

Tiny Particles & Macro Challenges: Evaluating the Rational Debate of Social and Ethical Issues in Nanotechnology

Kundan Sagar¹ and Gaurav Kumar Bharti²

¹*School of Ecology and Environment Studies, Nalanda University, Rajgir, Nalanda, Bihar, (India). 803116*

²*Department of Electrical Engineering, Bhagalpur Engineering College, NH 80, P.O. Sabour, Bhagalpur, Bihar (India). 813210
E-mail: ¹kundansagar.2010@gmail.com, ²gauravkumarbharti7@gmail.com*

Abstract—Nanotechnology has turned into the recent scientific lingo and swift innovation in this field are significantly impacting the courses in which we conceptualise the future and human capacity to control matter at the nuclear and atomic levels, by offering undreamt promises for scientific innovations. Since the merging of nanotechnology with biotechnology, data innovation, subjective science discipline has crafted and hold guarantee for the change of human enactment at various levels, hence 'social and ethical issues' turns into a repeating expression in the scientific group. Hence stakeholders paying consideration on nanotechnology innovation with a vital question: whether nanotechnology is demonstrating ethically and socially unique issues or the ethical and social issues are related to nanotechnology like other innovative technologies. The present article endeavours to comprehend the discussion over nanotechnology with respect to its potential advantages and the threat to the society. One view in this discussion is that nanotechnology has a progressive potential and will have huge financial advantages, while the another view is wary about its potential with regards to ethical and social issues and values, for example, equity and social justice. Finally, an attempt is made to find the variance in the societal and ethical issue in both, those who want to promote it and those who have fears about its potential. Thus this write-up adds the level headed discussions by investigating foundational issues about the relationship of ethics and nanotechnology.

Keywords: Ethics; Nanotechnology, Nano science, Science-technology-society.

1. INTRODUCTION: THE GLOBAL NANO -WORLD

Nanotechnology is a thriving innovation that swiftly has entered society. It has wide applications in all fields of engineering and science, henceforth it is has been touted as a second industrial revolution [2]. Because of its ability of innovative mix at Nanoscale, it can possibly consolidate with other intense technologies like biotechnology, information technology, and intellectual science [3]. Hence nanotechnology is often stand out amongst the most noteworthy logical and modern changes of the 21st century. With nanotechnology, researchers are securing capacities to

comprehend and control materials at the size of particles and atoms. All the while, they are making the potential for individuals to see the world, demonstration in it, and change it, in on a very basic level new ways. As a result, Nanotechnology has caught wide consideration everywhere throughout the world and energised the creative energy of youthful and old alike. Enthusiasm for the subject has expanded amazingly amid the most recent couple of years as a result of potential innovative applications, and therefore nanotechnologies are drawing in expanding venture from \$6.25 billion in 2003 to trillion dollars (expected) industry in 2015, from governments and industry around the globe [4]. Overall governments have launched numerous nanotechnology-specific projects to influence the possibilities of the nanotechnology for social and financial increases. Till 2005, more than 62 nations propelled national nanotechnology-particular exercises worldwide [5]. The innovative work (R&D) exertion was fundamentally advanced worldwide over with the declaration of the *National Nanotechnology Initiative (NNI)* in 2001 by the USA, hence most developing nations have constructed their own projects in light of the foundation laid by the NNI, which is based on research and development program in nanoscience and innovation on the planet [5]. *China* has put resources into nanotechnology through its medium and long-term programs. *The National Enabling Technologies Strategy (NETS)* was propelled by the Australian Government to give a structure for the dependable improvement of empowering innovations, for example, nanotechnology and other new advances as they rise in Australia [8]. In 2003, Taiwan propelled its *National Science and Innovation Program for Nanoscience* and Nanotechnology and has likewise created Nano Mark which is the world's first government-set up the framework for ensuring nano-items [9]. The government spending on nanotechnology in the Republic of Korea has expanded under *Korea Nanotechnology Initiative (10-Year Moving Plan)*, and as per the revised planning Korea expects to join the positions of the main three countries in worldwide innovative aggressiveness.

In terms of SCI publications, Korea ranked eighth in the world in 2001 with 408 but jumped to fifth in 2005 as the number increased about 3.5-fold to 1,431[11]. Nanotechnology in Japan is to a great extent financed by government offices and expansive enterprises. It is the main nation in regions like nanomaterials, nanoelectronics, also, nano-bio-gadgets. In Singapore, the nanotechnology subsidising is done through *Agency for Science, Technology and Research* that was begun in September 2001 with an objective of starting nanotechnology inquire about as a major aspect of Singapore's push to expand on amassed abilities and the advancement of developments in ranges that fuel Singapore ventures. Canada's nanotechnology exercises for the most part move around local systems and the *National Institute for Nanotechnology (NINT)*. Thus, the number of published patents in nanotechnology expanded many times from 1995, 531 patents, 2001 1976 patents to 19,544 nanotechnology patents in 2015, among which 8,588 are granted patents and 10,956 are published patent applications. Therefore add up to worldwide spend is thought to be at present, yet this is set to rise [6]. Glancing back at the first National Nanotechnology Initiative gauges, the greatest financial commitments of nanotechnology originated from materials (\$340bn), gadgets (\$300bn), pharmaceuticals (\$180bn), chemicals (\$100bn), transportation (\$70bn) and remaining others [6]. No doubt, large portions of today's uses of nanotechnology are ordinary, surely tomorrow's applications may appear to be supernatural. This skyrocketed race of nanotechnology has significantly altered and affected the market. A research carried out in 2013 by a business consulting administration firm RNCOS on, "Nanotechnology Market Outlook 2017" has distinguished that the worldwide nanotechnology industry has been developing at a fast pace with rising applications in parts like pharmaceuticals, demonstrative gadgets and so forth. What's more, market patterns like nanotechnology-based thin film solar cells with high proficiency, nanomaterials with higher quality, strong development in nanofibers and nanomedicine showcase, and so on, are the massive development in this industry [7]. Pretty much of this innovation are crystallising the power sectors, autos, and PCs, therefore individuals will utilise nanotechnology to change their lives, their work, their propensities, there thoughts of fun and play, thus substantially more.

2. WHAT IS NANOTECHNOLOGY

The term nanotechnology is an umbrella term that envelops an inconceivable scope [8].The "nano" prefix gets from the Greek noun "nanos", which means dwarf. A nanometre (nm) is one billionth (1×10^{-9}) of a length: the length of around ten atoms put next to each other, or 1/80,000th of the thickness of a human hair [9]. Nanotechnology is regularly comprehended as an innovation including the control and utilization of matter, in view of its properties at the nuclear scale. The term covers a group of advances, including nanosciences and nanotechnologies. "Nanoscience is the investigation of

phenomena and control of materials at nuclear, atomic and macromolecular scales, where properties vary fundamentally from those at a bigger scale. Nanotechnologies are the outline, characterization, generation and use of structures, gadgets and frameworks by controlling shape and size at nanometre scale." The conceivable uses of nanotechnology are various and diverse. Technological integration at atomic level makes it conceivable to deliver systems with abilities far better than current gadgets. It has been found that the mechanical, electrical, optical, thermal, and attractive properties of a nanoparticle are unique in relation to that of its bulk material [10].

3. THE VOWS AND MENACE OF NANOTECHNOLOGY

An expansive a number of potential uses of nanotechnologies are presently opening up. In this article present and potential future improvements in nanoscience and nanotechnologies against which the wellbeing, security, ecological, social, and moral ramifications can be considered. A lot of nanoscience and numerous nanotechnologies are apprehensive with delivering new or improved materials. Many nanotechnology empowered items are as of now available and witnessing commercial success. For instance, self-cleaning windows utilise a 15 nm thick covering of initiated TiO₂ built to be exceedingly water-repellent, so that water just streams off the surface, washing away the dust [11]. Nanoparticles are utilised as a part of a few sunscreens to reflect and retain bright (UV) light [12]. Carbon nanostructures have been the centre of much intrigue and research. The football-formed Buckminsterfullerene (C₆₀) and its analogues demonstrate awesome guarantee as ointments and, because of their pen structures, as medication conveyance frameworks, and additionally in hardware [13]. Numerous applications are conceived in strengthened composites, sensors, nanoelectronics, and show gadgets. It is additionally conceivable to make comparative structures from inorganic substances, for example, MoS₂ and TiO₂, which might be helpful as impetuses and for vitality stockpiling, on account of their high limit for H₂ and Li [14]. Future utilizations of nanomaterials incorporate lighter, sturdier materials, the utilisation of nanoparticles to tidy up sullied land, and nanoengineered films for more energy effective water decontamination or desalination [15].In the more extended term, it is trusted that nanotechnologies will empower more proficient ways to deal with assembling utilising fewer crude materials and vitality. The other side to these advantages is the prospect of constructing agents and disassemblers being utilised to make weapons, be utilised as weapons themselves, or for them to run wild and wreak devastation. Weapons are a conspicuous negative utilisation of nanotechnology [16]. Just broadening today's weapon abilities by scaling down firearms, explosives, and electronic segments of rockets would be sufficiently dangerous. In any case, with nanotechnology, armed forces could likewise create disassemblers to assault

physical structures or even natural life form at the atomic level. A comparative peril would be if broadly useful disassemblers got free in the earth and began dismantling each particle they experienced. This is known as "*The Gray Goo Scenario* [17]." Furthermore, if Nano machines were made to act naturally duplicating and there were an issue with their restricting system, they would increase interminably like infections. Indeed, even without considering the outrageous catastrophe situations of nanotechnology, we can discover a lot of conceivably unsafe uses for it. It could be utilized to disintegrate our freedom and security; individuals could utilize sub-atomic estimated mouthpieces, cameras, and homing reference points to screen and track others.

4. ETHICAL AND SOCIAL ISSUES OF NANOTECHNOLOGY

Certainly, the ultimate goal of the scientific community and scientists who are involved in the development of nanotechnology is, to see its unlimited applications like to free the universe from diseases, to make a renewable energy source, and to bring mankind securely into the upcoming decades (See figure 1) [18]. Indeed the long haul guess is great. What is being ignored in the short term, in any case, is to a great extent an unacknowledged component that may convey an untimely end to this innovation: the social and ethical ramifications of nanotechnology that are as of now bringing on worry inside the technology. Unless the worries identified with ethical and social issues are completely tended to, the advance of nanotechnology could be extremely hampered [19]. Morals and social issues usually overlap, however comprehensively ethics is about good and bad activities and social issues are about patterns, circumstances and clashes in the public arena [20]. This article highlights following major social and ethical issues, which are found in the published literature

- **Social concern challenges:** As per the study from *Bruce V. Lewenstein* in 2005, social framework issues emerge from the association of nanotechnology with different nonscientific parts of the social or institutional and the different social setting issues can be named unequal access to human services, imbalances display in our training framework, unequal access to cutting edge innovation, lacking of data security/security insurance, unprotected licensed innovation frameworks, unequal introduction to ecological perils and deficient purchaser wellbeing assurance [21]
- **Global Division and exclusion:** The study from *Noela Invernizzi and Guillermo Foladori* in 2005 reflects that long haul effects of nanotechnologies are having genuine impact on worldwide society and the economies of numerous countries as their will increase the hole amongst rich and poor nations in light of their diverse abilities to create and misuse nanotechnologies, prompting a supposed a global divide. On the off chance

that global economic advancement in creating high-esteem products and services rely on scientific knowledge, is probably going to worsen existing divisions amongst rich and poor [22]. The condition will be shoddier if the more drastic 'visions' of promise to nanotechnologies were realised, for developing a 'technical fix' to a range of global and societal ills might obscure or divert investment from cheaper, more sustainable, or low-technology solutions to health and environmental problems [23].

- **Challenges from good and religion Issues:** In their article "*The Societal and Ethical Implications of Nanotechnology: A Christian Response*" *Dr Franz A. Foltz and Dr Frederick A. Foltz* represented that there are different good and customary religion conviction issues which may tussle with the advance in current Nanotechnology. Significant number communication with of ethically questionable practices or exercises - i.e., those that a A generous number of nationals accept ought to be deserted [24]. Cases of questionable good and religion issues will be rehearsed and the real exercises in which nano-scale science and innovation are probably going to be connected incorporate natural weapons advancement, engineered science, and development of fake life forms, undifferentiated cell exploring research and different hereditary controls of individuals [25, 26].
- **Techno culture Issues:** Techno culture challenges the rise up out of different basic issues of the part of innovation inside the present social frameworks. Techno culture issues incorporate an over the top reliance on the mechanical answer for counter different hazardous impacts as opposed to finding the basic reasons for the issues. There are other concerns is that youngsters are utilising different nanotechnology-based PC and adding machine. Those adding machines are so quite complex that the whole numerical related issue can be fathomed with any utilising their logical considering. Thus the essential logical learning is not up to the stamp [27]. Also, overdependence on innovation makes individuals languid and affects sociocultural factors such as language, cultural heritage etc. [28].

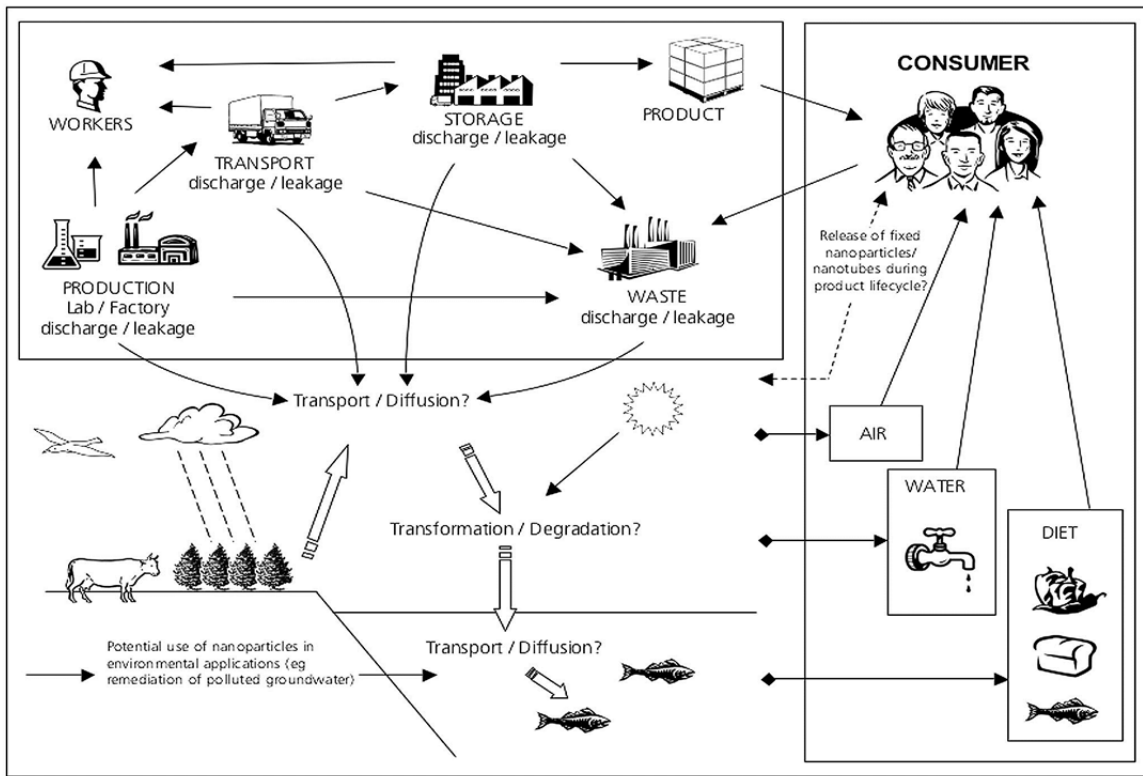


Figure 1: possible exposure routes for nanoparticles and nanotubes based on current and potential future applications. (Image adopted from 2004, The Royal Society & The Royal Academy of Engineering report on Nano science and nanotechnologies)

Type of Life Issues: There are different issues identified with personal satisfaction emerge from nanotechnology's synergistic effects on parts of the human social life. In the event that nanomedicine increment the normal human life expectancy even around 10 invigorating years, standards and state of human life should be reevaluated and this will have a huge effects on different family standards and structures ,life arrangements and social and political foundations [29][30].

- **Transformational Issues:** Transformational of nanotechnology into other developing innovations, for example, biotechnology, data innovation, software engineering, intellectual science and apply autonomy may change the essential elements of the human circumstance in such kind of cases some vital part of our moral idea would be reconstituted- - for instance, Personal character or the ethical status of exceptionally intelligent robots [31].

5. THE DILEMMA: ARE THERE ETHICAL ISSUES RELATED TO NANOTECHNOLOGY OR DOES NANOTECHNOLOGY RAISE UNIQUE ETHICAL ISSUES?

If one goes to the Google and search for social and ethical issue of nanotechnology, can find huge number of write-ups, report and articles. Similarly, more than 800 technically

precise articles on this topic, from trustworthy scientific bulletins one can find on “*Science Direct*” (www.sciencedirect.com). Despite such no of information and reports, still, the nanotechnology world is in dilemma whether “*ethical and social issues related to nanotechnology?* or does nanotechnology raise unique ethical issues?” While huge ethical and social issues identified with nanotechnology have been distinguished, none has all the earmarks of being subjectively new in kind. Many articles analysed and affirmed cases of such issues and evaluated the nanotechnology-related issues are special add up to old moral wine in new innovative containers. *Adam Keiper*, in his article “*Nanoethics as a Discipline?*” argued that dreams of using nanotechnology to merge man and machine, and for the man to fundamentally alter and eventually leave behind his given biological nature, thus nanoethics are necessary [32]. While *Anna Julie Rasmussen, Mette Ebbesen and Svend Andersen* in their article “*Nanoethics—A Collaboration Across Disciplines*” argued that- The phrase ethics of nanotechnology could chance estrangement the innovation from the ethics. In this way, ethics will get isolated and underscored which may permit nonscientists to overlook the call for engagement around there of nanoscience and innovation. Utilizing the term nanoethics, then again, could add to the better engagement of the nanoscientists in the open deliberation: Since the term accentuates nano, this makes it less demanding for

nanoscientists to relate. Hence, they would at present be including themselves in something with an undeniable premise in their own particular field, regardless of the possibility that it is a generally new territory of study [33]. While authors like *Fritz Allhoff and Patrick Lin*, in their articles “*What’s So Special about Nanotechnology and Nanoethics?*”, believes that the potential societal ramifications of the scientific and technological development prepare in the domain of nano science, hence are just somewhat comprehended and in this manner should be further investigated. Thus there is no such unique social and ethical issue related with nanotechnology [34]. Thus, all known social and ethical issues identified with nanotechnology have roots that are socio-specialized, not absolutely specialized, in nature. Why is it so? Clearly, persons make nanotechnologies. However, we frequently discuss and blame technologies as if individuals have practically no power to control over them and another innovation achieves social change or that it “impacts” society. Be that as it may, blaming the nanotechnology to bound social change is wrong as peoples are in control of all parts of the generation, circulation, operation, and utilisation of new technology like nanotechnology and such changes are beyond the capacity of the single man [35]. The society changes when individuals settle on decisions at all phases of technology improvement [36][37]. An innovation might be actually practical, yet unless somebody puts forth an influential shield for its development, it might never cause any change or impact the society. For instance, when labourers were put out of their occupations since farmers chose to purchase tractors to work their fields. In this way, when individuals say that innovation causes social change, we ought to rather look behind the appearances for the decisions individuals are making that are achieving that change. Nanotechnologies are likewise adaptable, both in the application and in understanding. For example, a modest bunch of researchers are attempting to utilize nanotechnology to construct interfaces amongst people and machines that they accept will permit the individuals who can bear the cost of the innovation to live enormously expanded lives. Definitely, many different researchers and legislators fight that are such endeavours, in fact, unconceivable as well as that the inspiring such endeavours are not appropriate and perilous. That’s why an assembly of persuasive researchers, strategy makers, business pioneers, and NGOs called ICON and the Meridian Institute has pushed for subsidising nanotechnology research that might benefit towards the alleviation of overall poverty [38]. If we take a glance in historical change of society, we obtain that individuals live with and through innovations is that social and mechanical changes are firmly coupled [39]. All through history, changes in technologies have run as an inseparable unit with changes in the wide association of society. Today, for instance, workers and laborers working in production lines seek after lives and work that would have been unfathomable before the development of the advanced assembling advances [40]. Social orders have changed drastically with the presentation of the automobile into far reaching use, and again

with the reception of with computers, mobiles and the Internet [41][42][43]. For every situation, as individuals have outlined, tried, showcased, and purchased new innovations, they have likewise settled on novel options about how and where to experience their lives, bringing far reaching and in some cases sensational social change despite of their “unique” social and ethical issues. History reflected that at every level of changes, initially there are a big shout on ethical and social issue however with wider acceptance by individuals, society retreats from established notions of ethics and social deeds. In the mid-1980s, another technique for reproduction called in vitro was created in which specialists separated eggs and sperm and treated them in the research center rather than in the body [44]. People considered this to be exceptionally supportive who, organically, were not able have kids now had a conceivable course to pregnancy. This intrigue propelled specialists to make centers committed to in vitro treatment (IVF) which is helping number of couples to have kids every year including couples of Africa who are infected with HIV [46] [47]. With time IVF specialists now make extensive earnings in the field and new open doors for social and mechanical development have opened up, including markets for sperm, eggs, and surrogate moms [48]. The progressions have not just been financial but rather social and moral too. Some IVF systems, for instance, bring up issues about parental rights and obligations [49]. What happens if a surrogate mother chooses not to surrender the hereditarily random infant she has conveyed to term to the kid’s hereditary guardians? [50, 51]. For this situation, the courts have turned into the scene for choosing the legalities of parenthood and many other guideline worldwide for IVF [52,53]. And this way society finds the answer for such ethical and social issue of IVF. Since being another innovation, nanotechnology has given us the capacity to know and act in new ways. Answers to such inquiries are frequently disputable unequivocally in light of the fact that they speak to takeoffs from settled thoughts of ethical value and social conduct. Hence noting these inquiries involves social consultation through which people and groups choose for themselves as well as other people what sort of a world the future will be with the new innovation in it. This is the manner by which social change happens around nanotechnologies. So the contentions about nano innovations ought not be viewed as essentially hurdles to new “advances.” They are a vital route in which we assess new advances and open deliberation about what qualities are generally imperative. In the event that we are to create and acknowledge advances that promote our objectives, and hence we should effectively talk about the upsides and downsides of new improvements. Considerations over how to best utilize nano innovation—and how to best sort out our reality around this innovation—are a crucial piece of building better social orders. Thus it is evident that nanotechnologies are free from “unique” social, ethical and techno moral issues. Thus in the words of *Tsjalling Swierstra*, through his article “*Nanotechnology and Technomoral Change*” [54]

So, what marriage counseling do I have to offer? I realize that marriages come in all sorts and kinds, and what works for one doesn't work for someone else. But all the same it is possible to say something in general about the marriage between technology and morality. As divorce is not an option, the only way they can make their relation work is by respecting one another's differences. In most cases, morality will be the stiff, conservative partner, only willing to change when all other options are cut off. In comparison, nanotechnology is likely to be the investigative, dynamic partner, always open to new opportunities. Neither can make the other obey, but what they can offer to each other is to keep the other alert. And thus learn from one another. How the problems will be solved eventually, or who will solve them this time, is then of little consequence. And sometimes, of course, it helps to bang the doors

6. CONCLUSION

Innovative technologies are regularly joined by guarantees of future returns, and nanotechnologies are the same. The defenders of nanotechnology guarantee that it will mitigate human enduring by growing new diagnostics and pharmaceuticals and that it will end contamination through clean creation and the improvement of new systems to tidy up old wrecks. Then again, a few people fear the eventual fate of nanotechnology, proposing that it will exasperate existing disparities, permit observation of everybody and everything, and irritate being human by combining people and machines in disturbing ways. These trusts and fears of social and ethical issue about whether new and developing advances in nanotechnology will be great or awful for society are molded by various ideas of human advance. For a few people, advance means more beneficial, more important lives. For others, it implies more prominent material riches. For yet others, it implies an existence more sensitive to nature and the earth. These thoughts are significant to how we comprehend and offer intending to innovation. All of these "big ideas" related to social and ethical issue of nanotechnology in the public eye, can help nanotechnology to end up more reflexive about new advancements. This sort of intuition is critical in light of the fact that, with a specific end goal to settle on better choices about the future, we have to comprehend not just the role of science and innovation in the society additionally our own role in crafting science and innovation. Being intelligent about the future and practicing our technological imagination is especially vital with regards to nanotechnology. Nanotechnology remains moderately unformed as an innovation; however the envisioned potential outcomes of nanotechnology—great and terrible—are as of now circling. It is vital that we subject those envisioned fates to basic investigation and perceive that nobody ought to have a monopoly on the future development of nanotechnology. It is vital that extensive array of citizens get to be included in envisioning the Nano technological future. Researchers and entrepreneurs may design nanotechnologies, yet we will all

need to live later on that those innovations envision and make. The thought of nanotechnology energizes the utilization of our creative energy since many of potential outcome is still to come. Every one of the contentions connected with moral and social issue which utilize history, fiction, and theory in the stories, is drawing analogies, investigate conceivable outcomes, or impart notices about what may happen in the years to come. These creative impulses can impact choices about what scientific group and policy makes ought to or ought not do or finance new research, and how to conform our lives to the conceivable outcomes of new advances of nanotechnology. Along these lines the situation of social and moral issue related with Nano innovation is at any rate is imperative since what we envision advises what we make. All the controversies related to nanotechnology in the form are unique ethical and social issue will guide and manage the future utilization of nanotechnology. The destinies that we imagine today for nanotechnology, along these lines shape the destinies that we truly get tomorrow. All the societal and moral ramifications about nanotechnology are similar to other innovative technologies and hence display huge chances to reconceptualize how societal and moral concerns can function with the numerous and different strengths that drive technological change, specifically nanotechnological change

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