VOLUME 21 (2)
July-December, 2021

ISSN: 2229-7014

JOURNAL
Punjab Academy of Sciences

Editor-in-Chief: **Prof. S. S. Hundal**
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SCIENCE FOR PEACE AND PROSPERITY
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alanx: A Quarterly Review for Continuing Debate
Vol-17, No-4, October - December, 2022
(UGC Care Listed Journal) ISSN: 2320-7698

ROLE OF NANOTECHNOLOGY IN MEDICINE, ENERGY, ENVIRONMENTAL REMEDIATION AND TRANSPORTATION

[1]Mrs. Sunita Verma

Abstact

Nanotechnology is an exciting new area in science and engineering devoted to designing, producing, and using structures, devices, and systems by manipulating atoms and molecules at nanoscale, i.e. having one or more dimensions of the order of 100 nanometres (100 millionth of a millimetre) or less.

Keywords: Medicine, Nanotechnology, Energy, Environmental Remediation, Transportation

Introduction

Nanotechnology can be defined as the science and engineering involved in the design, synthesis, characterization, and application of materials and devices whose smallest functional organization, in at least one dimension, is on the nanometer scale or one billionth of a meter. At these scales, consideration of individual molecules and interacting groups of molecules in relation to the bulk macroscopic properties of the material or device becomes important, as it has a control over the fundamental molecular structure, which allows control over the macroscopic chemical and physical properties. The properties of some nanomaterials make them ideal for improving early diagnosis and treatment of neurodegenerative diseases or cancer. Nanotechnology can change dental medicine, healthcare, and human life more profoundly than several developments of the past. However, they even have the potential to evoke important advantages, like improved health, higher use of natural resources, and reduced environmental pollution. Nanotechnology has found many applications in medicine Energy, Environmental Remediation and Transportation and this article will outline some such applications.

Possible Mechanisms & Applications Of Nanotechnology In Medicine

Nanotechnology is not in itself a single emerging scientific discipline, but rather, a meeting of different traditional sciences, such as, chemistry, physics, materials science and biology, to bring together the required collective expertise needed to develop these novel technologies. Nanomaterials and devices can be designed to interact with cells and tissues at a molecular (i.e., sub cellular) level, for applications in medicine and physiology, with a high degree of functional specificity, thus allowing a degree of integration between technology and biological systems not previously attainable.

By manipulating drugs and other materials at the nanometer scale, the fundamental properties and bioactivity of the materials can be altered. These tools can permit a control over the different characteristics of drugs or agents such as alteration in solubility and blood pool retention time, controlled release over short or long durations, environmentally triggered controlled release or highly specific site-targeted delivery.

These applications include fluorescent biological labels, drug and gene delivery, bio-detection of pathogens, detection of protein, probing of DNA structure, tissue engineering, tumor detection, separation and purification of biological molecules and cells, MRI contrast enhancement and phagokinetic studies. The long-term goal of nanomedicine research is to

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characterize the quantitative molecular-scale components known as nanomachinery. Precise control and manipulation of nanomachinery in cells can lead to better understanding of the cellular mechanisms in living cells, and to the development of advanced technologies, for the early diagnosis and treatment of various diseases. Nanotechnology is already broadening the medical tools, knowledge, and therapies currently available to clinicians. Nanomedicine, the application of nanotechnology in medicine, draws on the natural scale of biological phenomena to produce precise solutions for disease prevention, diagnosis, and treatment. Below are some examples of recent advances in this area:

Commercial applications have adapted gold nanoparticles as probes for the detection of targeted sequences of nucleic acids, and gold nanoparticles are also being clinically investigated as potential treatments for cancer and other diseases.

Better imaging and diagnostic tools enabled by nanotechnology are paving the way for earlier diagnosis, more individualized treatment options, and better therapeutic success rates.

Nanotechnology is being studied for both the diagnosis and treatment of atherosclerosis, or the buildup of plaque in arteries. In one technique, researchers created a nanoparticle that mimics the body's "good" cholesterol, known as HDL (high-density lipoprotein), which helps to shrink plaque.

The design and engineering of advanced solid-state nanopore materials could allow for the development of novel gene sequencing technologies that enable single-molecule detection at low cost and high speed with minimal sample preparation and instrumentation.

Nanotechnology researchers are working on a number of different therapeutics where a nanoparticle can encapsulate or otherwise help to deliver medication directly to cancer cells and minimize the risk of damage to healthy tissue. This has the potential to change the way doctors treat cancer and dramatically reduce the toxic effects of chemotherapy.

Research in the use of nanotechnology for regenerative medicine spans several application areas, including bone and neural tissue engineering. For instance, novel materials can be engineered to mimic the crystal mineral structure of human bone or used as a restorative resin for dental applications. Researchers are looking for ways to grow complex tissues with the goal of one day growing human organs for transplant. Researchers are also studying ways to use graphene nanoribbons to help repair spinal cord injuries; preliminary research shows that neurons grow well on the conductive graphene surface.

Nanomedicine researchers are looking at ways that nanotechnology can improve vaccines, including vaccine delivery without the use of needles. Researchers also are working to create a universal vaccine scaffold for the annual flu vaccine that would cover more strains and require fewer resources to develop each year.

Energy Applications Of Nanotechnology

Nanotechnology is finding applications in traditional energy sources and is greatly enhancing alternative energy approaches to help meet the world's increasing energy demands. Many scientists are looking into ways to develop clean, affordable, and renewable energy sources, along with means to reduce energy consumption and lessen toxicity burdens on the environment:

Nanotechnology is improving the efficiency of fuel production from raw petroleum materials through better catalysis. It is also enabling reduced fuel consumption in vehicles and power plants through higher-efficiency combustion and decreased friction.

Nanotechnology is also being applied to oil and gas extraction through, for example, the use of nanotechnology-enabled gas lift valves in offshore operations or the use of nanoparticles to detect microscopic down-well oil pipeline fractures.

Researchers are investigating carbon nanotube "scrubbers" and membranes to separate carbon dioxide from power plant exhaust.

Researchers are developing wires containing carbon nanotubes that will have much lower resistance than the high-tension wires currently used in the electric grid, thus reducing transmission power loss.

Nanotechnology can be incorporated into solar panels to convert sunlight to electricity more efficiently, promising inexpensive solar power in the future. Nanostructured solar cells could be cheaper to manufacture and easier to install, since they can use print-like manufacturing processes and can be made in flexible rolls rather than discrete panels. Newer research suggests that future solar converters might even be "paintable."

Nanotechnology is already being used to develop many new kinds of batteries that are quicker-charging, more efficient, lighter weight, have a higher power density, and hold electrical charge longer.

An epoxy containing carbon nanotubes is being used to make windmill blades that are longer, stronger, and lighter-weight than other blades to increase the amount of electricity that windmills can generate.

In the area of energy harvesting, researchers are developing thin-film solar electric panels that can be fitted onto computer cases and flexible piezoelectric nanowires woven into clothing to generate usable energy on the go from light, friction, and/or body heat to power mobile electronic devices. Similarly, various nanoscience-based options are being pursued to convert waste heat in computers, automobiles, homes, power plants, etc., to usable electrical power.

Energy efficiency and energy saving products are increasing in number and types of application. In addition to those noted above, nanotechnology is enabling more efficient lighting systems; lighter and stronger vehicle chassis materials for the transportation sector; lower energy consumption in advanced electronics; and light-responsive smart coatings for glass.

Applications Of Nanotechnology In Environmental Remediation

In addition to the ways that nanotechnology can help improve energy efficiency, there are also many ways that it can help detect and clean up environmental contaminants:

Different global events such as industrial development and the population increment have triggered the presence and persistence of several organic and inorganic contaminants, representing a risk for the environment and human health. Consequently, the search and application of novel technologies for alleviating the challenge of environmental pollution are urgent. Nanotechnology is an emerging science that could be employed in different fields. In particular, *Nanoremediation* is a promising strategy defined as the engineered materials employed to clean up the environment, is an effective, rapid, and efficient technology to deal with persistent compounds such as pesticides, chlorinated solvents, halogenated chemicals, or heavy metals. Furthermore, nanoremediation is a sustainable alternative to eliminate emerging pollutants such as pharmaceutics or personal care products. Due to the variety of nanomaterials and their versatility, they could be employed in water, soil, or air media. This review provides an overview of the application of nanomaterials for media remediation. It

analyzes the state of the art of different nanomaterials such as metal, carbon, polymer, and silica employed for water, soil, and air remediation.

Nanotechnology could help meet the need for affordable, clean drinking water through rapid, low-cost detection and treatment of impurities in water.

Engineers have developed a thin film membrane with nanopores for energy-efficient desalination. This molybdenum disulphide (MoS_2) membrane filtered two to five times more water than current conventional filters.

Nanoparticles are being developed to clean industrial water pollutants in ground water through chemical reactions that render the pollutants harmless. This process would cost less than methods that require pumping the water out of the ground for treatment.

Researchers have developed a nanofabric "paper towel" woven from tiny wires of potassium manganese oxide that can absorb 20 times its weight in oil for cleanup applications. Researchers have also placed magnetic water-repellent nanoparticles in oil spills and used magnets to mechanically remove the oil from the water.

Many airplane cabin and other types of air filters are nanotechnology-based filters that allow "mechanical filtration," in which the fiber material creates nanoscale pores that trap particles larger than the size of the pores. The filters also may contain charcoal layers that remove odors.

Nanotechnology-enabled sensors and solutions are now able to detect and identify chemical or biological agents in the air and soil with much higher sensitivity than ever before. Researchers are investigating particles such as self-assembled monolayers on mesoporous supports (SAMMS™), dendrimers, and carbon nanotubes to determine how to apply their unique chemical and physical properties for various kinds of toxic site remediation. Another sensor has been developed by NASA as a smartphone extension that firefighters can use to monitor air quality around fires.

Future Transportation Benefits Of Nanotechnology

Nanotechnology offers the promise of developing multifunctional materials that will contribute to building and maintaining lighter, safer, smarter, and more efficient vehicles, aircraft, spacecraft, and ships. In addition, nanotechnology offers various means to improve the transportation infrastructure:

As discussed above, nano-engineered materials in automotive products include polymer nanocomposites structural parts; high-power rechargeable battery systems; thermoelectric materials for temperature control; lower rolling-resistance tires; high-efficiency/low-cost sensors and electronics; thin-film smart solar panels; and fuel additives and improved catalytic converters for cleaner exhaust and extended range. Nano-engineering of aluminum, steel, asphalt, concrete and other cementitious materials, and their recycled forms offers great promise in terms of improving the performance, resiliency, and longevity of highway and transportation infrastructure components while reducing their life cycle cost. New systems may incorporate innovative capabilities into traditional infrastructure materials, such as self-repairing structures or the ability to generate or transmit energy.

Nanoscale sensors and devices may provide cost-effective continuous monitoring of the structural integrity and performance of bridges, tunnels, rails, parking structures, and pavements over time. Nanoscale sensors, communications devices, and other innovations enabled by nanoelectronics can also support an enhanced transportation infrastructure that can communicate with vehicle-based systems to help drivers maintain lane position, avoid

collisions, adjust travel routes to avoid congestion, and improve drivers' interfaces to onboard electronics.

"Game changing" benefits from the use of nanotechnology-enabled lightweight, high-strength materials would apply to almost any transportation vehicle. For example, it has been estimated that reducing the weight of a commercial jet aircraft by 20 percent could reduce its fuel consumption by as much as 15 percent. A preliminary analysis performed for NASA has indicated that the development and use of advanced nanomaterials with twice the strength of conventional composites would reduce the gross weight of a launch vehicle by as much as 63 percent. Not only could this save a significant amount of energy needed to launch spacecraft into orbit, but it would also enable the development of single stage to orbit launch vehicles, further reducing launch costs, increasing mission reliability, and opening the door to alternative propulsion concepts.

Conclusion

Thus, it is concluded that, nanotechnology or systems / device manufacture at the molecular level, is a multidisciplinary scientific field undergoing explosive development. The genesis of nanotechnology can be traced to the promise of revolutionary advances across medicine, communications, genomics, energy, environmental remediation, transportation and robotics.

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AB ACADEMY OF SCIENCES JPAS, 2021; 21 (2): 33-36
en Access Journal ISSN 2229-7014 (P)
Available online at www.jpas.in

STEM CELL THERAPY: A REVIEW

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ABSTRACT

Stem cells offer great promise for new medical treatments. Stem cell therapy is also known as regenerative medicine. Stem cells are the body's raw materials — cells from which all other cells with specialized functions are generated. Under the right conditions in the body or a laboratory, stem cells divide to form more cells called daughter cells. These daughter cells become either new stem cells or specialized cells (differentiation) with a more specific function, such as blood cells, brain cells, heart muscle cells or bone cells. No other cell in the body has the natural ability to generate new cell types. There are several sources of stem cells like: Embryonic stem cells, Adult stem cells, perinatal stem cells etc. Therapeutic cloning, also called somatic cell nuclear transfer, is a technique to create versatile stem cells independent of fertilized eggs.

Keywords: Embryonic stem cells, Adult stem cells, Perinatal stem cells, Regenerative medicine, Therapeutic cloning.

INTRODUCTION

Stem cells help us to increase understanding of how diseases occur. By watching stem cells mature into cells in bones, heart muscle, nerves, and other organs and tissue, researchers may better understand how diseases and conditions develop. Stem cells can generate healthy cells to replace cells affected by disease (regenerative medicine). Stem cells can be guided into becoming specific cells that can be used in people to regenerate and repair tissues that have been damaged or affected by disease.

People who might benefit from stem cell therapies include those with spinal cord injuries, type 1 diabetes, Parkinson's disease, amyotrophic lateral sclerosis, Alzheimer's disease, heart disease, stroke, burns, cancer and osteoarthritis.

Stem cells may have the potential to be grown to become new tissue for use in transplant and regenerative medicine. Researchers continue to advance the knowledge on stem cells and their applications in transplant and regenerative medicine. Stem cell research helps us to test new drugs for safety and effectiveness. Before using investigational drugs in people, researchers can use some types of stem cells to test the drugs for safety and quality. This type of testing will most likely first have a direct impact on drug development for cardiac toxicity testing.

New areas of study in this field include the effectiveness of using human stem cells that have been programmed into tissue-specific cells to test new drugs. For the testing of new drugs to be accurate, the cells must be programmed to acquire properties of the type of cells targeted by the drug. Techniques to program cells into specific cells are under study. For instance, nerve cells could be generated to test a new drug for a nerve disease. Tests could show whether the new drug had any effect on the cells and whether the cells were harmed.

Sources of Stem Cells:

There are several sources of stem cells:

Embryonic stem cells: These stem cells come from embryos that are 3 to 5 days old. At this stage, an embryo is called a blastocyst and has about 150 cells. These are

pluripotent (ploo-RIP-uh-tunt) stem cells, meaning they can divide into more stem cells or can become any type of cell in the body. This versatility allows embryonic stem cells to be used to regenerate or repair diseased tissue and organs.

Adult stem cells: These stem cells are found in small numbers in most adult tissues, such as bone marrow or fat. Compared with embryonic stem cells, adult stem cells have a more limited ability to give rise to various cells of the body. Until recently, researchers thought adult stem cells could create only similar types of cells. For instance, researchers thought that stem cells residing in the bone marrow could give rise only to blood cells.

However, emerging evidence suggests that adult stem cells may be able to create various types of cells. For instance, bone marrow stem cells may be able to create bone or heart muscle cells.

This research has led to early-stage clinical trials to test usefulness and safety in people. For example, adult stem cells are currently being tested in people with neurological or heart disease.

Altered Adult cells to have properties of embryonic stem cells: Scientists have successfully transformed regular adult cells into stem cells using genetic reprogramming. By altering the genes in the adult cells, researchers can reprogram the cells to act similarly to embryonic stem cells.

This new technique may allow use of reprogrammed cells instead of embryonic stem cells and prevent immune system rejection of the new stem cells. However, scientists don't yet know whether using altered adult cells will cause adverse effects in humans.

Researchers have been able to take regular connective tissue cells and reprogram them to become functional heart cells. In studies, animals with heart failure that were injected with new heart cells experienced improved heart function and survival time.

Perinatal stem cells: Researchers have discovered stem cells in amniotic fluid as well as umbilical cord blood. These stem cells have the ability to change into specialized cells.

Amniotic fluid fills the sac that surrounds and protects a developing foetus in the uterus. Researchers have identified stem cells in samples of amniotic fluid drawn from pregnant women for testing or treatment - a procedure called amniocentesis.

Controversy about using embryonic stem cells: Embryonic stem cells are obtained from early-stage embryos — a group of cells that forms when eggs are fertilized with sperm at an in vitro fertilization clinic. Because human embryonic stem cells are extracted from human embryos, several questions and issues have been raised about the ethics of embryonic stem cell research. The National Institutes of Health created guidelines for human stem cell research in 2009. The guidelines define embryonic stem cells and how they may be used in research, and include recommendations for the donation of embryonic stem cells. Also, the guidelines state that embryonic stem cells from embryos created by in vitro fertilization can be used only when the embryo is no longer needed.

The embryos being used in embryonic stem cell research come from eggs that were fertilized at in vitro fertilization clinics but never implanted in women's uteruses. The stem cells are donated with informed consent from donors. The stem cells can live and grow in special solutions in test tubes or Petri dishes in laboratories.

Although research into adult stem cells is promising, adult stem cells may not be as versatile and durable as are embryonic stem cells. Adult stem cells may not be able to be manipulated to produce all cell types, which limits how adult stem cells can be used to treat diseases. Adult stem cells are also more likely to contain abnormalities due to environmental hazards, such as toxins, or from errors acquired by the cells during replication. However, researchers have found that adult stem cells are more adaptable than was first thought.

Stem cell lines and their significance: A stem cell line is a group of cells that all descend from a single original stem cell and are grown in a lab. Cells in a stem cell line keep growing but don't differentiate into specialized cells. Ideally, they remain free of genetic defects and continue to create more stem cells. Clusters of cells can be taken from a stem cell line and frozen for storage or shared with other researchers.

Stem cell therapy (regenerative medicine): Stem cell therapy, also known as regenerative medicine, promotes the repair response of diseased, dysfunctional or injured tissue using stem cells or their derivatives. It is the next chapter in organ transplantation and uses cells instead of donor organs, which are limited in supply. Researchers grow stem cells in a lab. These stem cells are manipulated to specialize into specific types of cells, such as heart muscle cells, blood cells or nerve cells. The specialized cells can then be implanted into a person. For example, if the person has heart disease, the cells could be injected into the heart muscle. The healthy transplanted heart muscle cells could then contribute to repairing the injured heart muscle. Researchers have already shown that adult bone marrow cells guided to become heart-like cells can repair heart tissue in people, and more research is on-going.

Doctors have performed stem cell transplants, also known as bone marrow transplants. In stem cell transplants, stem cells replace cells damaged by chemotherapy or disease or serve as a way for the donor's immune system to fight some types of cancer and blood-related diseases, such as leukaemia, lymphoma, neuroblastoma and multiple myeloma. These transplants use adult stem cells or umbilical cord blood. Researchers are testing adult stem cells to treat other conditions, including a number of degenerative diseases such as heart failure. Potential problems with using embryonic stem cells in humans: For embryonic stem cells to be useful, researchers must be certain that the stem cells will differentiate into the specific cell types desired. Researchers have discovered ways to direct stem cells to become specific types of cells, such as directing embryonic stem cells to become heart cells. Research is ongoing in this area. Embryonic stem cells can also grow irregularly or specialize in different cell types spontaneously. Researchers are studying how to control the growth and differentiation of embryonic stem cells.

Embryonic stem cells might also trigger an immune response in which the recipient's body attacks the stem cells as foreign invaders, or the stem cells might simply fail to function as expected, with unknown consequences. Researchers continue to study how to avoid these possible complications.

Therapeutic cloning: Therapeutic cloning, also called somatic cell nuclear transfer, is a technique to create versatile stem cells independent of fertilized eggs. In this technique, the nucleus is removed from an unfertilized egg. This nucleus contains the genetic material. The nucleus is also removed from the cell of a donor. This donor nucleus is then injected into the egg, replacing the nucleus that was removed, in a process called nuclear transfer. The egg is allowed to divide and soon forms a blastocyst. This process creates a line of stem cells that is genetically identical to the donor's cells — in essence, a clone.

Some researchers believe that stem cells derived from therapeutic cloning may offer benefits over those from fertilized eggs because cloned cells are less likely to be rejected once transplanted back into the donor and may allow researchers to see exactly how a disease develops. Researchers haven't been able to successfully perform therapeutic cloning with humans despite success in a number of other species.

However, in recent studies, researchers have created human pluripotent stem cells by modifying the therapeutic cloning process. Researchers continue to study the potential of therapeutic cloning in people.

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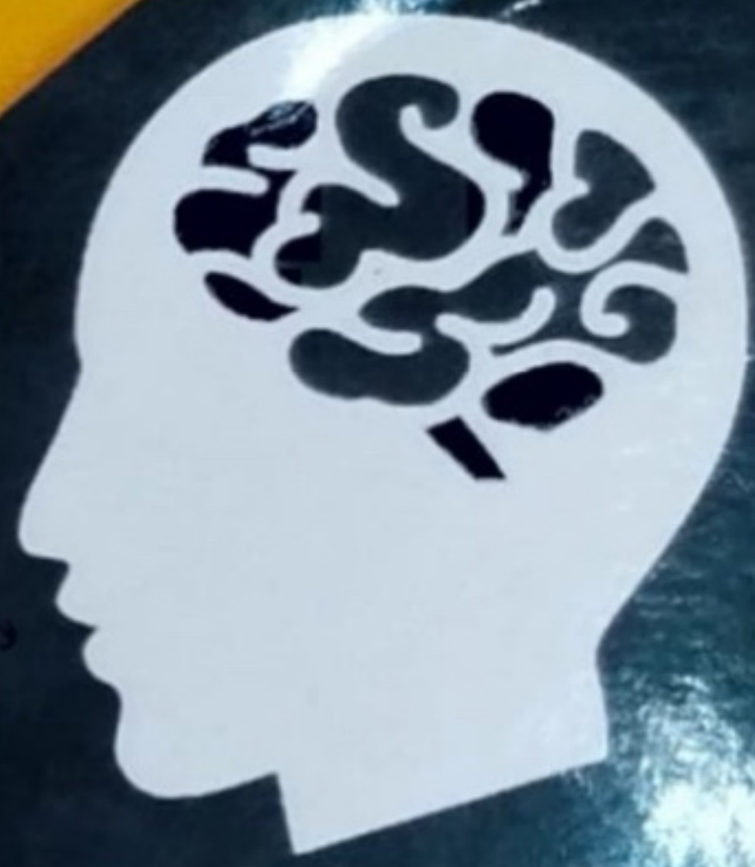
ISSN 2394-5303

Printing Area
UGC
Jr.No.43053
UGC Approved Refereed Journal

प्रिंटिंग एरिया



Mental Health & Todays Challenges

: Editor :

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Harshwardhan Publication Pvt.Ltd.

Mental Health & Todays Challenges

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❖ **Publisher :**

Harshwardhan Publication Pvt.Ltd.
Limbaganesh, Dist. Beed (Maharashtra)
Pin-431126, vidyawarta@gmail.com

❖ **Printed by :**

Harshwardhan Publication Pvt.Ltd.
Limbaganesh, Dist. Beed, Pin-431126
www.vidyawarta.com

❖ **Page design & Cover :**

Shaikh Jahuroddin,Parli-V

❖ **Edition: 19 Feb. 2018 (Shiv Jayanti)**

ISSN 2394 5303

❖ **Price : 215/ -**

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The Role of Addiction in Mental Health

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Drug use disorders often co-occur with other mental illnesses:-The high prevalence of comorbidity between drug use disorders and other mental illnesses does not mean that one caused the other, even if one appeared first. In fact, establishing causality or directionality is difficult for several reasons. Diagnosis of a mental disorder may not occur until symptoms have progressed to a specified level (per DSM); however, subclinical symptoms may also prompt drug use, and imperfect recollections of when drug use or abuse started can create confusion as to which came first. Still, three scenarios deserve consideration:

1. Drugs of abuse can cause abusers to experience one or more symptoms of another mental illness. The increased risk of psychosis in some marijuana abusers has been offered as evidence for this possibility.

2. Mental illnesses can lead to drug abuse. Individuals with overt, mild, or even subclinical mental disorders may abuse drugs as a form of self-medication. For example, the use of tobacco products by patients with schizophrenia is believed to lessen the symptoms of the disease and improve cognition

3. Both drug use disorders and other mental illnesses are caused by overlapping factors such as underlying brain deficits, genetic vulnerabilities, and/or early exposure to stress or trauma.

All three scenarios probably contribute, in varying

degrees, to how and whether specific comorbidities manifest themselves. Because mood disorders increase vulnerability to drug abuse and addiction, the diagnosis and treatment of the mood disorder can reduce the risk of subsequent drug use. Because the inverse may also be true, the diagnosis and treatment of drug use disorders may reduce the risk of developing other mental illnesses and, if they do occur, lessen their severity or make them more amenable to effective treatment. Finally, because more than 40 percent of the cigarettes smoked in this country are smoked by individuals with a psychiatric disorder, such as major depressive disorder, alcoholism, post-traumatic stress disorder (PTSD), schizophrenia, or bipolar disorder, smoking by patients with mental illness contributes greatly to their increased morbidity and mortality.

Common Factors :- Overlapping Genetic Vulnerabilities. A particularly active area of comorbidity research involves the search for genes that might predispose individuals to develop both addiction and other mental illnesses, or to have a greater risk of a second disorder occurring after the first appears. It is estimated that 40-60 percent of an individual's vulnerability to addiction is attributable to genetics; most of this vulnerability arises from complex interactions among multiple genes and from genetic interactions with environmental influences.

Involvement of Similar Brain Regions. Some areas of the brain are affected by both drug use disorders and other mental illnesses. For example, the circuits in the brain that use the neurotransmitter dopamine–a chemical that carries messages from one neuron to another– are typically affected by addictive substances and may also be involved in depression, schizophrenia, and other psychiatric disorders.Stress is also a known risk factor for a range of mental disorders and therefore provides one likely common

neurobiological link between the disease processes of addiction and those of other mental disorders.The overlap of brain areas involved in both drug use disorders and other mental illnesses suggests that brain changes stemming from one may affect the other. For example, drug abuse that precedes the first symptoms of a mental illness may produce changes in brain structure and function that kindle an underlying propensity to develop that mental illness. If the mental disorder develops first, associated changes in brain activity may increase the vulnerability to abusing substances by enhancing their positive effects, reducing awareness of their negative effects, or alleviating the unpleasant effects associated with the mental disorder or the medication used to treat it.

The National Bureau of Economic Research (NBER) reports that there is a "definite connection between mental illness and the use of addictive substances" and that mental health disorder patients are responsible for the consumption of:

- 38 percent of alcohol
- 44 percent of cocaine
- 40 percent of cigarettes

By far the most common issue connecting mental illness and substance abuse is the intention of patients to medicate the mental health symptoms that they find disruptive or uncomfortable by using alcohol and drugs.

Some examples include:

- The depressed patient who uses marijuana to numb the pain
- The patient suffering from social anxiety who drinks to feel more comfortable in social situations
- The patient who struggles with panic attacks and takes benzodiazepines like Xanax or Valium in order to calm the symptoms or stop the attacks before they start
- The patient with low energy and lack of motivation

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who takes Adderall, cocaine or crystal meth to increase their drive to get things done Unfortunately, drugs and alcohol often do little to address the underlying mental health symptoms and ultimately create a whole new batch of problems for the patient while also increasing the severity of the original mental health symptom or symptoms.

Often, certain drugs can create problems that trigger mental health symptoms. In other cases, substances can create mental health symptoms like paranoia, delusions or depression while the person is under the influence of the drug. When these symptoms last after the drugs wear off, then it can indicate a co-occurring mental health disorder. Some examples include:

- Chronic drug and alcohol abuse increases the chances of becoming a victim of assault or rape. These traumatic events can create serious mental health issues like PTSD, depression, eating disorders and more.
- Poor decision-making is common under the influence, and patients may break the law or make other choices that cause them to struggle with anxiety in addition to drug addiction.
- Unprotected sex or sharing needles with people infected with HIV or hepatitis C can lead to the contraction of the disease, which in turn can mean a struggle with depression and grief over the life-changing consequences.
- Depression is a common effect of certain drugs like crystal meth and alcohol as they begin to wear off, and it's a symptom that can deepen into a disorder over time.

Patients with schizophrenia have higher rates of alcohol, tobacco, and other drug abuse than the general population. Based on nationally representative survey data, 41 percent of respondents with past-month mental illnesses are current smokers, which is about double the rate of those with no mental illness. In clinical samples, the rate of smoking in patients with schizophrenia has ranged as high as 90 percent.

Various self-medication hypotheses have been proposed to explain the strong association between schizophrenia and smoking, although none have yet been confirmed. Most of these relate to the nicotine contained in tobacco products: Nicotine may help compensate for some of the cognitive impairments produced by the disorder and may counteract psychotic symptoms or alleviate unpleasant side effects of antipsychotic medications. Nicotine or smoking behavior may also help people with schizophrenia deal with the anxiety and social stigma of their disease.

Research on how both nicotine and schizophrenia affect the brain has generated other possible explanations for the high rate of smoking among people with schizophrenia. The presence of abnormalities in particular circuits of the brain may predispose individuals to schizophrenia, increase the rewarding effects of drugs like nicotine, or reduce an individual's ability to quit smoking. The involvement of common mechanisms is consistent with the observation that both nicotine and the medication clozapine (which also acts at nicotine receptors, among others) can improve attention and working memory in an animal model of schizophrenia. Clozapine is effective in treating individuals with schizophrenia. It also reduces their smoking levels. Understanding how and why patients with schizophrenia use nicotine is likely to help us develop new treatments for both schizophrenia and nicotine dependence.

Adolescence–A Vulnerable Time. Although drug abuse and addiction can happen at any time during a person's life, drug use typically starts in adolescence, a period when the first signs of mental illness commonly appear. It is therefore not surprising that comorbid disorders can already be seen among youth. Significant changes in the brain occur during adolescence, which may enhance vulnerability to drug use and the development of addiction and other mental disorders. Drugs

of abuse affect brain circuits involved in learning and mem
reward, decisionmaking, and behavioral control, all of w
are still maturing into early adulthood. Thus, understan
the long-term impact of early drug exposure is a critical
of comorbidity research.

The brain continues to develop into adulthood
undergoes dramatic changes during adolescence.
One of the brain areas still maturing during adolescence i
prefrontal cortex– the part of the brain that enables us to as
situations, make sound decisions, and keep our emotions
desires under control. The fact that this critical part o
adolescent's brain is still a work in progress puts ther
increased risk for poor decisions (such as trying drug
continuing abuse). Thus, introducing drugs while the bra
still developing may have profound and long-las
consequences.

Conclusion :- The high rate of comorbidity betw
drug abuse and addiction and other mental disorders ar
for a comprehensive approach to intervention that ident
and evaluates each disorder concurrently, providing treatm
as needed.

Early Occurrence Increases Later Risk. Strong evide
has emerged showing early drug use to be a risk factor
later substance abuse problems; additional findings sug
that it may also be a risk factor for the later occurrenc
other mental illnesses. However, this link is not necessar
simple one and may hinge upon genetic vulnerabi
psychosocial experiences, and/or general environme
influences. A 2005 study highlights this complexity, with
finding that frequent marijuana use during adolescence
increase the risk of psychosis in adulthood, but onl
individuals who carry a particular gene variant It is also
that having a mental disorder in childhood or adolescence
increase the risk of later drug abuse problems, as freque

occurs with conduct disorder and untreated attention-deficit hyperactivity disorder (ADHD). This presents a challenge when treating children with ADHD, since effective treatment often involves prescribing stimulant medications with abuse potential. This issue has generated strong interest from the research community, and although the results are not yet conclusive, Drug abuse programs for adolescents should include screening and, as needed, treatment for comorbid mental disorders.

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This is to Certify that the article entitled

ROLE OF NANOTECHNOLOGY IN MEDICINE, ENERGY, ENVIRONMENTAL REMEDIATION AND TRANSPORTATION

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Published in

Phalanx-A Quarterly Review for Continuing Debate

Vol-17, No.4 (October-December) 2022

ISSN: 2320-7698 Peer Reviewed Refereed UGC Care Listed Journal

Impact Factor: 5.6

ज्ञान-विज्ञान विमुक्तये

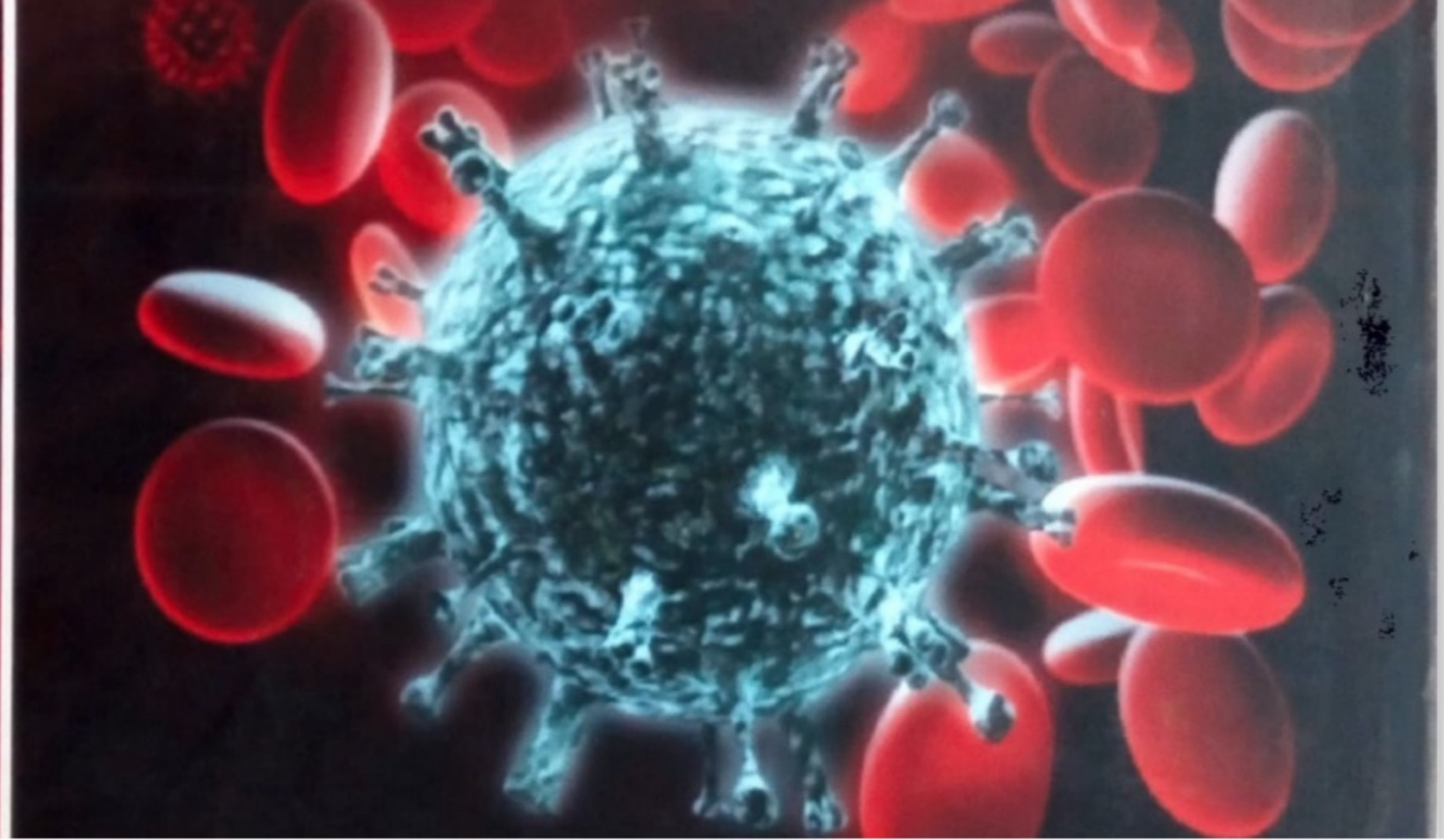
Phalanx

A Quarterly Review for Continuing Debate

Immunological and Biotechnological

Approach to Human Health-Care

Sunita Verma



Published by

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Immunological and Biotechnological
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© Editor
Ist Edition 2019
ISBN 978-93-88998-06-2

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Printed in India

Published by Jhapsu Yadav for Akhand Publishing House, Delhi.

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Therapeutic Gene Modulation

Mrs. Sunita Verma

Gene therapy is an experimental technique that uses genes to treat or prevent disease. In the future, this technique may allow doctors to treat a disorder by inserting a gene into a patient's cells instead of using drugs or surgery. Researchers are testing several approaches to gene therapy, including:

- Replacing a mutated gene that causes disease with a healthy copy of the gene.
- Inactivating, or "knocking out," a mutated gene that is functioning improperly.
- Introducing a new gene into the body to help fight a disease.

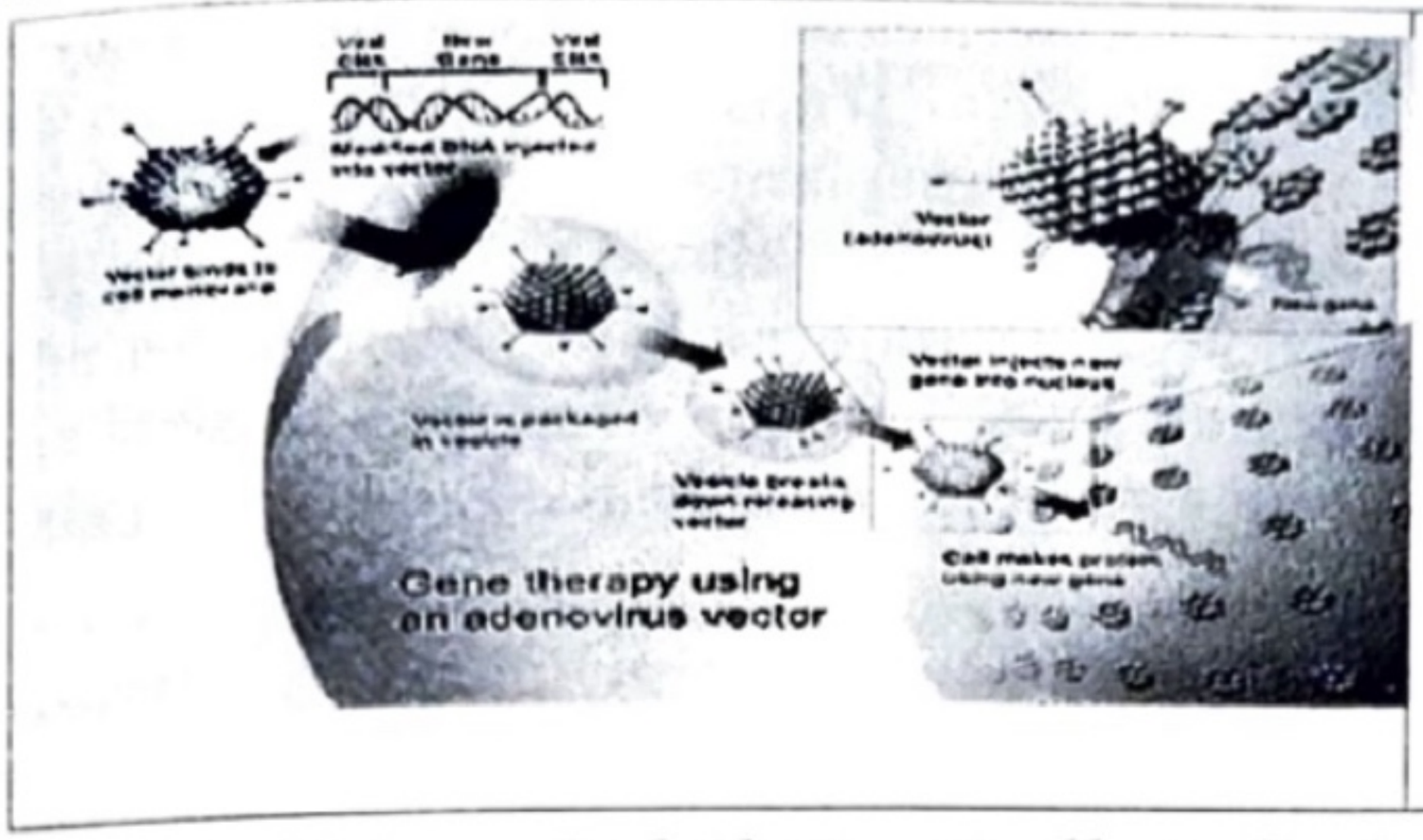
Although gene therapy is a promising treatment option for a number of diseases (including inherited disorders, some types of cancer, and certain viral infections), the technique remains risky and is still under study to make sure that it will be safe and effective. Gene therapy is currently only being tested for the treatment of diseases that have no other cures.

Gene therapy is the therapeutic delivery of nucleic acid polymers into a patient's cells as a drug to treat disease.

The first attempt at modifying human DNA was performed in 1980 by Martin Cline, but the first successful and approved nuclear gene transfer in humans was performed in May 1989. The first therapeutic use of gene transfer as well as the first direct insertion of human DNA into the nuclear genome was performed by French Anderson in a trial starting in September 1990.

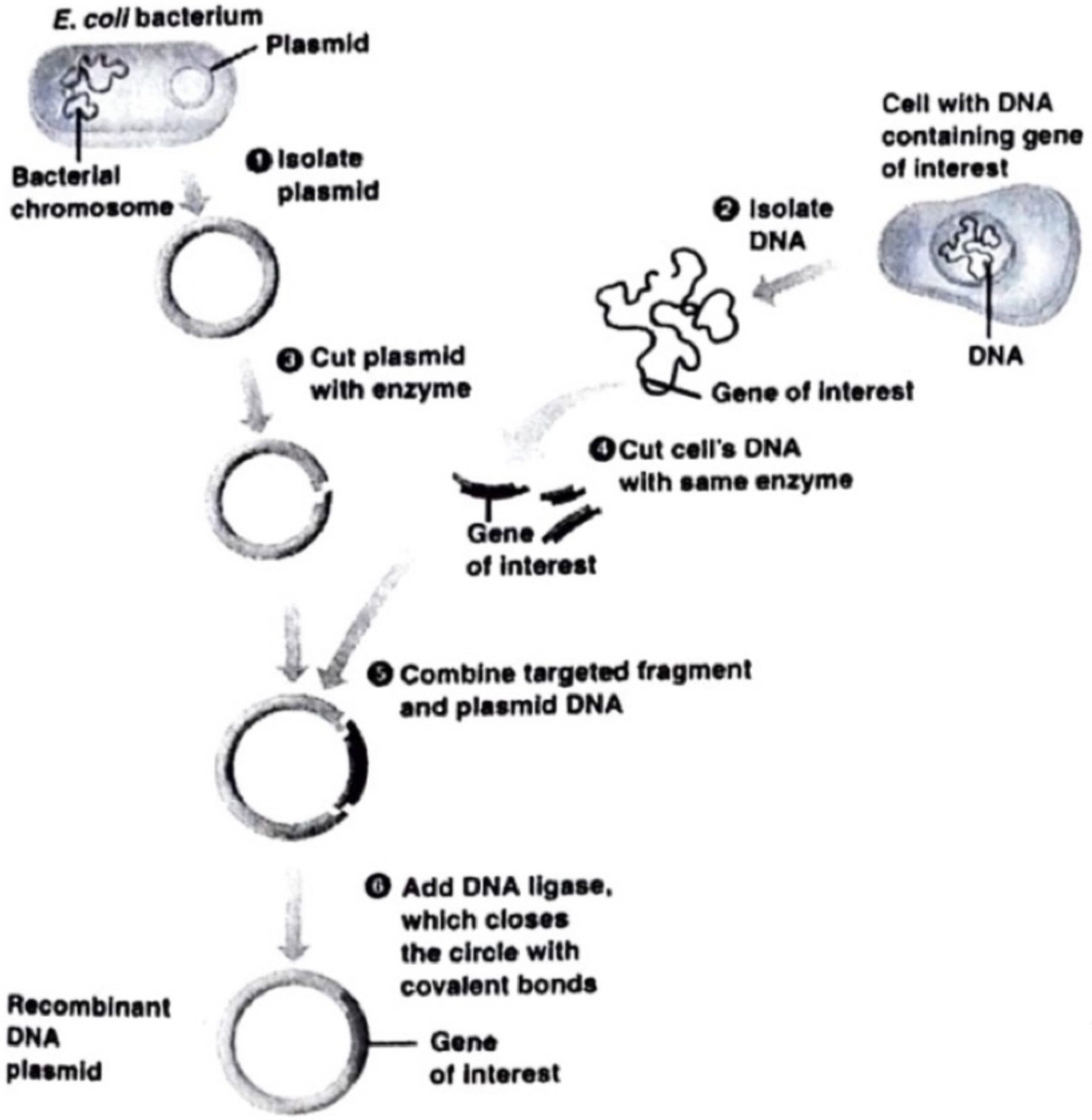
***Mrs. Sunita Verma,** Associate Professor, HOD, Zoology Department, SDAM College, Dinanagar (Distt. Gurdaspur)

Between 1989 and February 2016, over 2,300 clinical trials had been conducted, more than half of them in phase



Gene therapy using an adenovirus vector . In some cases, the adenovirus will insert the new gene into a cell. If the treatment is successful, the new gene will make a functional protein to treat a disease.

It should be noted that not all medical procedures that introduce alterations to a patient's genetic makeup can be considered gene therapy. Bone marrow transplantation and organ transplants in general have been found to introduce foreign DNA into patients. Gene therapy is defined by the precision of the procedure and the intention of direct therapeutic effects.



History:- Gene therapy was conceptualized in 1972, by authors who urged caution before commencing human gene therapy studies.

The first attempt, an unsuccessful one, at gene therapy (as well as the first case of medical transfer of foreign genes into humans not counting organ transplantation) was performed by Martin Cline on 10 July 1980 .Cline claimed that one of the genes in his patients was active six months later, though he never published this data or had it verified and even if he is correct, it's unlikely it produced any significant beneficial effects treating beta-thalassemia

After extensive research on animals throughout the 1980s and a 1989 bacterial gene tagging trial on humans, the first gene therapy widely accepted as a success was demonstrated in a trial that started on September 14, 1990, when Ashi DeSilva was treated for ADA-SCID.

The first somatic treatment that produced a permanent genetic change was performed in 1993.

This procedure was referred to sensationally and somewhat inaccurately in the media as a "three parent baby", though mtDNA is not the primary human genome and has little effect on an organism's individual characteristics beyond powering their cells.

Gene therapy is a way to fix a genetic problem at its source. The polymers are either translated into proteins, interfere with target gene expression, or possibly correct genetic mutations.

The most common form uses DNA that encodes a functional, therapeutic gene to replace a mutated gene. The polymer molecule is packaged within a "vector", which carries the molecule inside cells.

Early clinical failures led to dismissals of gene therapy. Clinical successes since 2006 regained researchers' attention, although as of 2014, it was still largely an experimental technique. These include treatment of retinal diseases Leber's congenital amaurosis and choroideremia, X-linked SCID, ADA-SCID, adrenoleu - kodystrophy, chronic lymphocytic leukemia (CLL), acute lymphocytic leukemia (ALL), multiple myeloma, haemophilia and Parkinson's disease. Between 2013 and April 2014, US companies invested over $600 million in the field.

The first commercial gene therapy, Gendicine, was approved in China in 2003 for the treatment of certain cancers. In 2011 Neovasculgen was registered in Russia as the first-in-class gene-therapy drug for treatment of peripheral artery disease, including critical limb ischemia. In 2012 Glybera, a treatment for a rare inherited disorder, became the first treatment to be approved for clinical use in either Europe or the United States after its endorsement by the European Commission.

Approaches:-

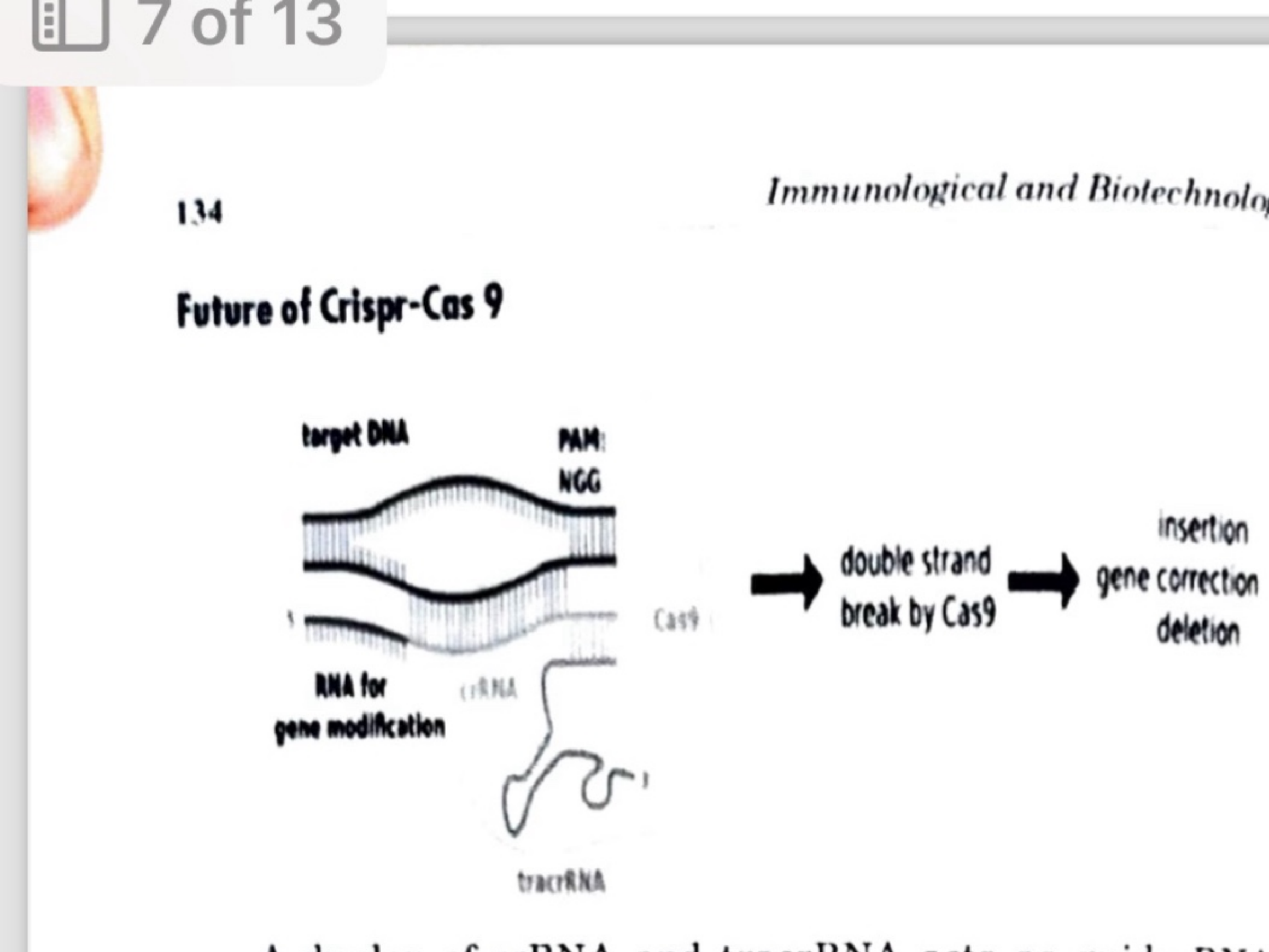
Following early advances in genetic engineering of bacteria, cells, and small animals, scientists started considering how to apply it to medicine. Two main approaches were considered – replacing or disrupting defective genes. Scientists focused on diseases caused by single-gene defects, such as cystic fibrosis, haemophilia, muscular dystrophy, thalassemia and sickle cell anemia. Glybera treats one such disease, caused by a defect in lipoprotein lipase.

DNA must be administered, reach the damaged cells, enter the cell and express/disrupt a protein. Multiple delivery techniques have been explored. The initial approach incorporated DNA into an engineered virus to deliver the DNA into a chromosome. Naked DNA approaches have also been explored, especially in the context of vaccine development.

Generally, efforts focused on administering a gene that causes a needed protein to be expressed. More recently, increased understanding of nuclease function has led to more direct DNA editing, using techniques such as zinc finger nucleases and CRISPR. The vector incorporates genes into chromosomes. The expressed nucleases then knock out and replace genes in the chromosome. As of 2014 these approaches involve removing cells from patients, editing a chromosome and returning the transformed cells to patients.

- **Crispr/Cas**

Crispr stands for Clustered Regularly Interspaced Short Palindromic Repeats. The discovery of the type II prokaryotic Crispr "immune system" has allowed for the development for an RNA-guided genome editing tool that is simple, easy and quick to implement.



A duplex of crRNA and tracrRNA acts as guide RNA to introduce a specifically located gene modification based on the RNA 5' upstream of the crRNA. Cas9 binds the tracrRNA and needs a DNA binding sequence (5'NGG3'), which is called protospacer adjacent motif (PAM). After binding, Cas9 introduces a DNA double strand break, which is then followed by gene modification via homologous recombination (HDR) or non-homologous end joining (NHEJ).

Gene editing has been a potential therapy for many genetic diseases. Targeted genome editing using nucleases provides a general method for inducing deletions or insertion. An earlier method for targeting relies on protein-DNA interactions; however, the most recent one, using CRISPR – associated protein 9 (Cas9), provides better specificity, simplicity, speed and pricing. The CRISPR System was first identified in single cell archaea (Prokaryotes). It is now widely used in different cell types and organisms including human cells (HEK293T,HeLa, iPSC), mouse, fruit fly, rice, wheat etc. CRISPR –Cas9 genome editing has potential applications in human gene therapy, screening drug targets, synthetic biology, agriculture, programmable RNA targeting, and viral gene disruption.

Other technologies employ antisense, small interfering RNA and other DNA. To the extent that these technologies do not alter DNA, but instead directly interact with molecules such as RNA, they are not considered "gene therapy"

Cell types:-

Gene therapy may be classified into two types:

1. Somatic

In somatic cell gene therapy (SCGT), the therapeutic genes are transferred into any cell other than a gamete, germ cell, gametocyte or undifferentiated stem cell. Any such modifications affect the individual patient only, and are not inherited by offspring. Somatic gene therapy represents main stream basic and clinical research, in which therapeutic DNA (either integrated in the genome or as an external episome or plasmid) is used to treat disease.

Over 600 clinical trials utilizing SCGT are underway in the US. Most focus on severe genetic disorders, including immunodeficiencies, haemophilia, thalassaemia andcystic fibrosis. Such single gene disorders are good candidates for somatic cell therapy. The complete correction of a genetic disorder or the replacement of multiple genes is not yet possible. Only a few of the trials are in the advanced stages.

2. Germ line

In germ line gene therapy (GGT), germ cells (sperm or eggs) are modified by the introduction of functional genes into their genomes. Modifying a germ cell causes all the organism's cells to contain the modified gene. The change is therefore heritable and passed on to later generations. Australia, Canada, Germany, Israel, Switzerland and the Netherlands prohibit GGT for application in human beings, for technical and ethical reasons, including insufficient knowledge about possible risks to future generations and higher risks versus SCGT. The US has no federal controls specifically addressing human genetic modification (beyond FDA regulations for therapies in general).

➢ *Vectors in gene therapy*

The delivery of DNA into cells can be accomplished by multiple methods. The two major classes are recombinant viruses (sometimes called biological nanoparticles or viral vectors) and naked DNA or DNA complexes (non-viral methods).

- **Viruses**

In order to replicate, viruses introduce their genetic material into the host cell, tricking the host's cellular machinery into using it as blueprints for viral proteins. Scientists exploit this by

substituting a virus's genetic material with therapeutic DNA. (The term 'DNA' may be an oversimplification, as some viruses contain RNA, and gene therapy could take this form as well.) A number of viruses have been used for human gene therapy, including retrovirus,adenovirus,lentivirus,herpes simplex,vaccinia and adeno-associated virus Like the genetic material (DNA or RNA) in viruses, therapeutic DNA can be designed to simply serve as a temporary blueprint that is degraded naturally or (at least theoretically) to enter the host's genome, becoming a permanent part of the host's DNA in infected cells

- **Non-viral**

Non-viral methods present certain advantages over viral methods, such as large scale production and low host immunogenicity. However, non-viral methods initially produced lower levels of transfection and gene expression, and thus lower therapeutic efficacy. Later technology remedied this deficiency.

Methods for non-viral gene therapy include the injection of naked DNA, electroporation, the gene gun, sonoporation, magnetofection, the use of oligonucleotides, lipoplexes, dendrimers, and inorganic nanoparticles.

- **Hurdles:-**

Some of the unsolved problems include

- Short-lived nature – Before gene therapy can become a permanent cure for a condition, the therapeutic DNA introduced into target cells must remain functional and the cells containing the therapeutic DNA must be stable. Problems with integrating therapeutic DNA into the genome and the rapidly dividing nature of many cells prevent it from achieving long-term benefits. Patients require multiple treatments.
- Immune response – Any time a foreign object is introduced into human tissues, the immune system is stimulated to attack the invader. Stimulating the immune system in a way that reduces gene therapy effectiveness is possible. The immune system's enhanced response to viruses that it has seen before reduces the effectiveness to repeated treatments.
- Problems with viral vectors – Viral vectors carry the risks of toxicity, inflammatory responses, and gene control and targeting issues.
- Multigene disorders – Some commonly occurring disorders, such as heart disease, high blood pressure, Alzheimer's disease, arthritis, and diabetes, are affected by variations in multiple genes, which

complicate gene therapy.

- Some therapies may breach the Weismann barrier (between soma and germ-line) protecting the testes, potentially modifying the germline, falling afoul of regulations in countries that prohibit the latter practice.
- Insertional mutagenesis– If the DNA is integrated in a sensitive spot in the genome, for example in a tumor suppressor gene, the therapy could induce a tumor. This has occurred in clinical trials for X-linked severe combined immunodeficiency (X-SCID) patients, in which hematopoietic stem cells were transduced with a corrective transgene using a retrovirus, and this led to the development of T cell leukemia in 3 of 20 patients. One possible solution is to add a functional tumor suppressor gene to the DNA to be integrated. This may be problematic since the longer the DNA is, the harder it is to integrate into cell genomes. CRISPR technology allows researchers to make much more precise genome changes at exact locations.
- Cost – Alipogene tiparvovec or Glybera, for example, at a cost of $1.6 million per patient, was reported in 2013 to be the world's most expensive drug.

➢ **Deaths**

Three patients' deaths have been reported in gene therapy trials, putting the field under close scrutiny. The first was that of Jesse Gelsinger in 1999. One X-SCID patient died of leukemia in 2003. In 2007, a rheumatoid arthritis patient died from an infection; the subsequent investigation concluded that the death was not related to gene therapy.

➢ **History:- 2016**

In April the Committee for Medicinal Products for Human Use of the European Medicines Agency endorsed a gene therapy treatment called Strimvelis and recommended it be approved. This treats children born with ADA-SCID and who have no functioning immune system - sometimes called the "bubble baby" disease. This would be the second gene therapy treatment to be approved in Europe.

➢ **Speculative uses:-**

Speculative uses for gene therapy include

Fertility:- Gene Therapy techniques have the potential to provide alternative treatments for those with infertility. Recently, successful experimentation on mice has proven that fertility can

be restored by using the gene therapy method, CRISPR. Spermatogenical stem cells from another organism were transplanted into the testes of an infertile male mouse. The stem cells re-established spermatogenesis and fertility.

Gene doping:- Athletes might adopt gene therapy technologies to improve their performance. Gene doping is not known to occur, but multiple gene therapies may have such effects. Kayser et al. argue that gene doping could level the playing field if all athletes receive equal access. Critics claim that any therapeutic intervention for non-therapeutic/enhancement purposes compromises the ethical foundations of medicine and sports.

Human genetic engineering:-

Genetic engineering could be used to change physical appearance, metabolism, and even improve physical capabilities and mental faculties such as memory and intelligence. Ethical claims about germ line engineering include beliefs that every foetus has a right to remain genetically unmodified, that parents hold the right to genetically modify their offspring, and that every child has the right to be born free of preventable diseases.

Possible regulatory schemes include a complete ban, provision to everyone, or professional self-regulation. The American Medical Association's Council on Ethical and Judicial Affairs stated that "genetic interventions to enhance traits should be considered permissible only in severely restricted situations: (1) clear and meaningful benefits to the fetus or child; (2) no trade-off with other characteristics or traits; and (3) equal access to the genetic technology, irrespective of income or other socioeconomic characteristics."

Regulations:-

Regulations covering genetic modification are part of general guidelines about human-involved biomedical research. The Helsinki Declaration (Ethical Principles for Medical Research Involving Human Subjects) was amended by the World Medical Association's General Assembly in 2008. This document provides principles physicians and researchers must consider when involving humans as research subjects. The Statement on Gene Therapy Research initiated by the Human Genome Organization (HUGO) in 2001 provides a legal baseline for all countries. HUGO's document emphasizes human freedom and adherence to human rights, and offers recommendations for somatic gene therapy,

including the importance of recognizing public concerns about such research.

➢ Ethical issues surrounding gene therapy?

Because gene therapy involves making changes to the body's set of basic instructions, it raises many unique ethical concerns. The ethical questions surrounding gene therapy include:

- How can "good" and "bad" uses of gene therapy be distinguished?
- Who decides which traits are normal and which constitute a disability or disorder?
- Will the high costs of gene therapy make it available only to the wealthy?
- Could the widespread use of gene therapy make society less accepting of people who are different?
- Should people be allowed to use gene therapy to enhance basic human traits such as height, intelligence, or athletic ability?

Current gene therapy research has focused on treating individuals by targeting the therapy to body cells such as bone marrow or blood cells. This type of gene therapy cannot be passed on to a person's children. Gene therapy could be targeted to egg and sperm cells (germ cells), however, which would allow the inserted gene to be passed on to future generations. This approach is known as germline gene therapy.

The idea of germline gene therapy is controversial. While it could spare future generations in a family from having a particular genetic disorder, it might affect the development of a fetus in unexpected ways or have long-term side effects that are not yet known. Because people who would be affected by germline gene therapy are not yet born, they can't choose whether to have the treatment. Because of these ethical concerns, the U.S. Government does not allow federal funds to be used for research on germline gene therapy in people.

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