



## CURRENT AFFAIRS 2012: SCIENCE & TECHNOLOGY – PART I

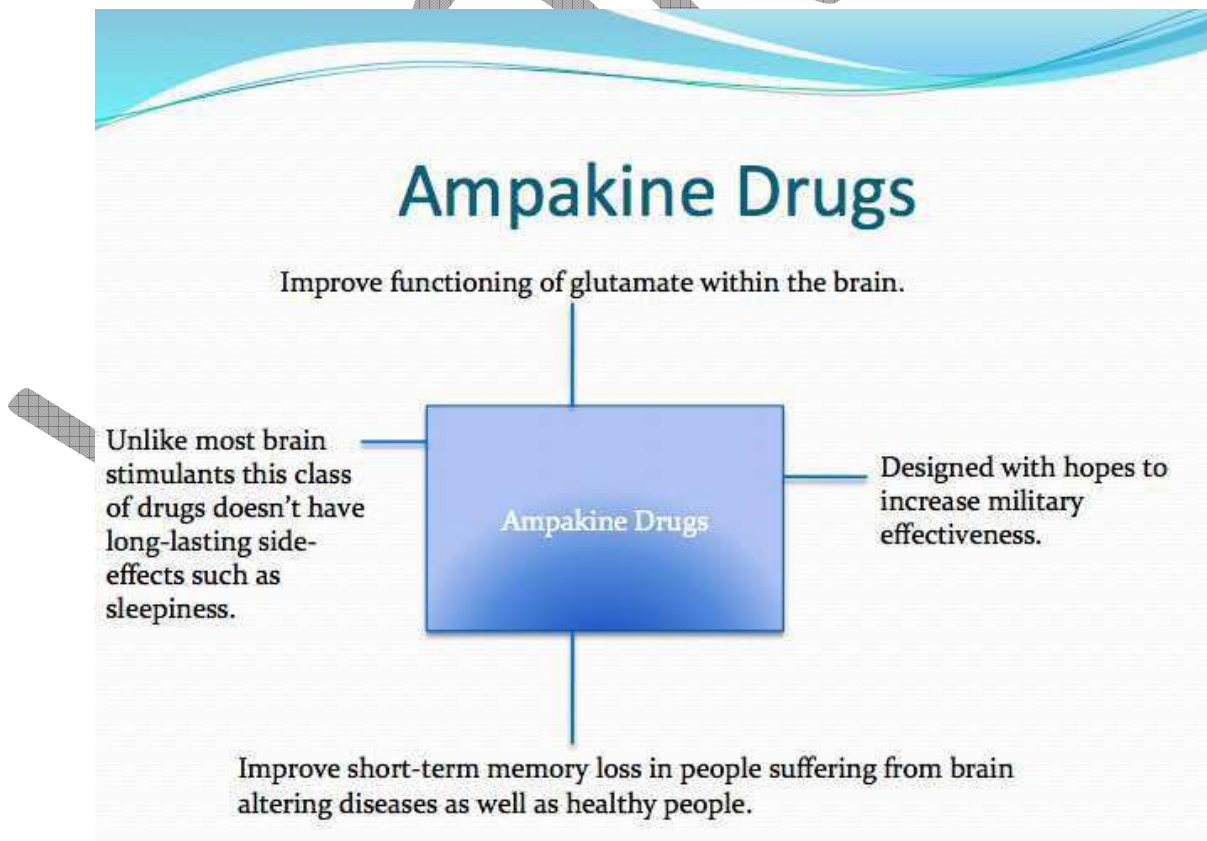
### AMPAKINES/AMPAKINES TECHNOLOGY-

#### AMPAKINES

- Ampakines are a class of compounds known to enhance attention span and alertness, and facilitate learning and memory.

#### Working:

- The brain is filled with connections – trillions of connections. Ampakines work by enhancing the communication between the connections in the brain. In doing so, they are able to facilitate learning and memory, and to overcome some of the chemical imbalances that can occur in the brain with certain diseases.



**Uses:**

1. Ampakines can be used to treat the effects of Alzheimer's disease, attention-deficit disorder, strokes, and the dementias associated with Parkinson's disease and schizophrenia, treatment-resistant depression (TRD), Rett's syndrome et.
2. Ampakines have shown to have an effect after they had left the body, continuing to enhance learning and memory.
3. Ampakines have been investigated by DARPA for potential use in increasing military effectiveness.

**BRAIN-COMPUTER INTERFACE (BCI)/MMI/BMI**

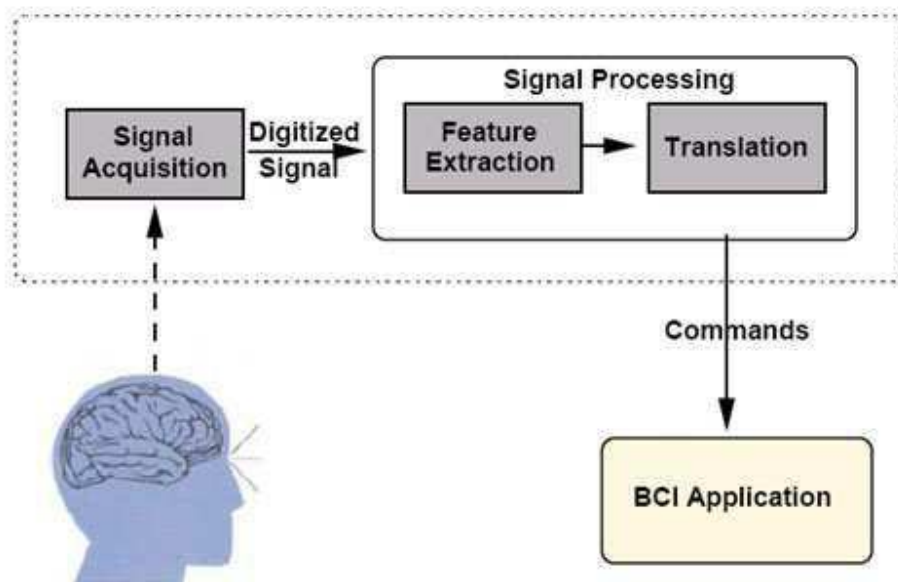
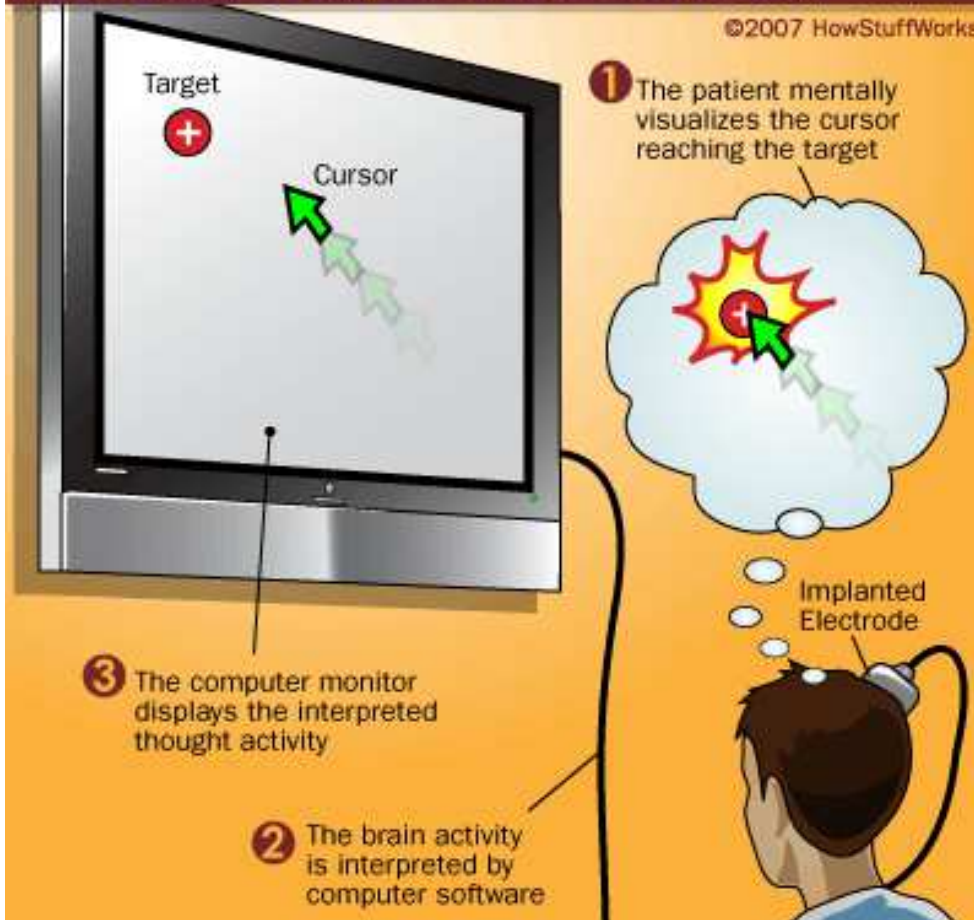
A brain-computer interface (BCI), often called a mind-machine interface (MMI), or sometimes called a direct neural interface or a brain-machine interface (BMI), is a direct communication pathway between the brain and an external device. BCIs are often directed at assisting, augmenting, or repairing human cognitive or sensory-motor functions. THIS IS YOUR BRAIN ON SILICON..!

**Applications:**

- It holds the promise of bringing sight to the blind, hearing to the deaf, and the return of normal functionality to the physically impaired.
- By interfacing with a computer through a direct neural connection, patients report a higher rate of mental engagement and, ultimately, recovery.
- BCI technology shows promising signs in both preventing and delaying the onset of dementia, Alzheimer's and Parkinson's disease in the elderly.
- BCI has military, consumer electronics and other uses as well. Its leading edge technology is known as "MindReader". A simple thought in mind could be digitalized and become reality.

# How Brain-Computer Interfaces Work

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## **BRAIN READING-**

- Every thought is associated with a characteristic pattern of activation in the brain. By training a computer to recognize these patterns, it becomes possible to read a person's thoughts from patterns of their cerebral activity. In this way a person's brain activity can betray their thoughts and emotions, can give clues whether they are lying, or can even predict what they are about to do.
- This recent progress in brain science has made completely new insights into thought processes possible. We can now investigate how thoughts are stored in the brain, or how intentions unconsciously arise and affect our behaviour. But these findings are not just of interest for the scientific disciplines involved. They have important implications for our understanding of human nature. Also, they lay foundations for important applications: For example, with the help of a "brain computer interfaces", paralysed patients can control technical devices solely "with the power of their thoughts".
- Brain reading uses fMRI in order to decode the original stimulus.

### **Background:**

#### **fMRI**

- Functional magnetic resonance imaging or functional MRI (fMRI) is an MRI procedure that measures brain activity by detecting associated changes in blood flow.

#### **MRI**

- Magnetic resonance imaging (MRI) is a test that uses a magnetic field and pulses of radio wave energy to make pictures of organs and structures inside the body.

## **NEUROINFORMATICS-**

- Neuroinformatics is an emerging research area at the interface between information technology with and brain research. It covers all aspects of study the brain, including its form, function, development, and illnesses. Techniques of particular interest are the many kinds of neuroimaging and the analysis of such images, brain databases of all kinds, and computational modeling of brain function.
- Combining informatics research and brain research provides benefits for both fields of science. On one hand, informatics facilitates brain data processing and data handling, by providing new electronic and software technologies for arranging databases, modeling and communication in brain research. On the other hand, enhanced discoveries in the field of neuroscience will invoke the development of new methods in information technologies (IT).
- Neuroinformatics integrates information across all levels and scales of neuroscience - from genes to behavior - to help understand the brain and treat disease. It encompasses the tools and techniques for data acquisition, sharing, publishing, storage, analysis, visualization, modeling and simulation.

## **GENENETWORK-**

- Networks of interacting genes are responsible for generating life's diversity. Gene networks play a central role in our sophisticated immune response, the ability to digest food, and even for causing

cancer - the disaster that occurs when gene networks become un-regulated. Thus understanding the properties of gene networks is of fundamental importance in the post-genomic era.

- GeneNetwork consists of two major components:
  - Massive collections of genetic, genomic, and phenotype data for large families
  - Sophisticated statistical analysis and gene mapping software that enable analysis of regulatory networks and genotype-to-phenotype relations
- GeneNetwork is primarily used by researchers but has also been adopted successfully for undergraduate courses in genetics, bioinformatics, physiology, and psychology. Researchers and students typically retrieve sets of genotypes and phenotypes from one or more families and use built-in statistical and mapping functions to explore relations among variables and to assemble networks of associations. Key steps include the analysis of these factors:
  1. The range of variation of traits
  2. Covariation among traits (scatterplots and correlations)
  3. Architecture of larger networks of traits
  4. **Quantitative trait locus** mapping and causal models of the linkage between sequence differences and phenotype differences

## NEUROPROSTHETICS

- Neuroprosthetics (also called neural prosthetics) is a discipline related to neuroscience and biomedical engineering concerned with developing neural prostheses (In medicine, a prosthesis, prosthetic, or prosthetic limb is a device that replaces a missing body part) . Neural prostheses are a series of devices that can substitute a motor, sensory or cognitive modality that might have been damaged as a result of an injury or a disease. Cochlear implants (The cochlea is the auditory portion of the inner ear)-(for hearing aid) provide an example of such devices. These devices substitute the functions performed by the ear drum and Stapes, while simulating the frequency analysis performed in the cochlea. A microphone on an external unit gathers the sound and processes it; the processed signal is then transferred to an implanted unit that stimulates the auditory nerves through a microelectrode array. Through the replacement or augmentation of damaged senses, these devices intend to improve the quality of life for those with disabilities.
- These implantable devices are also commonly used in animal experimentation as a tool to aid neuroscientists in developing a greater understanding of the brain and its functioning. In wirelessly monitoring the brain's electrical signals sent out by electrodes implanted in the subject's brain, the subject can be studied without the device affecting the results.

## IN VITRO MEAT

- In vitro meat, also known as cultured meat or shmeat, is an animal flesh product that has never been part of a complete, living animal. Alternative names include hydroponic meat, test-tube meat, vat-grown meat, victimless meat and vitro meat. This form of meat has been described, sometimes derisively, as "laboratory-grown" meat. A long-term goal for in vitro meat laboratories would be to grow fully developed muscle tissue after they made the first-generational products economically

feasible for most people. Cultured meat is currently prohibitively expensive, but it is anticipated that the cost could be reduced to about twice that of conventionally produced meat. Potentially, any animal's muscle tissue could be grown through the in vitro process, even human.

- In vitro meat production is a specialized form of tissue engineering, a biomedical practice in which scientists try to grow animal tissues like bone, skin, kidneys and hearts. Proponents say it will ultimately be a more efficient way to make animal meat, which would reduce the carbon footprint of meat products.
- With the costs of conventional meat farming techniques constantly increasing and an increased demand from a rising world population, in vitro meat may be one of several new technologies needed to maintain food supplies by the year 2050.
- Shmeat is a nickname given to lab-created meat grown from a cell culture of animal tissue.

### **VERTICAL FARMING- (farm vertically)**

- Vertical farming is a proposal to build high rise buildings within urban areas to enable the growing of food crops to help avoid the impending food shortage which is envisaged in the near future. It is thought that by the year 2050 the world's population will have grown by a further 3 billion people and with more land needed than is available to grow the crops needed to feed everybody, ideas have to be considered to how these extra crops can be grown. Vertical farming could provide year round food production and better crop production, being able to yield more produce by area like for like compared to traditional horizontal farming. To put in a nutshell vertical farming is like a high rise greenhouse, sometimes having the label farmscrapers.

### **Advantages of Vertical Farming**

- Year-round crop production; 1 indoor acre is equivalent to 4-6 outdoor acres or more, depending upon the crop (e.g., strawberries: 1 indoor acre = 30 outdoor acres)
- No weather-related crop failures due to droughts, floods, pests
- All VF food is grown organically: no herbicides, pesticides, or fertilizers
- VF virtually eliminates agricultural runoff by recycling black water
- VF returns farmland to nature, restoring ecosystem functions and services
- VF greatly reduces the incidence of many infectious diseases that are acquired at the agricultural interface
- VF converts black and gray water into potable water by collecting the water of evapotranspiration
- VF adds energy back to the grid via methane generation from composting non-edible parts of plants and animals
- VF dramatically reduces fossil fuel use (no tractors, plows, shipping.)
- VF converts abandoned urban properties into food production centers
- VF creates sustainable environments for urban centers
- VF creates new employment opportunities
- We cannot go to the moon, Mars, or beyond without first learning to farm indoors on earth
- VF may prove to be useful for integrating into refugee camps

- VF offers the promise of measurable economic improvement for tropical and subtropical LDCs. If this should prove to be the case, then VF may be a catalyst in helping to reduce or even reverse the population growth of LDCs as they adopt urban agriculture as a strategy for sustainable food production.
- VF could reduce the incidence of armed conflict over natural resources, such as water and land for agriculture



## PROSTHESIS-

Prosthesis, artificial substitute for a missing part of the body. The artificial parts that are most commonly thought of as prostheses are those that replace lost arms and legs, but bone, artery, and heart valve replacements are common, and artificial eyes and teeth are also correctly termed prostheses. The term is sometimes extended to cover such things as eyeglasses and hearing aids, which improve the functioning of a part. The medical specialty that deals with prostheses is called prosthetics.

## HEAD TRANSPLANT-

- A head transplant is a surgical operation involving the grafting of an organism's head onto the body of another. It should not be confused with another, hypothetical, surgical operation, the brain transplant. Head transplantation involves decapitating the patient. Although it has been successfully performed using dogs, monkeys and rats, no human is known to have undergone the procedure.
- This technique has been proposed as possibly useful for people who are already quadriplegics and who are also suffering from widespread organ failures which would otherwise require many different and

difficult transplant surgeries. Quadriplegia may be an acceptable option for the terminally ill. There is no uniform consensus on the ethics of such a procedure.

### **ISOLATED BRAIN-**

- Isolated brain refers to keeping a brain alive in-vitro. This is done either by perfusion by a blood substitute, often an oxygenated solution of various salts, or by submerging the brain in oxygenated artificial cerebrospinal fluid (CSF). An isolated brain however is more typically attached to an artificial perfusion device rather than a biological body.
- The brains of many different organisms have been kept alive in-vitro for hours, or in some cases days. The central nervous system of invertebrate animals is often easily maintained as they need less oxygen and to a larger extent get their oxygen from CSF, for this reason their brains are more easily maintained without perfusion. Mammalian brains on the other hand have a much lesser degree of survival without perfusion and an artificial blood perfusate is usually used.

### **LIFE EXTENSION-**

- Life extension science, also known as anti-aging medicine, experimental gerontology, and biomedical gerontology, is the study of slowing down or reversing the processes of aging to extend both the maximum and average lifespan. Some researchers in this area, and "life extensionists" or "longevists" (who wish to achieve longer lives for themselves), believe that future breakthroughs in tissue rejuvenation with stem cells, molecular repair, and organ replacement (such as with artificial organs or xenotransplantations) will eventually enable humans to have indefinite lifespans (agerasia) through complete rejuvenation to a healthy youthful condition.
- The sale of putative anti-aging products such as nutrition, physical fitness, skin care, hormone replacements, vitamins, supplements and herbs is a lucrative global industry.
- During the process of aging, an organism accumulates damage to macromolecules, its cells, its tissues and its organs. This accumulated damage is the result of oxidation damage to the cell contents caused by free radicals. Theoretically, extension of maximum lifespan could be achieved by reducing the rate of aging damage, by periodic replacement of damaged tissues, or by molecular repair or rejuvenation of deteriorated cells and tissues and the enhancement of telomerase enzyme activity.

### **HIBERNATION-**

- Hibernation is a state of inactivity and metabolic depression in animals, characterized by lower body temperature, slower breathing, and/or lower metabolic rate. Hibernating animals conserve energy, especially during winter when food supplies are limited, tapping energy reserves, body fat, at a slow rate. Hibernation during summer months is known as aestivation.
- Although often associated with cold temperatures, the root purpose of hibernation is to conserve food during a period when sufficient food is scarce. It is the animal's slowed metabolic rate which leads to a reduction in body temperature and not the other way around. Hibernation may last several days, weeks, or months depending on the species, ambient temperature, time of year, individual animal's body condition, and fur on the animal's body.

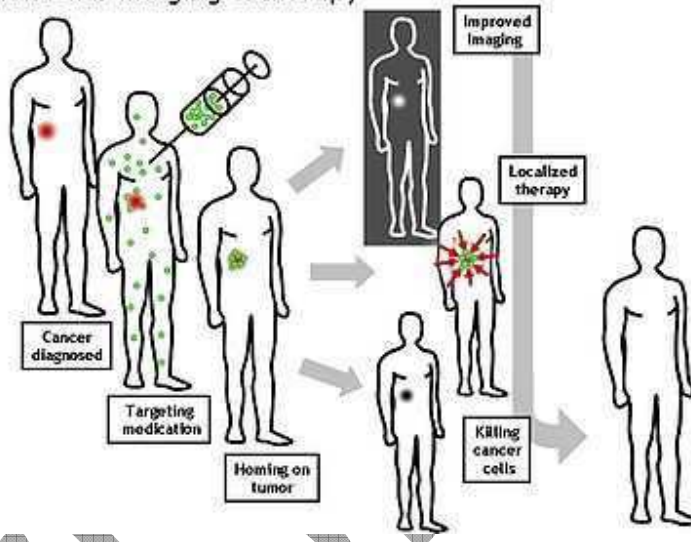


- Before entering hibernation, most species eat a large amount of food and store energy in fat deposits to survive the winter. Some species of mammals hibernate while gestating young, which are either born while the mother hibernates or shortly afterwards.

## NANOMEDICINES-

- Nanomedicine is the medical application of nanotechnology. Nanomedicine ranges from the medical applications of nanomaterials, to nanoelectronic biosensors, and even possible future applications of molecular nanotechnology.
- Nanomedical approaches to drug delivery centre on developing nanoscale particles or molecules to improve drug bioavailability. Bioavailability refers to the presence of drug molecules where they are needed in the body and where they will do the most good. Drug delivery focuses on maximizing bioavailability both at specific places in the body and over a period of time. This can potentially be achieved by molecular targeting by nanoengineered devices. It is all about targeting the molecules and delivering drugs with cell precision.

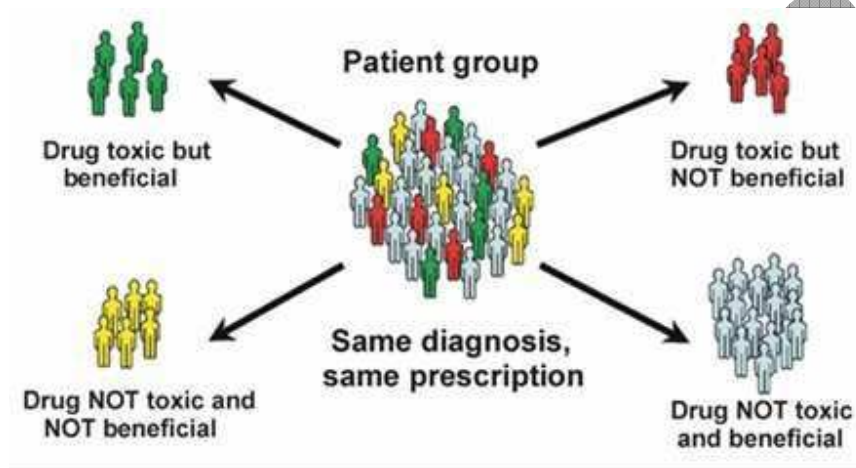
### Molecular imaging & therapy



## PERSONALIZED MEDICINE-

- Personalized medicine is a young but rapidly advancing field of healthcare that is informed by each person's unique clinical, genetic, genomic, and environmental information. Because these factors are different for every person, the nature of diseases—including their onset, their course, and how they might respond to drugs or other interventions—is as individual as the people who have them.
- Personalized medicine is about making the treatment as individualized as the disease. It involves identifying genetic, genomic, and clinical information that allows accurate predictions to be made about a person's susceptibility of developing disease, the course of disease, and its response to treatment.
- Specific advantages that personalized medicine may offer patients and clinicians include:
  - Ability to make more informed medical decisions

- Higher probability of desired outcomes thanks to better-targeted therapies
- Reduced probability of negative side effects
- Focus on prevention and prediction of disease rather than reaction to it
- Earlier disease intervention than has been possible in the past
- Reduced healthcare cost



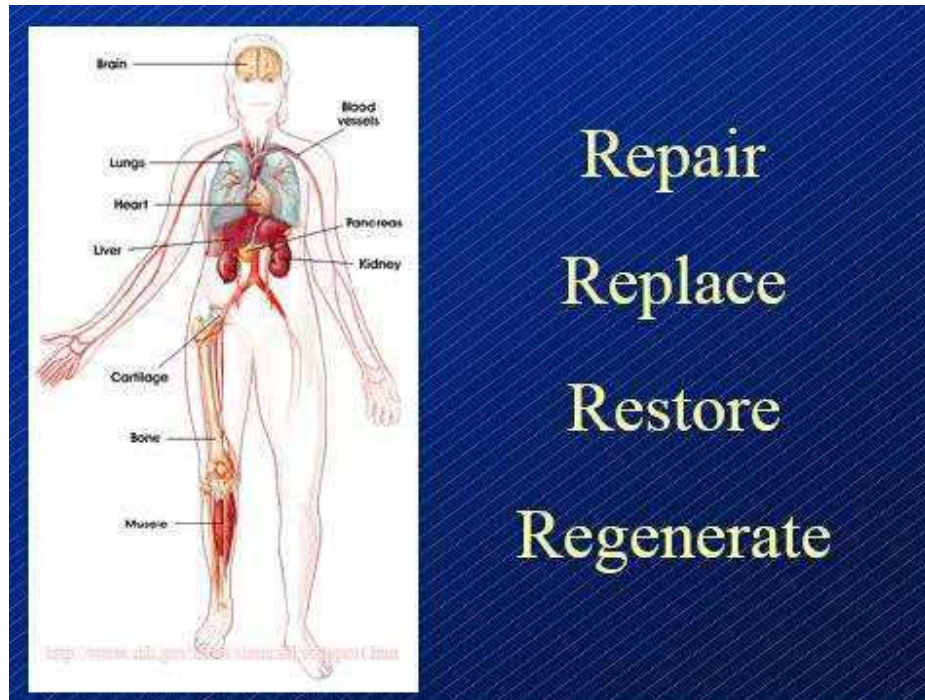
### FULL GENOME SEQUENCING-

- Whole genome sequencing (also known as full genome sequencing, complete genome sequencing, or entire genome sequencing), is a laboratory process that determines the complete DNA sequence of an organism's genome at a single time. This entails sequencing all of an organism's chromosomal DNA as well as DNA contained in the mitochondria and, for plants, in the chloroplast. Almost any biological sample—even a very small amount of DNA or ancient DNA—can provide the genetic material necessary for full genome sequencing. Such samples may include saliva, epithelial cells, bone marrow, hair (as long as the hair contains a hair follicle), seeds, plant leaves, or anything else that has DNA-containing cells.
- Full genome sequencing will allow health care professionals to analyze the entire human genome of an individual and therefore detect all disease-related genetic variants, regardless of the genetic variant's prevalence or frequency. This will enable the rapidly emerging medical fields of Predictive Medicine, Preventive Medicine and Personalized Medicine and will mark a significant leap forward for the clinical genetic revolution. Full genome sequencing is clearly of great importance for research into the basis of genetic disease and has shown significant benefit to a subset of individuals with rare disease in the clinical setting.

### REGENERATIVE MEDICINE-

- Regenerative medicine helps natural healing processes to work faster and better. These technologies and techniques create an environment in which missing or damaged tissue that would not ordinarily regrow in fact regenerates fully.

- Strategies presently under development include transplants of stem cells, the manipulation of the patient's own stem cells, and the use of scaffold materials that emit biochemical signals to spur stem cells into action. Regenerative therapies have been demonstrated (in trials or the laboratory) to heal broken bones, bad burns, blindness, deafness, heart damage, nerve damage, Parkinson's disease, and a range of other conditions. Work continues to bring these advances to patients.



## ROBOTIC SURGERY-

- Robotic surgery is a technique in which a surgeon performs surgery using a computer that remotely controls very small instruments attached to a robot.
- The surgeon first inserts these instruments into your body through small surgical cuts. Under the surgeon's direction, the robot matches the doctor's hand movements to perform the procedure using the tiny instruments.
- A thin tube with a camera attached to the end of it (endoscope) allows the surgeon to view highly magnified three-dimensional images of your body on a monitor in real time.
- Major advances aided by surgical robots have been remote surgery, minimally invasive surgery and unmanned surgery. Some major advantages of robotic surgery are precision, miniaturization, smaller incisions, decreased blood loss, less pain, and quicker healing time. Further advantages are articulation beyond normal manipulation and three-dimensional magnification, resulting in improved ergonomics. Robotic techniques are also associated with reduced duration of hospital stays, blood loss, transfusions, and use of pain medication.



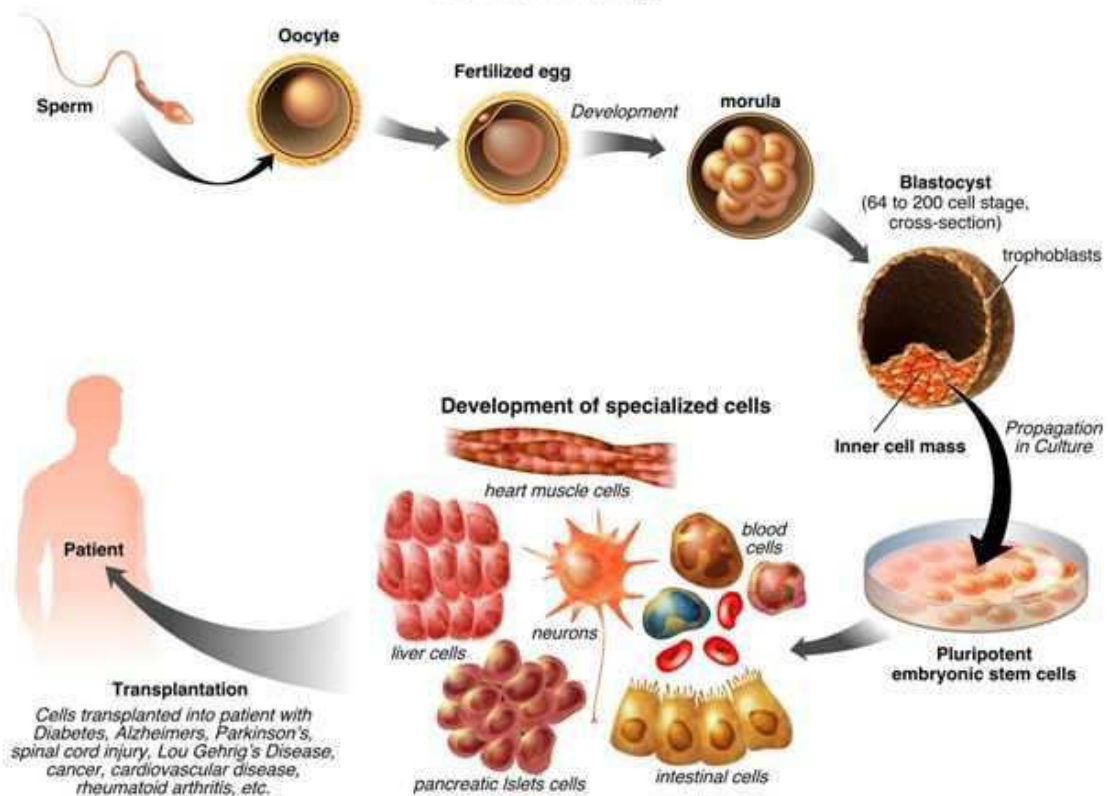
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- 1 Surgeon Console
- 2 Image Processing Equipment
- 3 Endowrist Instruments
- 4 Surgical Arm Cart
- 5 Hi-Resolution 3-D Endoscope

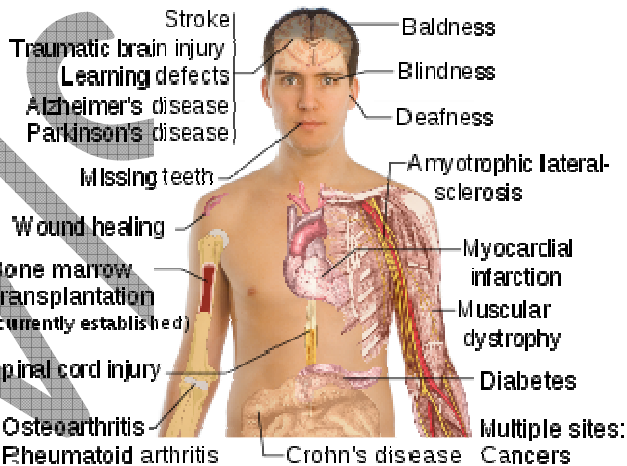
## STEM CELL TREATMENTS

- Stem cell treatments are a type of intervention strategy that introduces new adult stem cells into damaged tissue in order to treat disease or injury. Many medical researchers believe that stem cell treatments have the potential to change the face of human disease and alleviate suffering. The ability of stem cells to self-renew and give rise to subsequent generations with variable degrees of differentiation capacities, offers significant potential for generation of tissues that can potentially replace diseased and damaged areas in the body, with minimal risk of rejection and side effects.
- But there is widespread controversy over the use of human embryonic stem cells. This controversy primarily targets the techniques used to derive new embryonic stem cell lines, which often requires the destruction of the blastocyst. Opposition to the use of human embryonic stem cells in research is often based on philosophical, moral or religious objections.

## Stem Cell Therapy



## Potential uses of Stem cells



## TISSUE ENGINEERING-

- Tissue engineering is the use of a combination of cells, engineering and materials methods, and suitable biochemical and physio-chemical factors to improve or replace biological functions.
- While most definitions of tissue engineering cover a broad range of applications, in practice the term is closely associated with applications that repair or replace portions of or whole tissues (i.e., bone,



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by

**Anoop Kumar Singh**

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