

## **Xenotransplantation Technology and Its Potential Effects on The Environment**

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**Abstract:** Scientific research is currently geared towards making xenotransplantation a clinical procedure. Most articles and books have been written challenging xenotransplantation from the moral, religious and medical perspectives. However, little or no attention has been given to the potential threat of xenotransplantation to the environment. This work through critical reasoning takes up this daunting challenge of exposing the inherent potential threats that xenotransplantation could pose to the already degrading environment. It recommends a halt in the research on xenotransplantation to avoid its potential threats to humans and the environment at large.

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### **INTRODUCTION**

Xenotransplantation or xenografting is the transplantation of organs, tissues or cells from one species to a different species. It is contrasted with allotransplantation which is transplantation from one species to another animal of the same species. This work looks at xenotransplantation from the point of view of transplantation from animals to humans.

Though xenotransplantation has a lot of praiseworthy prospects for the health of humans, the problems that would accompany its advent could be catastrophic if not nipped at the bud, now that it is still at its infant stage of development. Diseases such as AIDS, diabetes, Parkinson's disease, acute liver failure, spinal cord injury, psoriasis, muscular dystrophy, myocardial infarction and other health conditions have plagued mankind for ages and have defied all attempts at cure. The news that organs, tissues and cells got from animals would cure these diseases is indeed a reason for celebration [1]. Though, the emergence of xenotransplantation offers great hope to the human race, it nevertheless is surrounded with evil, so dark that it drowns out what little hope it has for humanity. Xenotransplantation carries in itself the potential to sink the world. It could destabilize the ecosystem and thereby, increasing the environmental problems that are already proving too much to manage. The animals' existence would be threatened by xenotransplantation, thereby leading to a drastic reduction of the world's biodiversity – a biodiversity that is already speedily being lost.

Xenotransplantation is not yet a clinical success because, of the problem of immune rejection. However, in the nearest future it might become a huge success like other forms of genetic engineering. When this time comes, the researchers believe efforts would be diverted from the present drive to create a sustainable environment to xenografting. Most of the problems xenografting is out to solve are problems that have their roots in environmental degradation, if the solutions to these problems are found in xenotransplantation, then, there is likely to be a drop in the motivation to take care of the environment. The motivation to take care of the environment has hinged more on the knowledge that environmental degradation affects human health negatively. But if xenotransplantation clears off this source of motivation, then the environment may totally degrade.

Other problems that would necessarily accompany xenotransplantation include:

- It brings with it the risk of introducing new infectious diseases to humanity.
- It reduces the dignity of humans
- It brings about identity problem
- It questions God's existence and His creative role

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- It would lead to abuses of human rights
- It would lead to overpopulation <sup>[2]</sup>.

This work is aimed at nipping these looming problems at the bud. It is easier to tackle a problem before it develops than to tackle it when it is already in existence; prevention is always better than cure.

### **A BRIEF OVERVIEW OF THE ENVIRONMENT**

Environment, according to Symons <sup>[3]</sup>, encompasses all living and nonliving things occurring naturally on Earth or some region thereof. There are two types of environment – the human-built and the natural environment. The components of the natural environment include; vegetation, microorganisms, soil, rocks, atmosphere, and natural phenomena that occur within their boundaries, it also include; air, water, and climate, as well as energy, radiation, electric charge, and magnetism, that is not the result of human activities. The human-built environment on the other hand (like the Tinapa in Calabar city for instance) is composed of man-made properties like houses, roads, canoes, chairs etc.

The natural environment contains natural resources which could also be classified into renewable and non-renewable resources: the renewable resources are reproducible and in principle could be maintained perpetually. There include: forests, animals, and water. The non-renewable resources on the other hand cannot be restored or the restoration takes place so slowly that it will not increase significantly the stock of resources in any reasonable time span. There include: oil, gas, minerals, and so forth. The unwise use of these resources leads to depletion and other environmental problems like acid rain, rise in sea level, deforestation, biodiversity loss, ocean acidity, flooding, drought, global warming, et cetera <sup>[4]</sup> The causes of these environmental problems are both natural and man-induced. Examples of natural causes are erosion, leeching, earthquake et cetera. Examples of human causes include; bush burning, deforestation, transportation activities, industrial activities et cetera. These activities are generally believed to be increasing as human population increases. Since xenotransplantation is capable of increasing human population, it means success in xenotransplantation would increase human activities which will invariably lead to an increase in environmental impact of humans. Thus, success of xenotransplantation will mean an explosion of human population, which would lead to over exploitation of the environment <sup>[5]</sup>, leading to more health problems and survival risks.

### **POPULATION GROWTH AND THE ENVIRONMENT**

It is believed that for most of our history, humans have not been very numerous in comparison with other living species. However, it was the discovery of Agriculture and the domestication of animals about 10000 years ago, that gave a boost to our population. This is because, agriculture invention provided a larger and more secure food supply, thus allowing human population to increase to about 50 million people in 5000B.C. Since then human population had continually increased but very slowly. Thus, it is estimated that as at the time of Jesus Christ, human population figure stood at about 300000000 people <sup>[4]</sup>. However, in about 1600 A.D. population increased exponentially due to increase in sailing and navigating abilities (that stimulated commerce and communication among different countries), agricultural development, better power supply, improved health care et cetera. It took almost the entire length of human history, for population to reach one billion in 1804 A.D., but in just 150 years human population rose to 3 billion in 1960. It took another 39 years for it to double to 6 billion in 1999 <sup>[6]</sup>.

Due to this expected exponential growth in human population, many people worry that if it is (population) not controlled, we will witness a severe resource depletion and environmental degradation which will threaten the ecological life support system on which we all depend <sup>[7]</sup>. These worries and fears led to a clamour for an immediate global population control that would forestall this threat.

Human population control is the practice of intentionally altering the rate of growth of human population. Population control may use one or more of the following practices: Contraception, Abstinence, Abortion, Infanticide, War, emigration, Immigration reduction, Sterilization, Euthanasia, improving status of women causing departure from traditional sexual division of labour and reduction of infant mortality so that parents do not increase their family size to ensure at least some survive to adulthood <sup>[34]</sup>. The method(s) chosen by a given country could be strongly influenced by the religious and cultural beliefs of the area. Thus, while a particular population control method may be legal in one country, it may be illegal or restricted in another. For instance, abortion is illegal in Nigeria but legal in the USA - indicating the controversy surrounding this topic of human population control.

A lot of philosophers have debated on the issue of population control – some arguing for and others arguing against. Kautilya - a political philosopher, considered population as a source of political, economic, and military strength. He argues that of two evils – over population and under population, the greater evil is the latter. Plato and his student Aristotle argued that cities should be small enough for efficient administration and at the same time should be large enough to defend themselves against attacks from neighbouring states. This desired population size, they advised could be obtained through procreation, and if necessary, immigration, if the population size was too small and if it was too large, Emigration to other colonies should be encouraged. Aristotle advocated the use of abortion and the exposure of newborn, to combat overpopulation<sup>[8]</sup>.

Ibn Khaldoun as captured by Neurath argued that high population density rather than high absolute population numbers were desirable to achieve more efficient division of labour and cheap administration. Jean Bodin, argued that a larger population would mean more production and in turn more export, which would increase the wealth of a country. Giovanni Botero also avers that, "the greatness of a city rests on the multitude of its inhabitants and their power"<sup>[35]</sup>.

Malthus<sup>[27]</sup> argued that, "Population, when unchecked, increases in a geometrical ratio while subsistence increases only in an arithmetical ratio." He outlined ways in which over population could be checked. "Positive checks," increase the death rate, there include; diseases, war, disaster and famine. "Preventive checks" are factors that affect the birth rate such as moral restraint, abstinence and birth control. He predicted that "positive checks" on exponential population growth would ultimately save humanity from itself and that human misery was an "absolute necessary consequence".

Paul R. Ehrlich, a biologist and environmentalist, advocated for a stringent population control measures. He argues that

A cancer is an uncontrolled multiplication of cells; the population explosion is an uncontrolled multiplication of people. Treating only the symptoms of cancer may make the victim more comfortable at first, but eventually he dies - often horribly. A similar fate awaits a world with a population explosion if only the symptoms are treated. We must shift our efforts from treatment of the symptoms to the cutting out of the cancer. The operation will demand many apparent brutal and heartless decisions. The pain may be intense. But the disease is so far advanced that only with radical surgery does the patient have a chance to survive<sup>[10]</sup>.

He concluded that there is need for a compulsory birth regulation... [like] the addition of temporary sterilants to water supplies or staple food. Doses of the antidote would be carefully rationed by the government to produce the desired family size. Contrary to Ehrlich and other advocates of population control, Pope Benedict XVI stating the Catholic Church position avers that "The extermination of millions of unborn children, in the name of the fight against poverty, actually constitutes the destruction of the poorest of all human beings"<sup>[11]</sup>.

Though as has been shown above, conflicting views exist as to whether or not to control population, the majority of the countries seem to be tilting to the position of the advocates of population control. One good example is China's one-child policy, (though now amended) in which, having more than one child is discouraged<sup>[12]</sup>. In India only those with two or fewer children are eligible for election to a Gram panchayat, or local government. In Iran mandatory contraceptive courses are required for both males and females before a marriage license could be given<sup>[13]</sup>. In Uzbekistan there is a policy of forced sterilizations, hysterectomies and IUD insertions since the late 1990s in order to impose population control<sup>[14]</sup>. The adoption of these policies of population reduction shows that the effect of over population is well known and understood. The effects of overpopulation to the environment include:

1. Biodiversity Threats: Environmental degradation which is the product of human activities, leads to biodiversity threat. Biodiversity is the degree of variation of life forms within a given species, ecosystem, biome, or planet<sup>[15]</sup>. In 2006 many species were officially classified as rare, endangered or threatened by scientists; and they also estimated that millions more species which have not been formally recognized are at risk. About 40 percent of the 40,177 species assessed using the IUCN Red List criteria are now listed as threatened with extinction—a total of 16,119<sup>[16]</sup>.

2. Deforestation: Deforestation is another major effect of environmental plummeting that would necessary come with increased population by the help of xenografting and other biomedical practices. It is the removal of a forest or stand of trees where the land is thereafter converted to a non-forest use.

Deforestation occurs for many reasons: trees are cut down to be used as fuel or timber, while cleared land is used as pasture for livestock, plantations of commodities and human settlements. Trees provide windbreaks and shade; plant transpiration recycles rainwater and maintains constant annual rainfall; plants from around the world counter the accumulation of greenhouse gases in the atmosphere by sequestering carbon dioxide through photosynthesis [17]. The removal of trees without sufficient reforestation therefore, would result in damage to habitat, biodiversity loss and acidity. It has been estimated that about half of the Earth's mature tropical forests—between 7.5 million and 8 million km<sup>2</sup> (2.9 million to 3 million sq mi) of the original 15 million to 16 million km<sup>2</sup> (5.8 million to 6.2 million sq mi) that until 1947 covered the planet—have now been destroyed [18]. Some scientists have predicted that unless significant measures (such as seeking out and protecting old growth forests that have not been disturbed) are taken on a worldwide basis, by 2030 there would only be 10% of forest remaining with another 10% in a degraded condition 80% would have been lost, and with them hundreds of thousands of irreplaceable species [19]. Xenografting would save more lives; these lives would procreate and these new individuals would increase the demand for houses, farmlands and industrial expansion which would lead to more deforestation and even plundering with class struggle.

3. Global Warming: Global warming is the rise in the average temperature of the Earth's atmosphere and oceans. It is reported that since the beginning of the 20th century Earth's mean surface temperature has increased by about 0.8 °C (1.4 °F) [20]. Scientists generally believe that global warming is primarily caused by increasing concentrations of greenhouse gases produced by human activities such as the burning of fossil fuels and deforestation [21]. The effects of global warming include: extreme weather like heat waves, droughts and heavy rainfall; it also include ocean acidification, species extinctions, rise in sea levels and a change in the amount and pattern of precipitation, as well as a probable expansion of subtropical deserts [22]. Other effects are a threat to food security from decreasing crop yields, the loss of habitat from inundation, melting of snow and ice, increase in heat content of the oceans, increased humidity et cetera [23]. These changes are deemed to be virtually one hundred percent human induced [24]. Human activity since the advent of the Industrial Revolution has continually increased the amount of greenhouse gases in the atmosphere; leading to increased radioactive forcing from CO<sub>2</sub>, methane, tropospheric ozone, CFCs and nitrous oxide. According to work published in 2007, the concentrations of CO<sub>2</sub> and methane have increased by 36% and 148% respectively since 1750 [25]. In May 2013, it was reported that readings for CO<sub>2</sub> taken at the world's primary benchmark site in Mauna Loa surpassed 400 ppm. According to professor Brian Hoskins, this is likely the first time CO<sub>2</sub> levels have been this high for about 4.5 million years [26]. Among the human activities that have contributed to global warming, Fossil fuel burning alone is said to have produced about three-quarters of the increase in CO<sub>2</sub> from human activity over the past 20 years; and deforestation causing most of the remaining quarters.

4 Ozone Depletion: Ozone depletion refers to a steady decline of about 4% per decade in the total volume of ozone in Earth's stratosphere (the ozone layer), and its twin phenomena which is a much larger springtime decrease in stratospheric ozone over Earth's polar regions. This latter phenomenon is referred to as the ozone hole. The ozone layer prevents most harmful UVB wavelengths of ultraviolet light (UV light) from passing through the Earth's atmosphere, thereby shielding us from direct UVB wavelengths which have a lot of consequences like: skin cancer, cataracts, damage to plants, and reduction of plankton populations in the ocean's photic zone [27]. Chlorofluorocarbons (CFCs), halons (chlorine and bromine), carbon tetrachloride, trichloroethane and other contributory substances are referred to as ozone-depleting substances (ODS). Ozone is destroyed by a variety of free radical catalysts, released through human activities, the most renowned being hydroxyl radical (OH•), the nitric oxide radical (NO•), atomic chlorine ion (Cl•) and atomic bromine ion (Br•). The Cl and Br atoms can then destroy ozone molecules through a variety of catalytic reactions. The chemical equation is as shown below:

- Cl + O<sub>3</sub> → ClO + O<sub>2</sub>: The chlorine atom changes an ozone molecule to ordinary oxygen
- ClO + O<sub>3</sub> → Cl + 2 O<sub>2</sub>: The (chlorinemonoxide) ClO from the previous reaction destroys a second ozone molecule and recreates the original chlorine atom, which can repeat the first reaction and continue to destroy ozone.

The effect of this reaction is a decrease in the amount of ozone in the upper stratosphere. More complicated mechanisms have been discovered that lead to ozone destruction in the lower stratosphere as well.

5. Pollution: Passmore the Australian thinker defines pollution as, “the process of putting matter in the wrong place in quantities that are too large” [28]. A place may be “wrong” aesthetically (as in oil in an estuary; plastic bottles, bags or beer cans in a park); or wrong when it is dangerous to human health; or when it destroys wildlife, plants or humans. Poor handling of the environment releases tons of different types of pollution into the water, air and land. It is estimated that in the United States alone, about 4.5 trillion litres (1.2 trillion gallons) of contaminated water seep into the ground on a daily basis. This comes from septic tanks, cesspools, municipal and industrial landfills and waste disposal sites, agricultural chemicals and wastes [6]. It is also estimated that 1.5 million Americans fall ill from infections caused by fecal contamination which costs billions of dollars per year. Also 6 million metric tons of plastic bottles, packaging materials and other pollutants are thrown into the oceans from ships every year, where they choke seabirds, mammals and fishes. Oceanographers estimate that between 3 to 6 million metric tons of oil are discharged into the world’s ocean each year from oil tankers, fuel leaks, intentional discharges et cetera. Other examples of water pollutants include:

- Organic chemicals which include products used in industries, houses and agriculture. Examples are plastics, detergents, oil, gasoline, pesticides et cetera.
- Inorganic chemicals which emanates from industrial effluents, household cleansing, surface runoff et cetera. Pollutants in this category are acids, caustic, salts, metals et cetera. They come from human and animal excreta.
- Infectious materials which include bacteria, fungi, and viruses et cetera. They come from human and animal excreta.
- Radioactive materials which emanates from mining of ores, production of weapons, manufacture of weapons et cetera.
- Thermal changes like heat which emanates from power plants and industrial cooling.

The major air pollutants include: carbon monoxide, lead, nitrogen oxides, ozone, particulate matter, sulphur dioxide. Most of these pollutants are from burning fossil fuels, especially in coal-powered electric plants and in cars and trucks as well as in processing natural gas and oil. According to William Cunningham and Mary Cunningham, about 2 billion metric tons of air pollutants are released into the atmosphere every year worldwide.

It is a simple logic that the more the population, the more would be the environmental degradation. Successes of xenografting therefore would translate to environmental plummeting; it would increase the effects we outlined above, thereby affecting everyone including the future humans.

## **THE IMPACT OF XENOTRANSPLANTATION TECHNOLOGY ON THE ENVIRONMENT**

As has been shown above, population increase has a direct impact on the environment and is the cause of most of the environmental problems witnessed today. With the advancement in xenografting, tissue and stem cell engineering and other biomedical practices, the rate of doubling of the population would increase. Perhaps, the population after the successful take off of xenografting would double every 10 years or less. Because millions of people who would have otherwise died because of absence of organs and tissues for transplantation would be alive, and also those that would have died because of the various incurable diseases would be alive, thereby making the population to increase in an unprecedented rate in history [29]. In the United States alone for instance (that of the whole world is not known) according to Chiang and others, there are about 3 million Type 1 diabetic patients per year [30]. Also, as many as one million Americans live with Parkinson's disease, and about ten million live with it worldwide [36]. Many millions others also live with other diseases that xenoplantation is out to cure. This means that many millions of life will be saved by xenotransplantation if it becomes successful, implying that the population increase will become not just alarming but dangerous to the environment. The present population has added tremendously to global warming, deforestation, rise in sea level, increase in drought and flood, ocean acidity et cetera; xenotransplantation will increase their intensity.

Looking at the problem of over population, the advantages of xenografting become insignificant. Natural resources are like a human body, it has the capacity to regulate and repair itself and thereby able to maintain itself in existence. But when this human body is over stretched, its regulative and reparative capacity would be reduced and sometimes totally extinguished which, leads to either sickness or death, depending on the extent of the stretch. The environment too when over stressed, would be rendered incapable of repairing and regulating itself, thereby leading to shortage of resources for human consumption. Xenografting as feared by this researchers is capable of speeding up the rate of degradation

of the environment, if nothing significant is done to stop it. Xenografting is incompatible with environmental sustainability. It will not only increase population which will increase man's impact on the environment; it will also divert attention from the present drive to conserve the environment.

Presently, one great motivation to conserve and improve the environmental condition is to prevent diseases. According to Roberts "environmental degradation exerts significant pressure on human health. Exposure to air, water and soil pollution, to chemicals in the environment, or to noise, can cause cancer, respiratory, cardiovascular and communicable diseases, as well as poisoning and neuro-psychiatric disorders" [31]. It is believed that about eleven million children die worldwide from environment related diseases. Also according to World Health Organization WHO [32], almost one third of global disease can be directly related to environmental risk factors. Antibodies and immune systems have developed in part as a result of environmental change. Due to this link between environmental degradation and diseases, a lot of research and efforts are presently being put in place to protect and preserve the environment at least to avoid the numerous diseases that stem from it. This researcher believes that the success of xenotransplantation will reduce this present drive to sustain the environment. If xenotransplantation could cure the diseases, there will no longer be any strong motivation to preserve and protect the environment. This will leave the environment at the mercy of men, leading to further deterioration. This is unwise, because it is better to prevent diseases by preserving the environment from degradation than by curing it – for prevention is always better than cure. Based on this, this work advocates for the prevention of diseases through proper maintenance of environmental health than to try to cure through procedures like xenotransplantation which will produce more wrongs than goods.

Xenotransplantation no matter how well meaning, will lead to greater evil. The use of animals parts for the treatment of human diseases will lead to the fast reduction of the biodiversity which is already far lost. A lot of animals are already extinct, and many more are in danger of extinction. Xenotransplantation will make this worse, thereby destroying the balance in the ecosystem. Every organism plays a role in the ecosystem; extinction of one affects the ecosystem negatively. Xenotransplantation will lead to the extinction of an important aspect of the ecosystem (animals) and need to be discouraged. The extinction of these animals would ultimately lead to extinction of some plants, especially ones that depend on these animals for propagation and thus will distort the balance in the ecosystem.

## **CONCLUSION**

Xenografting at the surface may appear good, but a deep look at it, would bring to the fore the dangers inherent in it. This makes it evident that harm done to the other necessarily boomerangs on the self. Harm done to animals or any part of the ecosystem has a way of hitting back at us [33]. Using animals as means to serve the ends of man, may appear wise and well-meaning but will produce consequences that are capable of drowning humans and the entire world. It is better to live and let animals live as well.

Insistence on xenotransplantation would be a risk not only to the animals; but also to the recipients, the entire human population and even the environment. We therefore, advocate that this impending doom should be averted by banning the research on xenotransplantation. It is far better to prevent than to battle with a cure. It is far better to nip xenotransplantation now at the bud, than try to combat the trouble it would throw at humankind and the world at large.

Based on the above therefore, we conclude that xenotransplantation need to be halted. Research into other means of curing these ailments that are environment friendly should be made. It is the belief of the researcher that, if the money spend on the research on xenotransplantation was committed to a research into better ways to conserve the environment, it would have yielded significant result – a result that would be more ethically agreeable. Diseases would have drastically reduced and at the same time the environment would have been greatly improved.

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