarism. The term '*discoverer's complex*' has been used by Sorokin to describe the attitude of one generation of scientists to assume that they are the first to become aware of a particular phenomenon and that the previous generations were ignorant about it. The latter generation of scientists simply assumes that it is more intelligent and better informed than the previous generations (Sorokin 1956). This may lead to unnecessary duplication of research work wasteful of

time, energy and finances. Sigmund Freud used the term 'cryptomnesia' to describe unconscious plagiarism wherein the author is simply unaware of similar work published before (Garfield 1980). Some scientists may be unaware of their own work published before and may repeat the work! Otto Loewi, a Nobel Prize winner in physiology redid research on chemical neurotransmission without realising that he had worked on the same subject 18 years previously (Merton 1973).

Several methods of plagiarism have been described by Brian Martin (Martin 1984). In *plagiarism of secondary sources* the author cites references but from secondary sources and does not bother to read the primary source. In *plagiarism of ideas* the ideas of another author are borrowed but the wordings and format of presentation are changed. *Word for word plagiarism* involves exact copying of phrases from a previously published work without citation. In *paraphrasing plagiarism* some words are changed but not sufficiently enough. Some paraphrasing may be necessary to state the ideas but it should be done in an acceptable way and with full citation of the source. Omitting quotation marks and providing incomplete citation are also considered as plagiarism. In *plagiarism of authorship* a person claims himself or herself to be the author of a complete work belonging to others. This is probably the meanest form of plagiarism. It often occurs when mentors plagiarise the work done by their students or junior researchers and completely deny authorship to the vulnerable students even though the entire research may have been conceived and conducted by the students with hardly any participation by the mentor. The junior person often never gets any justice as exemplified by the case of Michael Pyshnov's research concerning cell division in the University of Toronto was 'stolen' by his mentor and her coterie of co-authors. All Pyshnov got after his fight for justice was loss of career as a brilliant researcher (http://ca.geocities.com/uoftfraud/ruthless.htm accessed on 15/7/08).

While the 'ffp' group are defined as the major sins of research there are other sins also (Brian and Melissa 2005). These include citation amnesia, multiple publication, divided publication, data suppression, data torturing, improper allocation of authorship credit, relationship with students, unethical behaviour in experiments involving humans and animals, overlooking the use of flawed data or questionable interpretation of data by others (friends), unauthorised use of confidential information in connection with ones own research, changing the design, methodology or results of a study in response to pressure from funding source, photomanipulation and bahramdipity and psuedobahramdipity.

Omission of citation of the relevant work of other researchers is deemed to be the most common type of scientific misconduct. This behaviour was called 'citation amnesia' by science sociologist Robert Merton, 'bibliographic neglect' by Eugene Garfield and 'disregard syndrome' by Issac Ginsburg (Merton 1973; Ginsburg 2001; Garfield 1991, 2002). The authors of an article claim that they are the first to describe a phenomenon but 'forget' to cite an important similar contribution published earlier by other authors. This may be purely due to oversight on the part of the researchers but it can also be a wilful act of omission in the race to establish priority of authorship. The latter action amounts to plagiarism as a certain work belonging to a researcher is being reproduced without due credit to the original researcher. This type of misconduct may lead to unfair loss of priority of authorship for the initial authors (Garfield 1982).

Sometimes the researchers may cite an article in their list of references with regard to a particular discovery or innovation but the author cited is not the original discoverer or innovator. The cited article simply describes the research work of the original author. Robert Merton called this '*palimpsestic syndrome*'. A palimpsest has been described as 'an ancient parchment on which an inscription has been made over an older one that has been erased' (Merton 1973). Some facts of science become so well known and are incorporated

into the canonical body of knowledge so much so that others do not feel the need to cite them at all. This is called '*obliteration phenomenon*' by Garfield (Garfield 1979). Garfield advocated the establishment of a 'Science Court' to deal with disputed authorships and citation irregularities. According to him wilful omission is a punishable act and one of the ways of punishing would be remove the name of the offending researcher from the 'Science Citation Index' data base so that he also loses out on citation advantage (Garfield 1987). *Selective journal self citation* means that articles tend to preferentially cite other articles in the same journal. This behaviour may be abetted by the editors to increase the impact factor of their journal (Delgado López-Cózar 2007).

Multiple publication involves publication of the same content with or without minor modifications in different journals under different titles. The author/s publish data without citing the earlier publication in the same field elsewhere. It is also referred to as auto-plagiarism, self-plagiarism duplicate publication, concurrent publication, simultaneous submission, dual publication or potentially dual publication. Occasionally it can be due to pure oversight. Merton cites the example of Otto Loewi, a Nobel Prize winner in physiology who redid research on chemical neurotransmission without realising his own work on the same subject 18 years earlier (Merton 1973). It is used by authors to inflate the volume of publications without having to do more actual research work. It is more common than plagiarism but often escapes being penalised. Group research abets multiple publication (http://www.jr2.ox.ac.uk/bandolier/band91/b91-6-html accessed on 27/09/08; Valderas et al. 2007). As there are more researchers working on a single theme they are in a position to publish more numbers of papers. Research is planned to enable publication rather than actual discovery. The result is that the advancement in science is not proportional to the number of papers published (Campanario 2003). Franz Ingelfinger, the editor of the New England Journal of Medicine between 1967 and 1977 tried to curb this practice and stated that "no article he printed should be published elsewhere beforehand" (*Ingelfinger rule*) (Toy 2002). *Divided publication* (salami slicing or data fragmentation) involves bit by bit publication of the data and results of what is essentially a single experiment (Editorial 2005). This is done to artificially increase the number of publications as well as citation counts to increase the 'impact' of the publication. Some universities have tried to discourage the tendency for salami slicing and dual publication by limiting the number of articles that the candidates are allowed to put on the bio-data that they submit to the university (Lock 1994). This is to send a message to the researchers that quality of research is more important than sheer quantity.

Data augmentation is a type of scientific misconduct wherein a researcher first publishes a study in a journal and later collects additional data to fortify his or her own research and publishes the combination of the old as well as the new results together as a new study in another journal. A false impression of two separate studies having been done is created in the mind of the readers (http://facepub.stjohns.edu/~roigm/plagiarism/salami%20slicing.html accessed on 1/8/08).

Unethical allocation of authorship credit includes the entities of disputed authorship and guest authorship (Edmunds 2007; Bennett and Taylor 2003; Costa and Gatz 1992). Ethically speaking only authors who have actually participated in the study deserve to be mentioned as authors. First authorship should rightfully belong to the person who has contributed maximally to the article. A benevolent kind of deviation from this norm is known to occur and it has been called 'noblesse oblige' by Harriet Zuckermann (1968). Well established scientists including Nobel laureates often give away genuine first authorship to juniors whose careers are less secure and who would be helped in their careers by first authorship of such papers. *Disputed authorship* occurs when other

researchers question a particular person's right to be the author or co-author of an article. Disagreement over authorship negatively affects the good will and reputation of the individual authors. Some universities have established guidelines for authorship during times of disagreement (http://www.hms.harvard.edu/integrity/authorship.html). The International Committee of Medical Journal Editors (ICMJE) has laid down authorship rules (http://www.icmje.org/ accessed on 27/09/08).

Guest author is one who has not done any significant work towards the paper but has his name as one of the authors. Types of guest authorship include *gift authorship, pressured authorship and ghost authorship*. In *gift authorship*, the authorship has been gifted to a person by other author/s. This is probably done by the authors to receive some other favours from the 'gift author' in return. The gift author may be a senior researcher who has a say in promotion and salary of the authors who are gifting the authorship. Gift authorship is not without its dangers. Gift authorship of Professor Geoffrey Chamberlain in a fraudulent case report by Malcolm Pearce in the British Journal of Obstetrics and gynaecology titled 'Term Delivery after Intrauterine Relocation of Ectopic Pregnancy' proved very costly for Professor Chamberlain (http://www.bmj.com/collections/author1.htm accessed on 3/8/08). In *ghost-writing*, the named author is not the actual author of the article. This is typically resorted to by drug companies to mask their involvement in the research (to hide conflict of interest). Because the real author is known to have close links with the company his or her name is substituted by the name of other author who is not identified with the company. The companies may also resort to this gain prestige and reputation using a 'well known name' in the scientific community for authorship. Ghost authorship is unethical because the original author is not taking responsibility for the publication and is evading answering questions about the article from other members of the community. *Pressured authorship* occurs when the original researchers have been forced to include the name of a senior colleague due to the fear of his or her authority in the institution. Kwok has termed the senior researcher who abuses his juniors to gain undue authorship credit a 'white bull' indulging in 'publication parasitism' (Kwok 2005).

Irresponsible co-authorship is a problem that is often seen in detected cases of scientific misconduct. The primary author would have falsified or fabricated the experiment without the knowledge of co-authors. Even if the co-authors are not involved in falsification or fabrication, they are still guilty of misconduct as they have not verified the contents of the paper that carries their names. In the fraudulent paper by Hwang et al published in Science in 2005 there were 23 co-authors. Dr. Gerald Schlatten from the University of Pittsburgh School of Medicine was a co-author. When the fraud was exposed Dr. Schlatten claimed that he had played only an 'advisory' role in the study and had no active part in it. Though the University of Pittsburgh cleared him of scientific misconduct it held him guilty of 'misbehaviour' in failing to ensure the veracity of the data in the paper (Parry 2006). John Darsee's co-authors in all his numerous falsified publications were probably as guilty as Darsee but it is unclear as to what happened to them in terms of disciplinary actions (Culliton 1983; Relman 1983). Many journals now require each author to spell out his or her exact role in the creation of the manuscript and also affirm the veracity of the contents of the manuscript. However misconduct may occur in spite of this. Jon Sudbø's paper in The Lancet in 2005 had as many as 13 co-authors who had actually submitted in writing that all of them had approved the final report (Sudbø et al. 2005)!

Data torturing involves continued manipulation of the data till a desired result is obtained. Mills said that "if the data are tortured long enough they will give the researcher whatever he or she wants to hear" (Mills 1993). He identified two types of data torturing—opportunistic data torturing and procrustean data torturing. In opportunistic data torturing

the researcher tortures the data until a 'significant association' can be found between some of the variables and later devices a plausible hypothesis to fit the association. This has also been called as HARKing by Kerr (Hypothesising After the Results are Known) (Kerr 1998). In the procrustean type of data torturing the hypothesis is formed first and the data is then tortured to fit the hypothesis 'some how'. This is named after Procrustes, a robber in Greek mythology who made all his victims to fit the length of his bed by either stretching or cutting off their legs.

Data suppression is the failure to publish a portion of the results deemed as being adverse to the interests of the scientist or his financial sponsor. R.B.Striker of the University of California at San Francisco had suppressed data selectively in his paper "Target Platelet Antigen in Homosexual Men with Immune Thrombocytopenia" in the New England Journal of Medicine in 1985 (Stricker 1985). He had only revealed data that gave an impression that a certain antibody was found in homosexuals and was absent in heterosexuals. He had suppressed data which showed the antibody in heterosexuals also. The paper was subsequently retracted by the journal. Data suppression is a malady of publications sponsored by drug companies. The companies often recruit external researchers for conducting clinical drug trials but do not provide them complete information about the product and other research findings concerning the drug. Dr. Aubrey Blumsohn, a bone metabolism researcher at the University of Sheffield, U.K participated in a clinical trial in 2002 involving the drug risedronate (actonel) manufactured by Procter and Gamble pharmaceuticals (http://www.thejabberwock.org//PG/blumsohn07radstats.pdf accessed on 3/8/08). The company denied him access to full data on the product despite the fact that he was named as the lead author of the study and two reports were published under his name. The university failed to take any action in this regard following complaints by Dr. Blumsohn which forced him to blow the whistle to medical journalists and eventually resign from his post as senior lecturer in disgust.

Failing to present data that contradict ones own previous research and failure to disclose conflict of interest are other variants of data suppression. Thompson has defined *conflict of interest* as a set of conditions in which professional judgement concerning a primary interest tends to be unduly influenced by a secondary interest (Thompson 1993). Conflict of interest can be individual or institutional. Institutional conflict of interest arises when a health care organisation has financial interest in the research conducted in their laboratories or clinics (Emanuel and Steiner 1995).

Primary interest in case of a clinician or a biomedical researcher should be improvement of humanity. Conflict of interest typically occurs when a researcher reports a study involving a drug or other product and the manufacturers of the product have sponsored the study. It also occurs when the author of a study is a share holder in the company whose product is the subject of the study (investor–researcher paradigm) (Commander 2000). Secondary interest may be financial gain, personal prestige, academic recognition and promotion. Conflict of interest usually occurs in industry sponsored research. 25% of researchers from the US were found to have been funded by the pharmaceutical companies and 50% of researchers received research related 'gifts'. One third of lead authors in 789 articles in major journals had financial interest in their research (Bekelman et al. 2003). A study on the use of calcium channel antagonists showed that researchers were much more likely to be supportive of calcium channel antagonists for cardiovascular disorders if they had a financial relationship with the manufacturers of the drugs (Stelfox et al. 1998). Another study showed that 75% of papers concluding that passive smoking was not harmful were written by authors having affiliation to the tobacco industry (Barnes and Bero 1998). Sponsored studies were found to be 4 times more likely than non industry sponsored

studies to have findings favourable to the industry (Friedman and Richter 2004; Davidson 1986).

While support from the industry is often beneficial to mankind by facilitating progression of research in health care the researcher should be careful to avoid situations that compromise that very ideal. The researcher who is involved in conflict of interest situation should always be mindful of that and act in such a way that the interests of the society are not harmed by personal interests. Certain methods have been described to deal with conflict of interest situations. These include *disclosure of the conflict*, *review and authorisation and prohibition* (Ray 2002). Disclosure means that the author openly discloses the existence of conflict of interest in the article so that the reader is free to make his own assessment. Most of the top rated journals in biomedical field now a days require the author/s to formally declare any conflict of interest. Review and authorisation involve the researcher reporting financial interests to the research ethics committee formed by the university or other organisations. Review can be internal or external. Oversight of industry sponsored research by commercially disinterested third party is desirable. Prohibition involves certain restrictive regulations national medical associations such as disapproval of acceptance of 'lucrative' compensation and 'finder's fee' and gifts from companies by the author/s and disapproval of 'confidentiality agreement' between the author and sponsoring companies. Lucrative compensation means remuneration far in excess of 'reasonable compensation' for extra work and loss of income through clinical practice. Finder's fee is remuneration for finding subjects for a clinical trial. It has been suggested that 'mutual fund' like investment is better than holding equity in individual companies for researchers wishing to invest in the research. This may minimise the economic pressures on the researchers to see that their product does well in the market (Moses and Martin 2001). Some authors have suggested that importance of professionalism and the need for avoidance of 'cosy' relationships with industry should be inculcated in the medical students even from a very early stage as a routine part of their training. This may help them to cope well with conflict of interest situations later on (Rothman 2000).

While close scrutiny of conflict of interest is desirable, judging articles on the basis of considerations other than the intrinsic worth of the article is also considered unethical. It amounts to McCarthyism and unfair censorship of authors (Rothman 1993). An author might have published a good and honest study even though there was a financial conflict of interest and such a study would be unfairly tainted if conflict of interest is given more importance than it deserves. All researchers who have declared a conflict of interest should not be labelled as dishonest. Some journals have required the researchers to disclose not only financial conflicts of interest but any other conflicts of interest that can potentially influence the outcome of the study. These include sexual orientation of the researchers, religious beliefs of the researchers and so on. This type of draconian attitude from the editors is said to promote irrational approach towards conflict of interest from the readers.

Photo-manipulation is a misconduct that has become easier to indulge in following digitisation of photography. Dr. Hwang Woo-Suk provided manipulated photos of stem cells to support his fabricated research published in 'Science' journal (Hwang et al. 2005). The journal of Cell Biology introduced tests for detecting photo-manipulation in 2002 and it was found that 25% of accepted manuscripts had some evidence of photo-manipulation (http://www.nytimes.com/2006/01/24/science/24frau.html accessed on 4/8/08). The Office of Research Integrity reported an increased incidence of photo-manipulation from 14.3% of cases of cases of scientific misconduct in 1999–2000 to 32% of cases in 2003 (http://www.nytimes.com/2006/01/24/science/24frau.html accessed on 4/8/08). An article by Kaushik Deb et al in 2006 in the 'Science' titled 'Cdx2 Gene Expression and Trophectoderm

Lineage Specification in Mouse Embryos' was retracted in July 2007 following discovery of deliberately altered photographs of the embryos (Deb et al. 2007). Jon Sudbø was discovered to have manipulated photographs in two of his papers on oral leukoplakia published in the New England Journal of Medicine. He had claimed the photomicrographs were from different patients who were in different stages of disease. However, the photographs were found to be different magnifications of a single photomicrograph (Curfman et al. 2006). Amitav Hajra had manipulated the photograph of a Western blot in his paper on cell transformation due to a fusion protein coded by an abnormal chromosome associated with acute myeloid leukaemia (Weissman 2006; Hajra et al. 1995). Luk Van Parijs lost his tenure at MIT after being exposed for fabricated graphs in his papers in the journal "Immunity" published in 1998 and 1999 (Couzin 2001).

Splicing together of different photographs, alteration of brightness and contrast of only part of the photographs, masking some features of the photos are not allowed by many journals. Photographs in other published articles may be stolen and reprinted with or without some modifications without the permission of the original authors. Pande et al published an article on toxoplasmosis in the Science journal where one of the photographs was a copy of a photograph published earlier in some other journal by a different author. The editors of the Science magazine subsequently published a regret letter about this (Pande et al. 1961; Frankel 1956).

Bahramdipity is an off-shoot of the better known term 'serendipity' (Sommer 2001). The term 'serendipity' refers to accidental discovery of a scientific phenomenon by a researcher who was not actually 'looking' for the discovery that he or she made eventually. The phrase was coined by Horace Walpole after he read a translation of the story of 'The Three Princes of Serendip' where sheer accidental events help the adventure of the princes. Serendip is the modern Sri Lanka. T.J Sommer proposed the term 'bahramdipity' to denote "suppression of a discovery, often a serendipitous discovery, by a more powerful individual (bahram) who does cruelly punish, not merely disdain, a person (or persons) of lesser power and little renown who demonstrates sagacity, perspicacity and truthfulness to the bahram". As written by Sommer, the term 'bahram' usually refers to the principal investigator of a scientific project and has been coined based on the character of Bahram Gur in the story of 'The Three Princes of Serendip'. Bahram Gur was a cruel, despotic leader who spared no attempts to suppress dissent from his subordinates. The principal investigator comes across some discovery made by his or her subordinates and suppresses it or tries to suppress it to deny credit to the subordinates. These discoveries may go totally unpublished. Sommer refers to them as 'nulltiple' discoveries ("a nulltiple discovery is a scientific discovery published zero times"). Examples of bahramdipity include suppression of the researches done by K.Sugiura on tumors in mice and by Ludwick Gross on transmission of cancer conducted in the Memorial Sloan-Kettering Hospital in 1970s (Sommer 2001). These works were eventually published later and widely accepted in the scientific community. *Psuedobahramdipity* was described by Sommer as the opposite of bahramdipity wherein the principal investigator (bahram) actually endorses and encourages publication of improperly carried out research or fraudulent research done by his or her subordinate because it serves his or her own purposes. Robert Good, Chief of William Summerlin and co-author of his paper that later became infamous for the 'patchwork mouse' issue was accused of psuedobahramdipity in order to attract huge funding for his institute (Memorial Sloan-Kettering) (Summerlin et al. 1973).

Unethical human experimentation is a serious scientific misconduct. Josef Mengele (Angel of Death), the Nazi German doctor supervising the Auschwitz concentration camp is the rock-bottom of cruelty in human experimentation (http://www.auschwitz.dk/mengele.

htm accessed on 05/08/08). He had a special interest in research on identical twins and nearly 1,500 pairs of identical twins paid with their life for his 'research' from which nothing of value resulted. The amount of physical torture and death in the name of dissection to prove racial inferiority of the victims is a chilling remainder of the excesses of a pervert scientist. The atrocities of Nazi experimentation on humans led to the establishment of the 'Nuremberg code' in 1946 followed in 1964 by Declaration of Helsinki developed by the World Medical Association (http://en.wikipedia.org/wiki/human_experimentation accessed on 05/08/08). These two are considered to be mandatory principles that researchers all over the world should be familiar with when indulging in human experimentation. Atrocious human experimentation in the name of biomedical research did not end with the Nazis. In the U.S the 'Tuskegee Study of Untreated Syphilis in the Negro Male' continued over a period of 40 years till 1972 (http://www.tuskgee.edu/global/story.asp?s=1207598 accessed on 05/08/08). It involved the observation of the natural history in illiterate patients of African American origin even though effective remedy for syphilis in the form of penicillin was available since 1947. The patients were not informed that treatment was being withheld. The 'Willow brook hepatitis study' done between 1963 and 1966 involved intentional inoculation of mentally retarded but otherwise healthy children with hepatitis virus to assess the effects of gamma globulin in immune response to infection. The web site 'listverse' lists the top 10 evil human experiments (http://listverse.com/crime/top-10-evil-human-experiments accessed on 05/08/08). Public outcry against the Tuskegee and Willow brook experiments led to the Belmont report and then the 'Common Rule' to guide ethical aspects of human experimentation in the U.S.

Unethical animal experimentation occurs far more frequently than human experimentation and often goes unnoticed and unpunished. Research involving animals has been justified on the grounds of being contributory to progress in medicine (http://www.fbresearch.org/dogsf.html accessed on 06/08/08; http://pin.primate.wisc.edu/research/pibr/p42.html accessed on 06/08/08; Best 1974). Of course, animal research has led to important breakthroughs in medicine benefiting mankind immensely. Millions of animals undergo pain and suffering and eventual death in the name of scientific research. There is now evidence to suggest that not all these animal experiments are done for medical progress. Curiosity-driven animal research accounts for more than 50% of the experiments. The 'publish or perish' attitude drives many biological researchers to take animals to the sacrificial altar just to publish a paper, useful or not. Critics of animal experimentation say that results of animal experiments are not very useful to humans because of biological variability between humans and animals. Also, laboratory animals are often bred in abnormal conditions and their physiological status may not be representative of normal physiology. Use of animals for genetic manipulation has led to patenting of animal breeds raising questions about the ethics of patents over living creatures. Most countries do not have strong legislation to ensure the rights of animals and animals most commonly used in laboratories (rats, mice and birds) are deprived of even minimal protection. Research facilities that use only these animals are not required to show even cursory standards for pain relief or veterinary care. Animal research is useful to biomedical science but purely curiosity-driven research and research involving especially cruel methods are best avoided.

II) Scientific misconduct by those assessing the research—Once the research is completed the researcher/s attempt to get it published in a journal so that priority of authorship is documented and the article is brought to the attention of the scientific community. In the course of the verification by the journal of the acceptability of the article the *peer reviewers and the editor* play an important role. Journals rely on peer review to decide

what to publish and what not to publish. Articles in peer reviewed journals command respect from all quarters at present. There is a feeling that editorial peer review ensures the genuineness of the published scientific research. Ideally, peer reviewer is should be an acknowledged expert in the field and should have high ethical standards. He or she should not let personal interest and bias to interfere with scientific judgement. However not everything is ideal with peer review at present. The peer review processes as well as the editorial work are both susceptible for misconduct allegations. The referee may be tempted to find fault with a rival's effort. Anonymous peer review has been labelled as 'power without accountability' and as 'malice's wonderland' (Osmond 1983; Rennie 1998). Conflict of interest may affect peer review. Peer reviewer is usually a researcher in the same field as the author and he or she may be a competitor for the same scarce resources or pages in prestigious journals (Campanario 1998).

The peer reviewer is vulnerable to nepotism, sexism and bias against new ideas, young scientists, and scholars from lesser known universities and from developing countries. Bias such as patriotism, linguistic preference and seniority of the author may affect peer review process. Older reviewers in senior faculty positions have been shown to down play the contribution of juniors (Kliewer et al. 2004; Ernest et al. 1992; Wenneras and Wold 1997; Lloyd 1990). Studies have shown that reviewers from the U.S have a significant preference for U.S papers. When U.S reviewers have reviewed articles from outside the U.S, preference has been shown towards authors from English speaking countries and articles from prestigious academic institutions (Link 1998). A French study showed that the number of French articles published in the U.S journals decreased significantly after the French veto of U.S military action in Iraq. The marked anti-French sentiment in the U.S at that time seems to have spread to scientific publication also with the editors and peer reviewers acting as conduits of such sentiments (Bégaud and Verdoux 2001). Reviewers can abuse the 'inside' information he or she gathers during review process (http://grants.nih.gov/grants/guide/notice-files/not93-177.html accessed on 25/09/08; Marshall 1995). The reviewer may reject a good study on minor grounds of technicality and he or she may launch a separate study using the new information and publish it before the initial author has had time to correct the mistakes and send the article for reassessment (plagiarism of ideas by reviewers).

The editor of the scientific journal may use his office to allow more publication of articles authored or co-authored by him or her (http://www.publicationethics.org.uk/cases/zerofiveeight accessed on 04/07/08). Sir Cyril Burt published more than 60 dubious articles in the British Journal of Statistical Psychology while he was its editor. He was also discovered to have fabricated and falsified research findings in some of his well known papers. Hans Eysenk, a pupil of Cyril Burt lived up to his master's expectations by mimicking what his mentor did. He too published plenty of junk science in two journals of which he was the founder as well as the editor ('Behaviour Research and Therapy' and 'Personality and Individual differences') (Richard Smith: Editorial misconduct: time to act, COPE Report 2003—Session 2: Editorial Accountability (Chair: Richard Smith) at http://publicationethics.org.uk/reports/2003/2003pdf9.pdf; http://pubs.socialistreviewindex.org.uk/sr196/parrington.htm accessed on 25/09/08). The editor may allow more publications from his or her favourite authors while rejecting papers from respected authors that state a contrary point of view. This generates an unfair bias in the readers. In 1998, Dr. Richard Horton, editor of The Lancet published junk science authored by his former colleague Dr. Andrew Wakefield of the Royal Free Hospital, London where Dr. Horton had worked

before. Dr. Wakefield's paper claimed a link between MMR vaccine and autism and the so called autistic colitis based on unscientific as well as unethical research. Most of the Dr. Wakefield's co-authors of the paper issued a retraction in The Lancet in 2004 (Wakefield et al. 1998; Brian Deer,"MMR: The Lancet Fiasco" at <http://briandeer.com/mmr/lancet-bbc.htm> accessed on 14/09/08; Murch et al. 2004).

The editorial office of a scientific journal may be misused for socio-political reasons. Antonio Arnaiz-Villena was a guest editor for the journal Human Immunology in which he published a conclusion that Jews and Palestinians are genetically very close and that their rivalry is based on cultural and religious grounds but not genetic differences. The article created a furore forcing its retraction and removal of Arnaiz-Villena's removal from the editorial board (Smith 2003). The editor may abuse his privilege and participate or wilfully facilitate publication of fraudulent research papers. Malcolm Pearce and Geoffrey Chamberlain misused their offices to publish fabricated article in the British Journal of Obstetrics and Gynaecology. Malcolm Pearce was the assistant editor of the British Journal of Obstetrics and Gynaecology and Professor Geoffrey Chamberlain was the editor in 1994. Malcolm Pearce was the first author of two papers published in the journal in the same year. One was a case report titled "Term Delivery after Intrauterine Relocation of an Ectopic Pregnancy" and the other article was titled "Randomised Controlled Trial of the Use of Human Chorionic Gonadotrophin in Recurrent Miscarriage Associated with Polycystic Ovaries". Subsequent inquiry into the papers which had received wide media publicity found that both papers were works of fiction rather than scientific research. Professor Chamberlain was the co-author of the paper containing the case report of ectopic pregnancy. Pearce was dismissed from service and his name was struck off the GMC register. Professor Chamberlain was obliged to relinquish all his appointments (Lock 1995).

Editors of scientific journals have the final say in what goes to print and what gets rejected. They rely on peer reviewers to assist them in the process of article selection but the final judgement is with the editors. Editors are expected to pass these judgements independently and without bias. However, editors are susceptible to certain external influences the foremost among them being the *influence of the financial sponsors of the journal on editorial practices*. Editors have to permit advertisements by the sponsors in their journals and the authenticity of the claims made by the advertisers is not verified. Repeated advertising has been shown to alter the prescribing practices of physicians (Rennie 1991).

Editors are also obliged to publish proceedings of symposia that have been sponsored by pharmaceutical companies under the name of the parent journal. The articles in these symposia show bias towards particular drugs or implants and are less likely to be peer reviewed with the same degree of stringency as the articles in the parent journal. It has been shown that papers published in the journal supplements sponsored by pharmaceutical companies are inferior in quality to those published in the parent journal (Rochon et al. 1994; Bero et al. 1992). In case of company studies involving drugs or implants editors demand conflict of interest statement but the corporate 'bullies' still arm-twist the editors by reserving the right to review the manuscript for a defined period of time (1 to 2 months) before publication. This is ostensibly done to provide time to file for additional patent protection if required but it still means that the editor is pressured to share unpublished data with industry sponsors who may manipulate the results to suit their own needs (Ray 2002).

III) Scientific misconduct by those funding the research—Scientific research is either funded by government agencies or private institutions. When researchers apply for funding they have to submit their research proposals to the funding authority. The

proposal will be subject to peer review. This peer review process is subject to all the drawbacks already discussed earlier under 'assessment of research'. The peer reviewer is often a competitor to the same scarce resources that the researcher is seeking. In 1992 it was found that L.A Paquette of Ohio State University had plagiarised from another scientist's grant application when he was a peer reviewer for the National Institutes of Health (NIH). He received a 10 year ban from NIH research and other activities from 1992 onwards. During the same year, James Freisham of the Medical College of Ohio was also found guilty of plagiarising research grant proposal of another scientist while doing peer review on behalf of the NIH. He was barred from receiving federal research funding for a period of 3 years (Marshall 1995).

Research dependent on federal funds is vulnerable to political intrusions also. Amount of funding is dependent on governmental policies and the importance that is given to research by the fund allocating bodies. In the U.S there were instances of unfair political intrusion into research during the times of Eisenhower administration in 1950s and Nixon administration in early 70s. *McCarthyism* originated during the time of president Eisenhower when senator Joseph McCarthy unleashed paranoid investigations on Americans 'perceived' to be supporters of communist ideals (http://www.spartacus.schoolnet.co.uk/USAmccarthyism.htm accessed on 19/08/08). This led to unfair loss of jobs and destruction of careers of many promising researchers. Scientists during that time who were considered for federal research grants were screened by the FBI (Federal Bureau of Investigation). Based on the reports of the FBI which were often unfounded or outlandish, grants were cancelled to many prominent scientists including Linus Pauling. Senator William Proxmire had instituted the dreaded 'Golden Fleece' awards given to scientific projects that Proxmire considered as being wasteful of taxpayer's money (http://www.encyclopedia.com/doc/1p1-116508859.html accessed on 19/08/08). Proxmire held monthly news conference for 13 years between 1973 and 1988 to announce the 'Golden Fleece' awards. Although Proxmire's concern on irrational spending was understandable it also discouraged some good researchers from coming out with their projects.

A more recent example of McCarthyism occurred in 2003 when the US Government released a list of 157 scientists who studied AIDS and human sexuality (http://www.commondreams.org/headlines03/1028-05.htm accessed on 25/9/08). The NIH program officers were directed to instruct the researchers to give a description of what possible 'public benefit' their research would have. These projects had already been approved and funded by the NIH. Some senators felt that research into human sexual behaviour was wasteful of taxpayer's money as it was already evident that abstaining from risky sexual situations is the answer to minimize the risk of AIDS. The list of AIDS scientists had been prepared by a conservative advocacy group (Traditional Values Coalition) claiming to represent 43,000 churches nation wide.

Those in authority can resort to harassment out of personal jealousy and unhealthy competitiveness. The victimisation of Lisa Blakemore-Brown by the British Psychological Society (BPS) is another good example (http://scientific-misconduct.blogspot.com/2007/01/victimisation-of-lisa-blakemore-brown.html accessed on 04/07/08). Ms. Blakemore-Brown is a psychologist whose views on the disorder of 'Munchausen's syndrome by proxy' irritated persons in authority in the BPS as well as the pharmaceutical companies. The BPS launched a venomous campaign against her to the extent of casting questioning her mental health and her ability to carry on with her practice. The work of Eleanor Storrs, who was growing vast numbers of leprosy bacilli in nine-banded armadillos in Louisiana (U.S) were sabotaged by officials of U.S public health service led by Captain Waldemar Kirchheimer

(http://www.uow.edu.au/arts/sts/bmartin/dissent/documents/burchfield/burchfield.pdf accessed on 16/07/08).

Storrs was targeted after failed attempts by these officials to plagiarise her work and claim false authorship of a ground breaking research carried out by Storrs. Storrs was not only stopped from doing her research but was even accused of starting a zoonosis by letting loose infected armadillos in the wild! The leprosy vaccine died a natural death with the exit of Eleanor Storrs from the scene. The improper research carried out later by a bunch of ignorant PHS officials failed to produce any meaningful vaccine. Another fact that that went against Storrs was that she had earlier investigated the toxic effects of pesticides and given honest views which alienated her from PHS officials who were uncomfortable about her findings.

Commercially productive industries such as the pharmaceutical industry often sponsor their own research. In industry sponsored research, the industry may intimidate, harass or indulge in defamatory action against a researcher who wants to publish his or her results honestly (Deyo et al. 1997). The industry expects a 'favourable' report from the research it has sponsored. If the results of the study are not really favourable and the researcher wants to publish them without any manipulation or does not want to suppress unfavourable results in the interest of the society, he or she will be considered as a troublesome 'whistleblower' and dealt with accordingly. *Lysenkoism* is used when a new scientific point of view is perceived to be antagonistic to the interests of a powerful group as a government, industrial corporation or a professional body, the members of these groups attempt to denounce the new ideas of the innovator and also the innovator personally. The term Lysenkoism refers to repressive socio-political campaigns against scientists after its originator Trofim Denisovich Lysenko (http://en.wikipedia.org/wiki/lysenkoism accessed on 19/8/08).

Lysenko was the director of the Institute of agricultural Sciences in the Soviet Union in 1930s during the time of Stalin. He was a pseudo-scientist propounding plagiarised or false theories. He cruelly suppressed geneticists of the Soviet Union of his time calling genetics a 'bourgeois science' or 'fascist science'. Many soviet geneticists were executed or sent to labour camps including the famous Nikolai Vavilov. In the present day lysenkoism the scientific freedom of the innovator is restricted by censoring writing and publication, with drawl of funding, taking legal action and indulging in character assassination of the researcher by spreading baseless rumours. This phenomenon is not new to scientists. Galileo's ideas about the universe were opposed by the priests and aristocrats and he was placed under house arrest (www.bbc.co.uk/history/historic_figures/galilei_galileo.shtml accessed on 28/09/08).

Brian Martin has documented government sponsored harassment in Australia of scientists publishing research criticising certain pesticides (http://www.uow.edu.au/arts/sts/bmartin/pubs/99rsppp.html). The pesticide manufacturers and their 'well wishers' in the government were obviously not amused by the reports. When researchers are battling against corporate giants they are usually alone and their employers either do not help or may act against the researchers themselves. Nancy Oliveri's job as a professor at the University of Toronto was threatened after she disclosed adverse results honestly about a particular drug (deferiprone) therapy of thalassemia (http://www.hopkinsmedicine.org/about/crossroads/11_11_05.html accessed on 28/09/08). A Canadian pharmaceutical company (Apotex) was not pleased with her findings and her sense of ethics and almost succeeded in getting her sacked in connivance with some obliging members in the university and her hospital who were supporting the company in return for millions of research funding promised by the company. Her career was saved following intervention from leading experts in the field from Britain. Dr. Paul Fischer of the Medical College of Georgia published three papers in the JAMA in December 1991 detailing the effects of the advertising campaigns of the Camel cigarette 'Old Joe' on children and adolescents (http://

www.law.duke.edu/journals/lcp/downloads/lcp59dsummer1996p159.pdf accessed on 28/09/08). The study received wide media coverage and prompted public debate on banning such campaigns. The R.J.Reynolds Tobacco Company was not amused by this and resorted to legal arm-twisting and harassment of Dr. Fischer to surrender all the confidential research files to the company. The Medical College of Georgia complied with the tobacco company rather than supporting its own professor, a fact that prompted Dr. Fischer to resign in disgust.

In the U.K Arpad Pusztai reported that GM (genetically modified) food was toxic to young rats and revealed his findings in a television broadcast in 1998. Shortly afterwards his job was terminated, his data was seized and he was gagged from speaking about his findings (http://www.i-sis.org.uk/independent-scientist.php accessed on 16/07/08). His critics were government scientists who were promoting GM foods to the public at the bidding of their biotechnology corporate sponsors. The corporate obviously did not like to lose any business in GM foods. Dr. David Kerns at the Brown University, Rhode Island lost his tenure at the University after he refused to withdraw the abstract he had sent to the Annual Meeting of the American Thoracic Society in May 1997 about 'Flock Worker's lung', an occupational lung disease affecting workers in the nylon flocking industry (http://scientific-misconduct.blogspot.com/2007/04/dr-david-kerns-dilemma-learning-from.html accessed on 15/08/08; Kerns et al. 1998). Dr. Kern had discovered this disease after examining patients from a nylon manufacturing unit, Microfibres Inc. His termination was no surprise as the proprietor of the Microfibres Inc and two of his relatives sat on the hospital's board and funded the hospital also. As usual the administration of the hospital and the University colluded with the industry against the whistle blower. It is obvious that serious steps are necessary to protect researchers from the present day McCarthys and Lysenkos.

Improper research is harmful to the society due to many reasons. It leads to wastage of funds and taxpayer's money without providing proper advance in science. Erroneous results may lead the scientific community astray into incorrect approach to a particular subject. Science is said to be self-correcting and flawed studies are usually exposed sooner or later and 'weeded' out of the system. But the process of repairing the damage to science may be costly in terms of time and expenses. Much more research would have to be done to 'expose' a flawed study thereby taking the impetus from real progressive research. Even if science were to be self-correcting improper research deserves to be halted because it allows the wrong kind of researcher to progress in career at the cost of the honest researcher. Misguided research would be funded more based on faulty results and leads to wastage of the already scarce funds. Universities from where research misconduct has reported would be negatively impacted in terms of prestige and further funding. D.G. Altman has said "we need less research, better research and research done for the right reasons" (Altman 1994).

Manipulated or suppressed research outcomes are deleterious to the interests of medical science. For example 'evidence based medicine' (EBM) is considered as the gold standard for clinical practice today. EBM considers PRCCT (prospective randomised controlled clinical trial) as the best evidence and PRCCTs are expensive to conduct. Thus funding comes into play and there is a fear that research that eventually influences EBM may be controlled by vested interests such as the pharmaceutical or implant industries which may be interested in demonstrating the safety and efficacy of their products. The term pseudo-evidence based medicine (PBM) has been applied to medicine based on false research that is published as 'true' evidence which is accepted as such by unsuspecting loyalists of evidence based medicine (Smith 2007).

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