
Science & Technology

50 most important topics

Part II

Science & Technology

50 Important Topics - 2024	
Scheduled Date	**Subject**
01/04/24	Economy
02/04/24	Science & Technology
03/04/24	Environment & D.M.
04/04/24	Science & Technology
05/04/24	Environment & D.M.
06/04/24	----------
07/04/24	----------
08/04/24	Economy
09/04/24	Science & Technology
10/04/24	Economy
11/04/24	English
12/04/24	International Relations
13/04/24	----------
14/04/24	----------
15/04/24	Geography
16/04/24	Polity & Governance
17/04/24	Polity & Governance
18/04/24	Geography
19/04/24	Polity & Governance
20/04/24	Maths
21/04/24	----------
22/04/24	Reasoning
23/04/24	Environment & D.M.
24/04/24	Social Schemes

Sleepy Classes IAS
Awakening Toppers

RAPID REVISION

MOST IMPORTANT TOPICS FOR PRELIMS 2024

CSAT	₹1,500	GS	₹3,500
CSAT + General Studies	₹4,000		

50 HOURS

1500 TOPICS

11th April 2024 – 29th April 2024

Special Inclusions

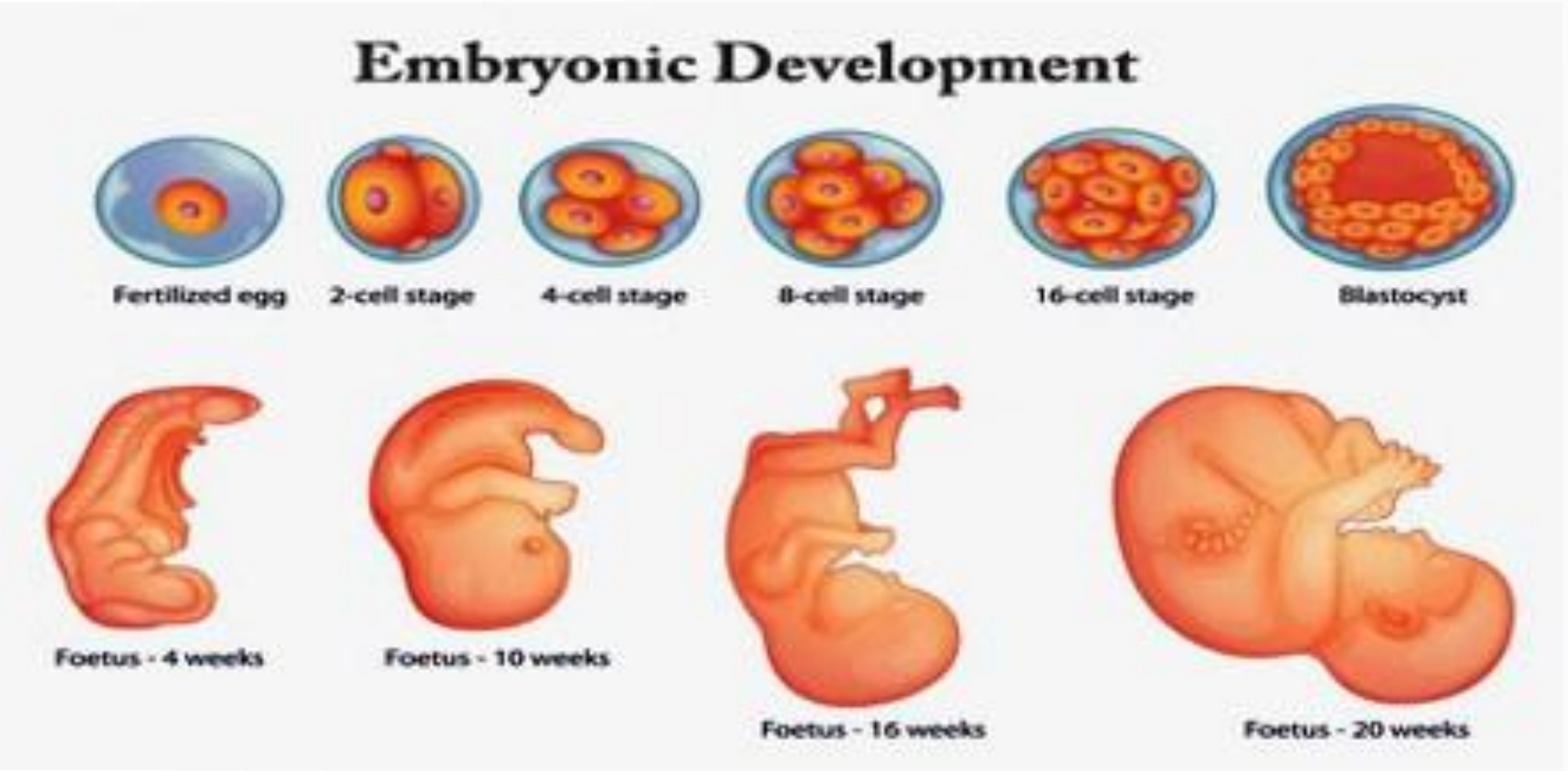
- 6 FLTs (3 GS+ 3 CSAT)
- Value Additions Material
- Subject Specific MCQS

1800-890-3043 sleepy.classes@gmail.com

Stem cells

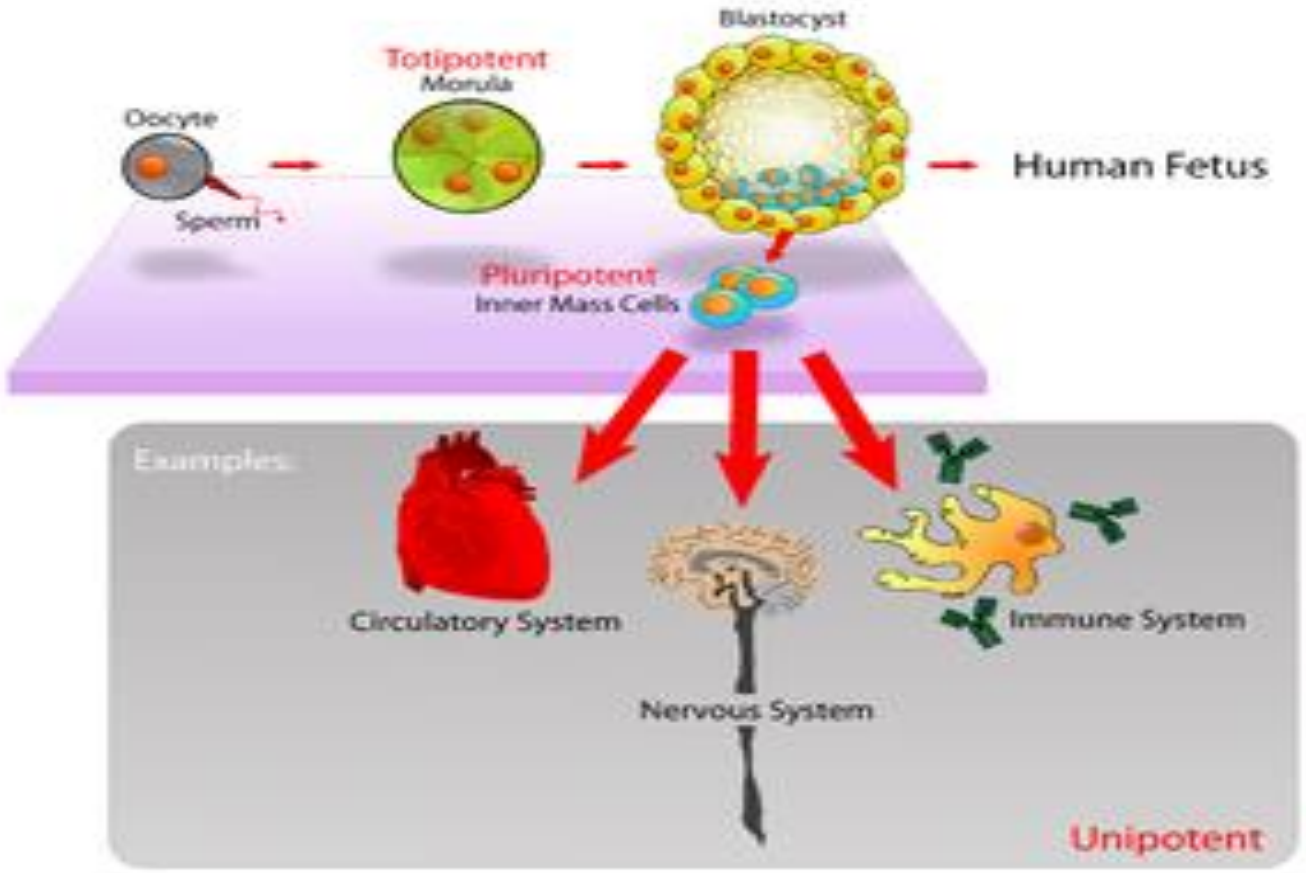
- A stem cell is a cell with the unique ability to develop into specialised cell types in the body. In the future they may be used to replace cells and tissues that have been damaged or lost due to disease.

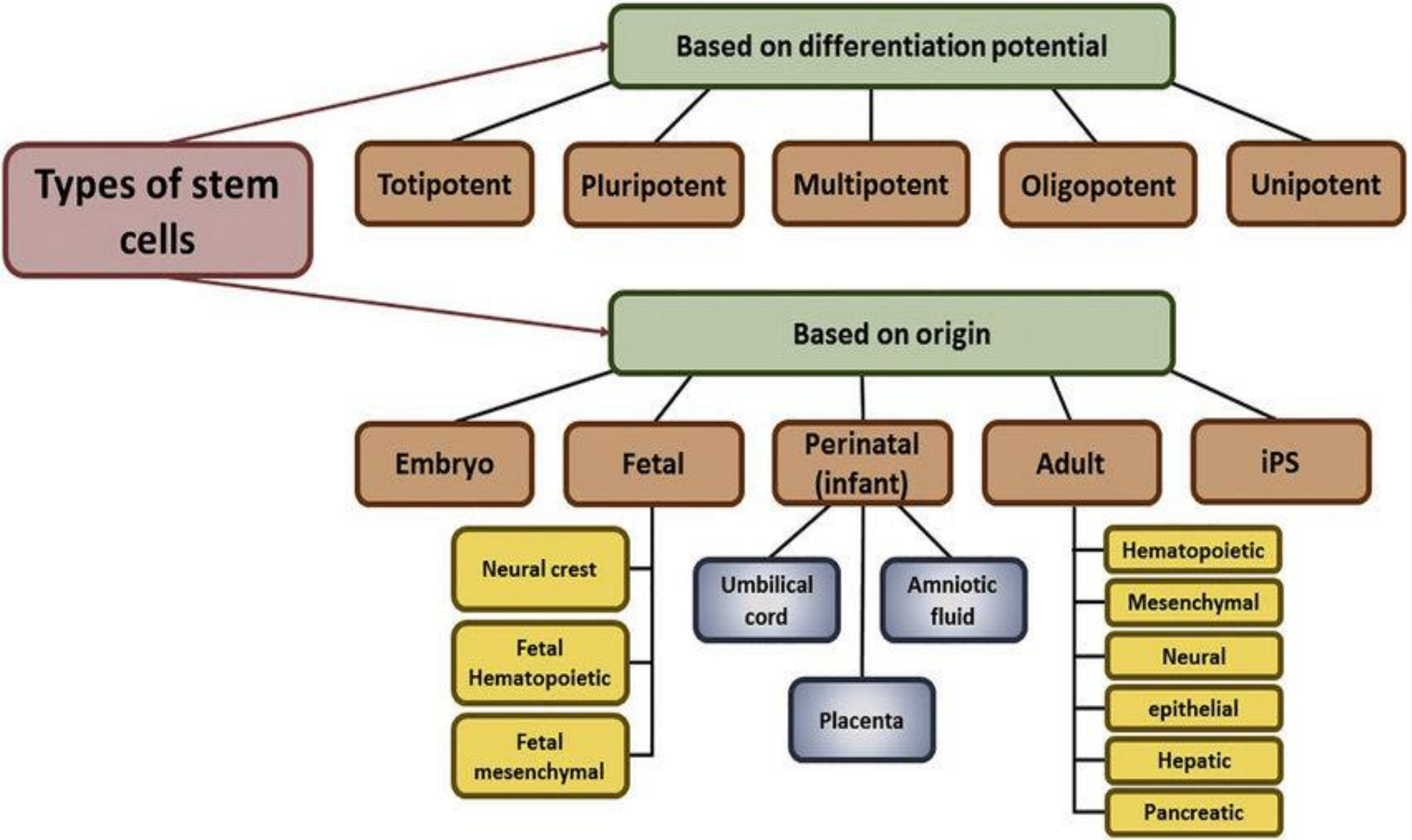
Embryonic development



Stem cell

Embryonic stem cell





Stem cell

Fetal stem cells

- The embryo is referred to as a fetus **after the eighth week of development.** The fetus contains stem cells that are **pluripotent** and eventually develop into the different body tissues in the fetus.

Stem cell

Perinatal stem cells

- Blood from the **umbilical cord and the amniotic fluid** contain some stem cells that are genetically identical to the newborn. Like adult stem cells, these are multipotent stem cells that are able to differentiate into certain, but not all, cell types.

Stem cell

Adult stem cells

- Adult stem cells are present in all humans in small numbers
- These cells are capable of giving rise only to a few types of cells that develop into a specific tissue or organ. They are therefore known as **multipotent** stem cells. Adult stem cells are sometimes referred to as somatic stem cells.

Stem cell

Induced pluripotent stem cells (iPSCs)

- are adult cells that have been genetically converted to an embryonic stem cell-like state.
- Human iPSCs can differentiate and become multiple different fetal cell types.
- iPSCs are valuable aids in the study of disease development and drug treatment, and they may have future uses in transplantation medicine.
- Further research is ongoing regarding the development and use of these cells.
- iPSCs are created through the introduction of **embryonic genes into a somatic cell** (a skin cell for example) that cause it to revert back to a "stem cell like" state.

Stem cell

- **ICMR Guidelines for stem cell research**
  - Commercial banking of all biological materials, **other than Umbilical Cord Blood (UCB), is prohibited** until further notification
  - At present there is no scientific evidence to substantiate clinical benefits with the use of stem cells other than UCB. Yet its procurement and banking has become a commercial activity.
  - ICMR has approved the stem-cell treatment for 30 odd categories of diseases **mostly cancer**.

Stem cell

- The guidelines also mention that **every other therapeutic use of stem cells shall be treated as investigational** and conducted **only in the form of a clinical trial** after obtaining necessary regulatory approvals.
- It **does not apply to research using non-human stem cells** or tissues.
- Intellectual Property Rights (IPRs) associated with the outcome of research on stem cells may have commercial value.

Stem cell

- In March 2019, the Union Health Ministry had notified the **'New Drugs and Clinical Trial Rules, 2019'** which state that stem-cell **derived products are to be used as "new drugs".** "This means that any doctor who uses stem-cell therapy needs to take permission from the government.

Q). With the references to 'stem cells' frequently in the news which of the following statement is/are correct (UPSC 2012)

1. Stem cells are discovered from mammals only
2. Stem cells can be used for screening of drugs
3. Stem cells can be used in medical therapies

Select the correct answer using codes given below

a) 1 and 2 only

b) 2 and 3 only

c) 3 only

d) 1,2 and 3 only

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c) 3 only

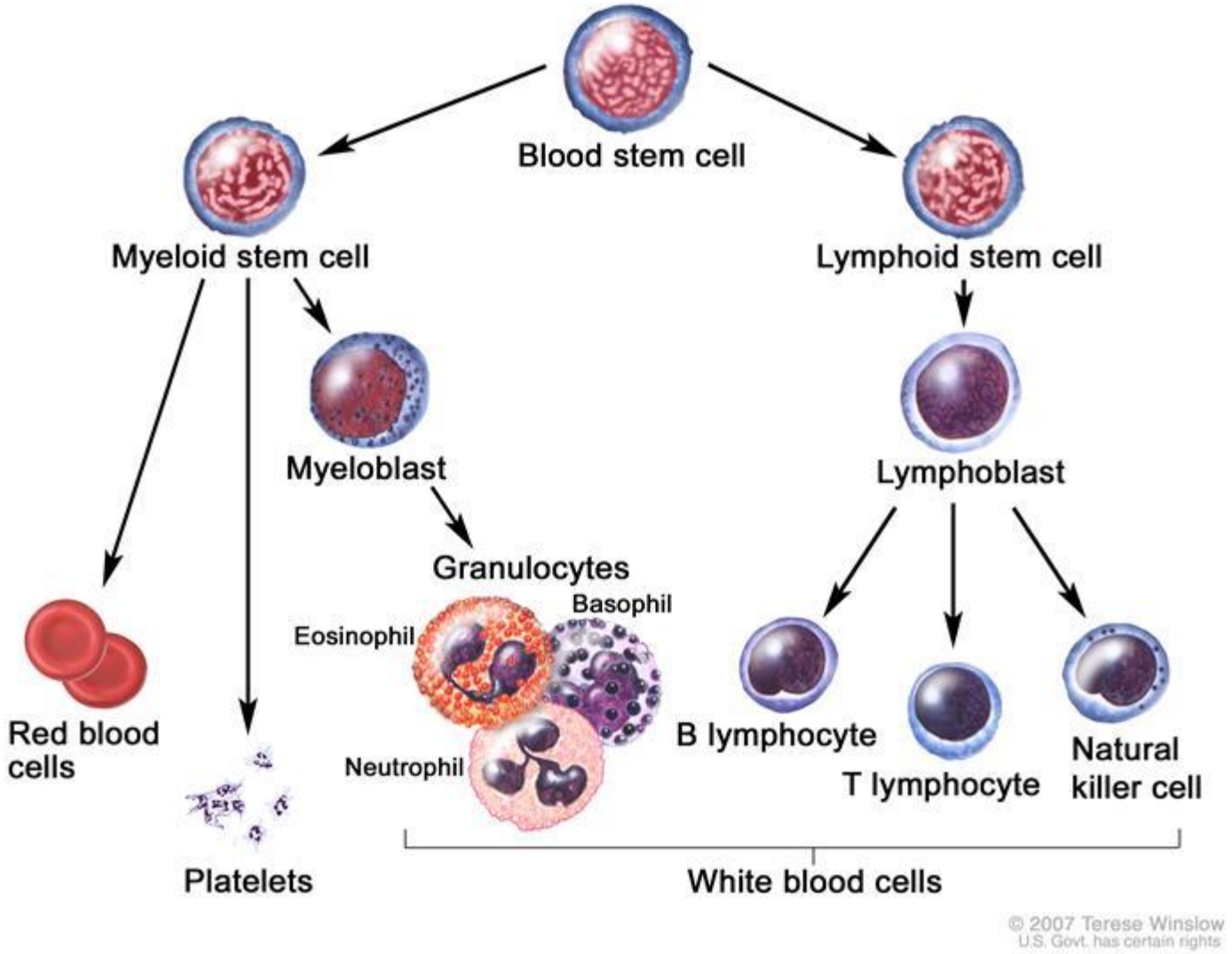
d) 1,2 and 3 only

Stem Cell-derived Mitochondria Transplantation

Context: Recently, **six children with rare disorders caused by deletion in the genomes of their mitochondria** were successfully treated for the first time by Stem-cell derived Mitochondria Transplantation

Stem Cell-derived Mitochondria Transplantation

- This process involved the **mitochondrial transplant from donor mothers into children's haematopoietic stem cells**, which give rise to all types of blood cells.
- Stem Cell-derived Mitochondria Transplantation involves the **spontaneous mitochondrial transfer of the stem cell to rescue the injured cells** or the injection of stem cell isolated mitochondria into the injured area to repair the damage.
- Stem cells are the most primitive cells at the top of the origin of cell lines, and they have a high capacity for differentiation and self-renewal.
- In addition, stem cells can differentiate into various tissues, organs, or functional cells of the human body; therefore, stem cells hold great promise for therapeutic tissue engineering and regenerative medicine.


Blood stem cell
Myeloid stem cell
Lymphoid stem cell
Myeloblast
Lymphoblast
Granulocytes
Eosinophil
Basophil
Neutrophil
Red blood cells
Platelets
B lymphocyte
T lymphocyte
Natural killer cell
White blood cells
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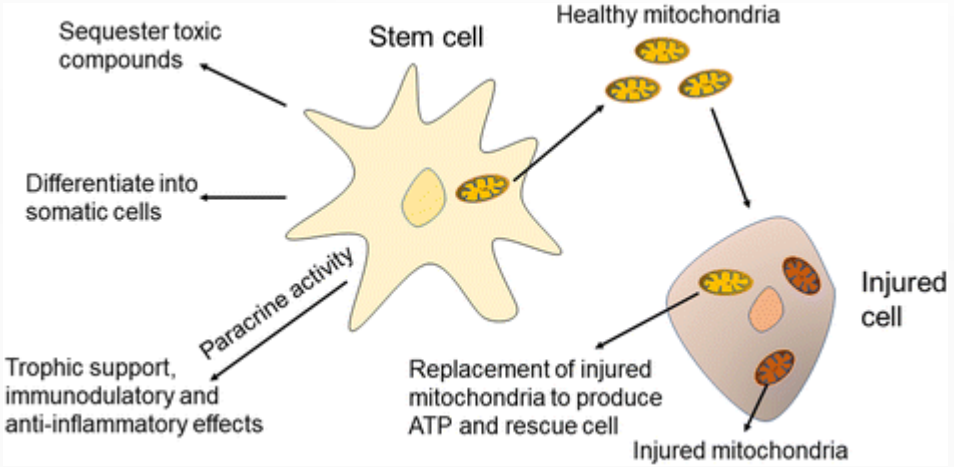
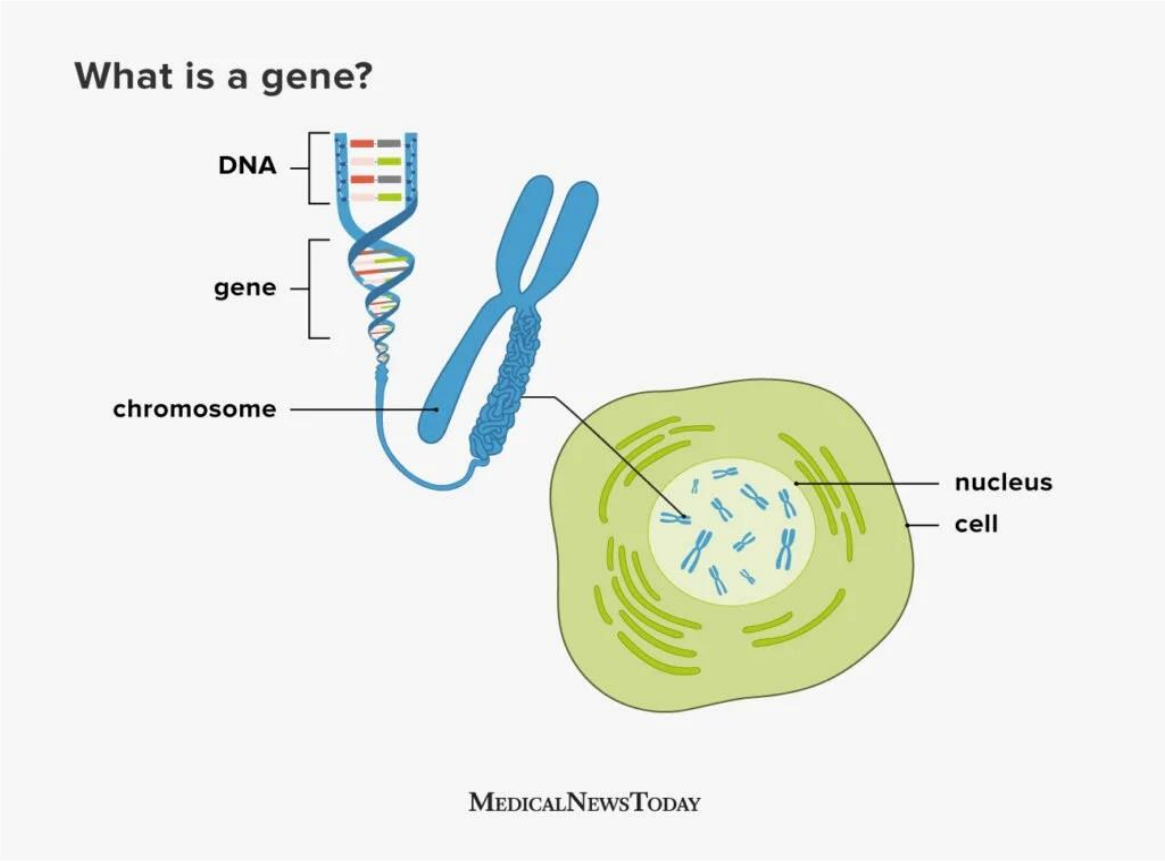
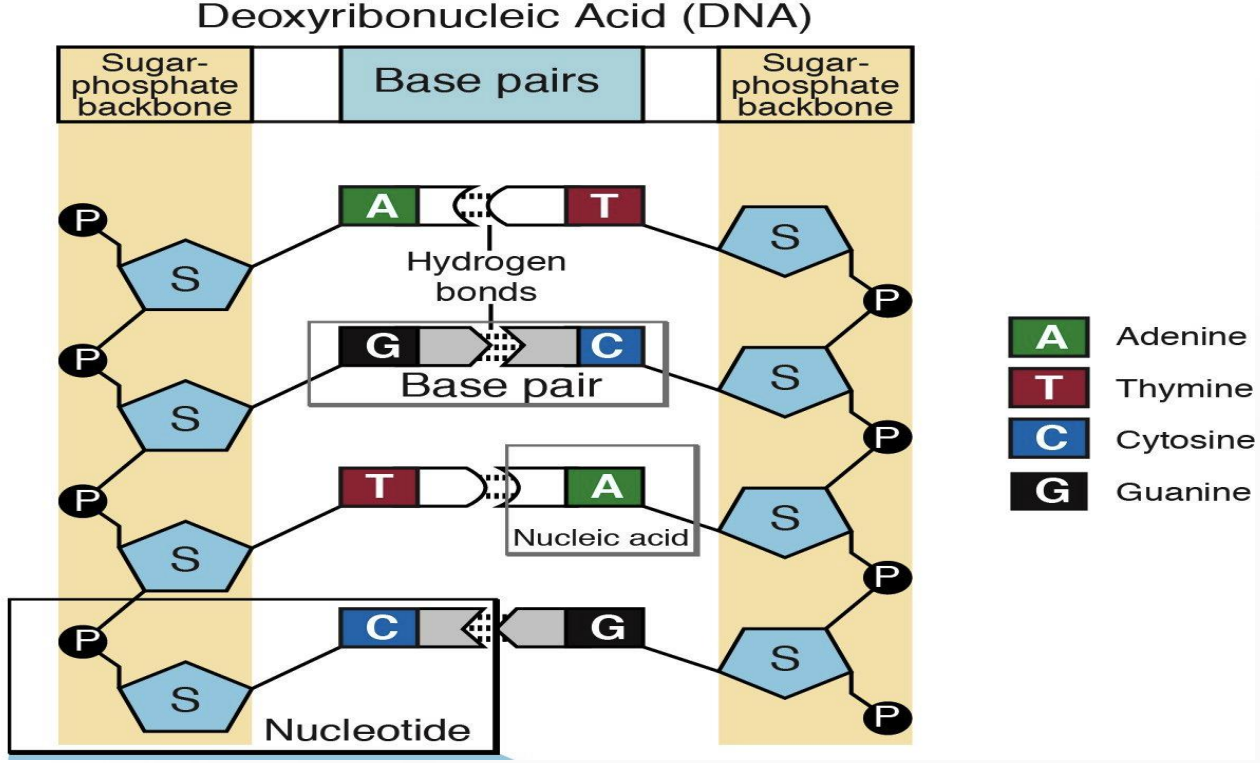
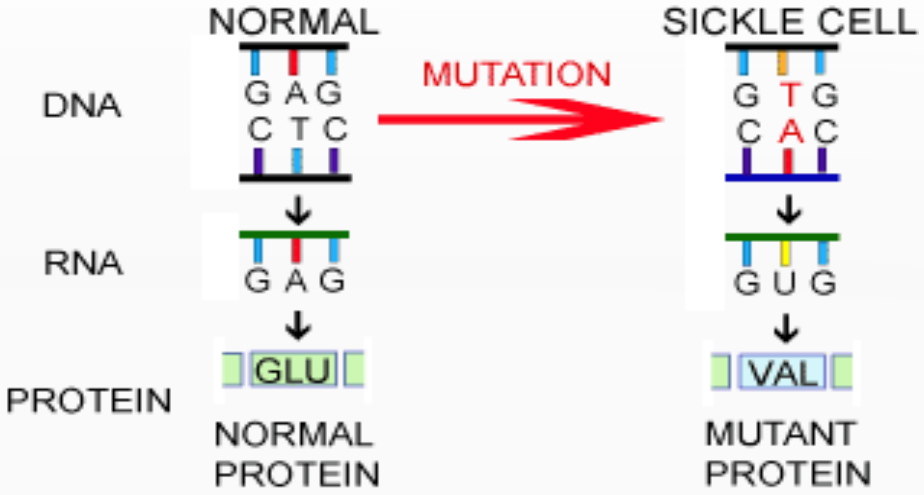

Sequester toxic compounds
Stem cell
Healthy mitochondria
Differentiate into somatic cells
Paracrine activity
Trophic support, immunodulatory and anti-inflammatory effects
Replacement of injured mitochondria to produce ATP and rescue cell
Injured cell
Injured mitochondria

What is Gene ?

- A gene is the basic **physical and functional unit of heredity. Genes are made up of DNA.**
- Some genes act as instructions to make molecules called proteins.
- However, many genes do not code for proteins. In humans, genes vary in size from a few hundred DNA bases to more than 2 million bases.




Deoxyribonucleic Acid (DNA)
Sugar-phosphate backbone
Base pairs
Sugar-phosphate backbone
A
T
Hydrogen bonds
G
C
Base pair
T
A
Nucleic acid
C
G
Nucleotide
P
S
A Adenine
T Thymine
C Cytosine
G Guanine


NORMAL
SICKLE CELL
MUTATION
DNA
G A G
C T C
G T G
C A C
RNA
G A G
G U G
PROTEIN
GLU
VAL
NORMAL PROTEIN
MUTANT PROTEIN

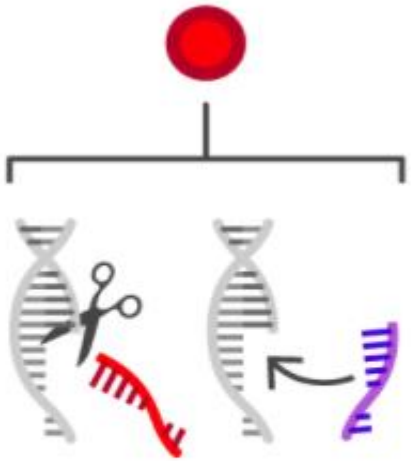
Gene editing VS gene therapy

- In gene editing, a mutated gene is **revised, removed, or replaced** at the DNA level.
- In **gene therapy**, the **effect of a mutation is offset by inserting a "healthy" version** of the gene, and the disease-related genes remain in the genome

SOMATIC GENE EDITING vs. GERMLINE GENE EDITING

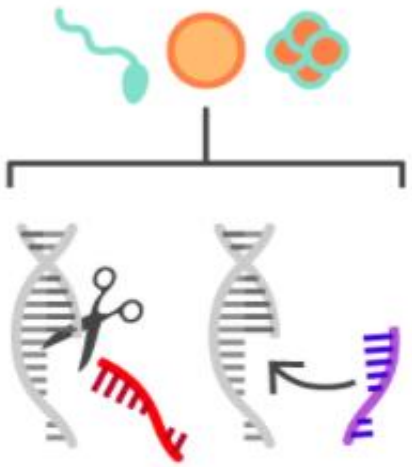
EDIT

BLOOD CELL



Somatic therapies target genes in specific types of cells (blood cells, for example).

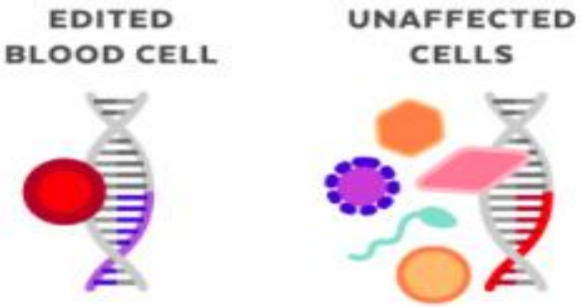
SPERM, EGG, OR EARLY EMBRYO



Germline modifications are made so early in development that any change is copied into all of the new cells.

SOMATIC GENE EDITING vs. GERMLINE GENE EDITING

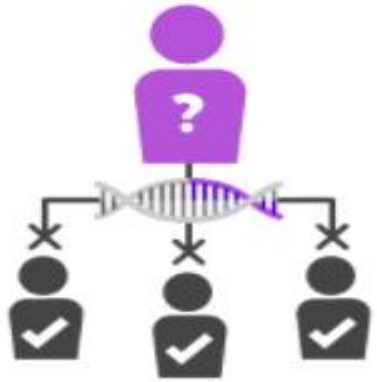
COPY



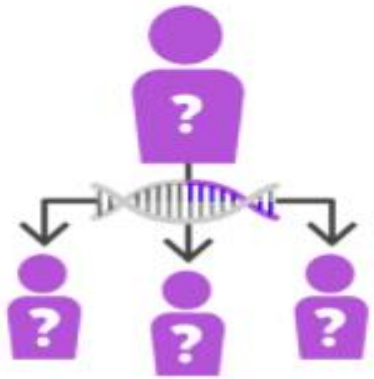
The edited gene is contained only in the target cell type. No other types of cells are affected.

The edited gene is copied in every cell, including sperm or eggs.

RISKS



Any changes, including potential off-target effects, are limited to the treated individual.



If the person has children, the edited gene is passed on to future generations.

SOMATIC GENE EDITING vs. GERMLINE GENE EDITING

CONSENSUS

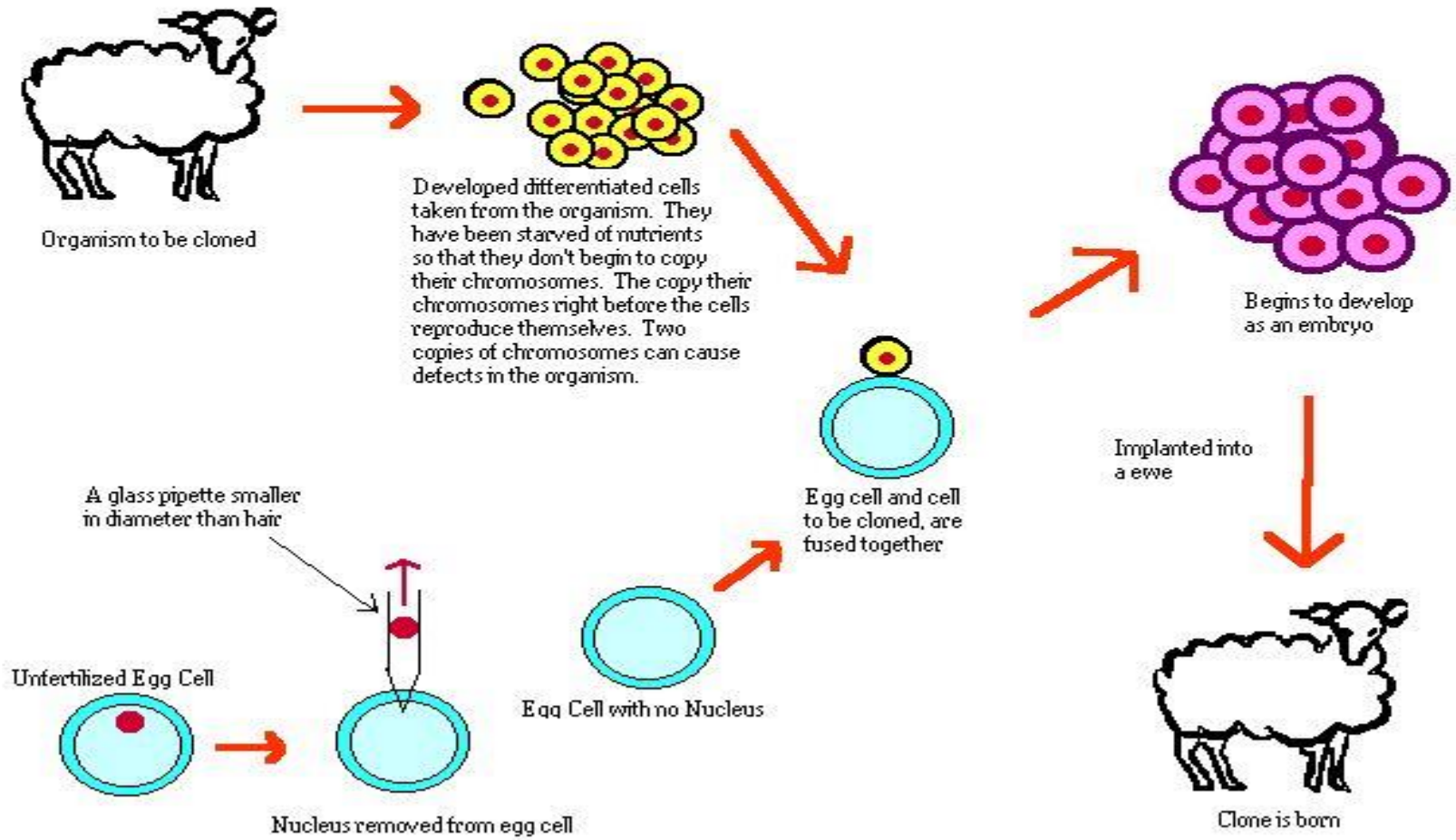
Somatic cell therapies have been researched and tested for more than 20 years and are highly regulated.

Human germline editing is new. Heritability of germline changes presents new legal and societal considerations.

Somatic cell nuclear transfer (SCNT)

- **A** technique in which the **nucleus of a somatic (body) cell is transferred to the cytoplasm of an enucleated egg** (an egg that has had its own nucleus removed). Once inside the egg, the **somatic nucleus is reprogrammed by egg cytoplasmic factors to become a zygote (fertilized egg) nucleus.**

Cloning:
Somatic Cell Nuclear Transfer



Q). What is the application of Somatic Cell Nuclear Transfer Technology? (2017)

a) Production of bio larvicides

b) Manufacture of biodegradable plastics

c) Reproductive cloning of animals

d) Production of organisms free of diseases

Gene editing Techniques	
1.	Zinc finger nucleases (ZFN)
2.	Transcription activator-like effector nucleases (TALENs)
3.	Meganucleases
4.	CRISPR-Cas9
5.	Base editing
6.	Prime editing
7.	PASTE: 'Drag-and-Drop' Editing for Large Insertions

SDN 1 Vs SDN 2 Vs SDN 3

Recently, the Government has **allowed genome-edited plants without the cumbersome GMO (Genetically Modified Organisms) regulation** at the Genetic Engineering Appraisal Committee (GEAC).

About

- The government has **exempted Site Directed Nuclease (SDN) 1 and 2 genomes** from Rules 7-11 of the **Environment Protection Act**, thus allowing it to avoid a long process for approval of GM crops through the Genetic Engineering Appraisal Committee (GEAC).
- The **Institutional BioSafety Committee (IBSC)** under the Environment Protection Act would now be entrusted to certify that the genome edited crop is devoid of any foreign DNA.
- While **SDN 1 and 2** do not involve the introduction of foreign DNA, SDN3 involves the introduction of foreign DNA making it typical of GMO development.
- In **SDN-3**, the newly developed plant falls under GMO legislation only if foreign DNA exceeding 20 base pairs is inserted.

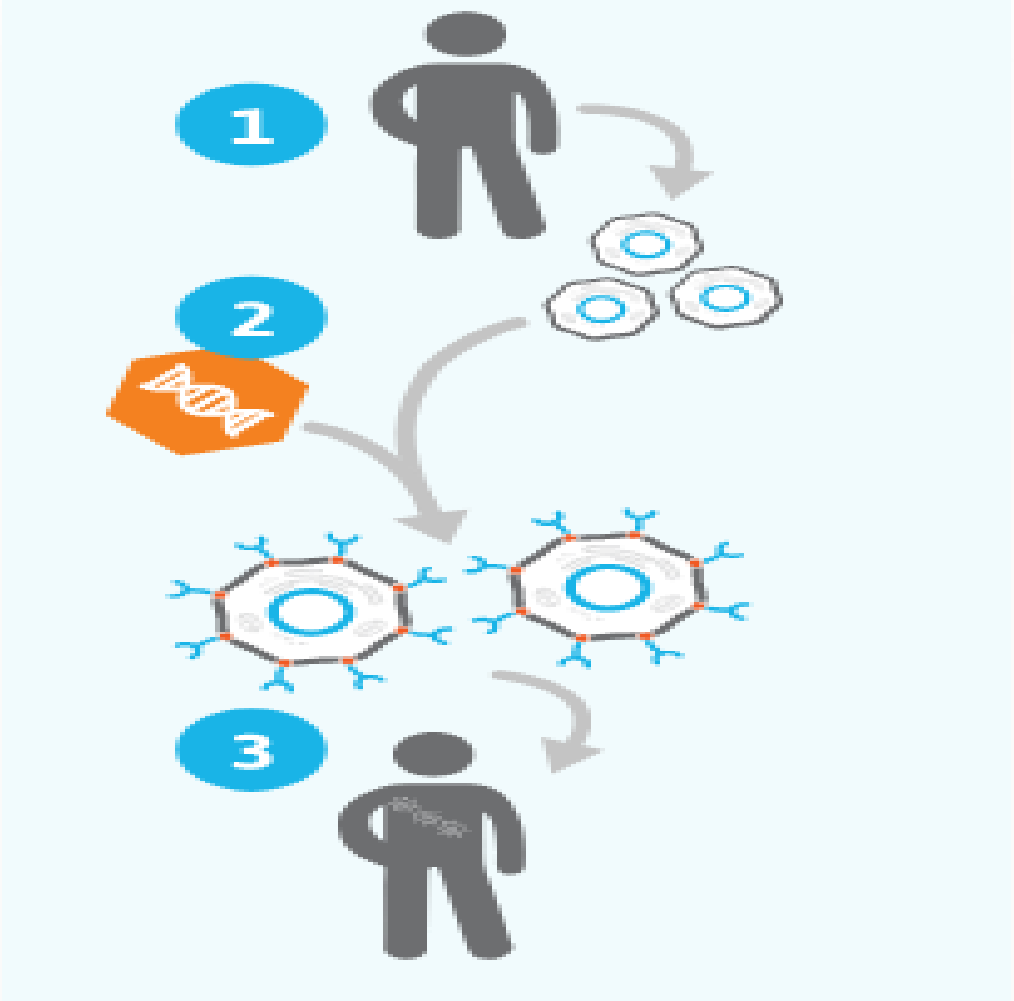
CAR-T cell therapy

- CAR-T stands for **chimeric antigen receptor** (CAR) T-cell therapy.
- It is a type of cell therapy that is **used with gene-based therapies,** but it is not a type of gene-based therapy by itself.
- CAR-T cell therapy involves changing a **person's own immune cells to recognize and fight cancer cells** inside the body.

CAR-T cell therapy

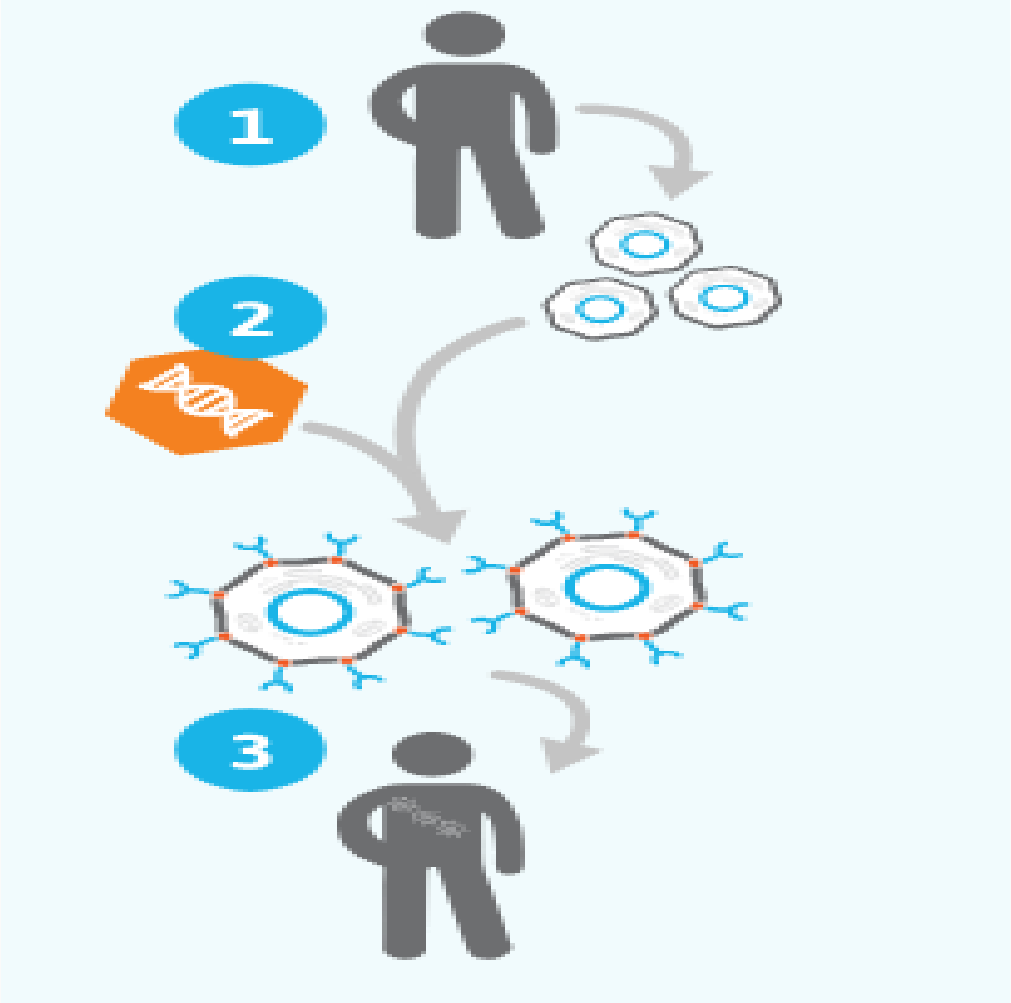
1. T cells, a type of immune cell, are taken from a person's blood.
2. Then, in the laboratory, gene replacement therapy is used to **add a new gene to T cells**.

This new gene adds a **special receptor, called a chimeric antigen receptor (CAR),** to T cells to make CAR-T cells. CAR-T cells are able to bind to and attack certain cancer cells.



CAR-T cell therapy

3.Large numbers of the CAR-T cells are made in the laboratory, and once a sufficient amount has been produced, the cells are put back into the body to fight certain cancers.

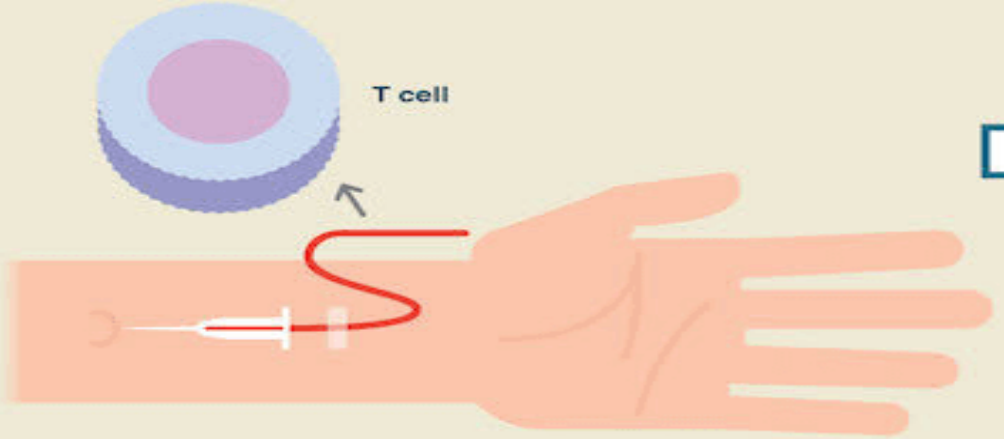


CAR-T cell therapy

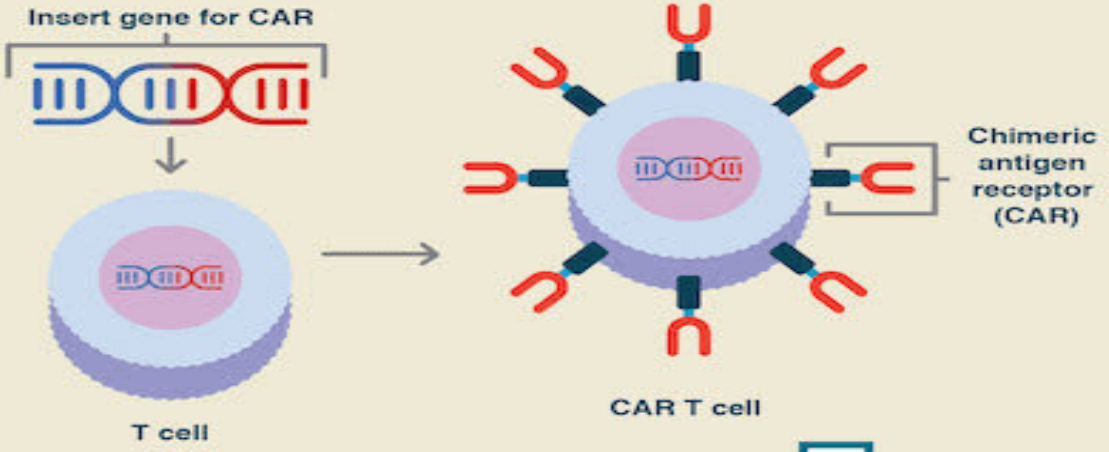
- US has recently approved the first gene therapy to fight childhood leukaemia
- It is called as CAR-T cell therapies and the **treatments** are called **Yescarta and kymriah.**

CAR T-cell Therapy

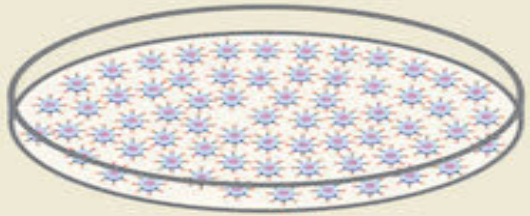
Get blood with T cells from patient



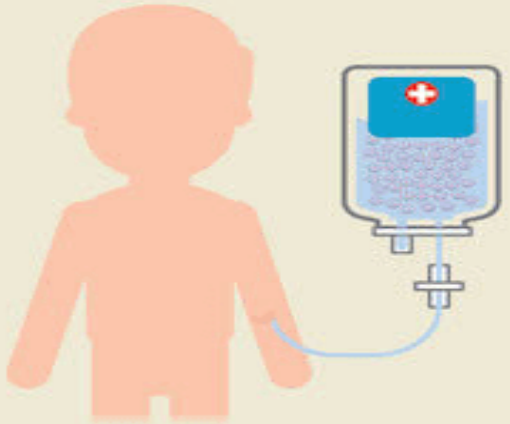
Create CAR T cells that react to cancer cells



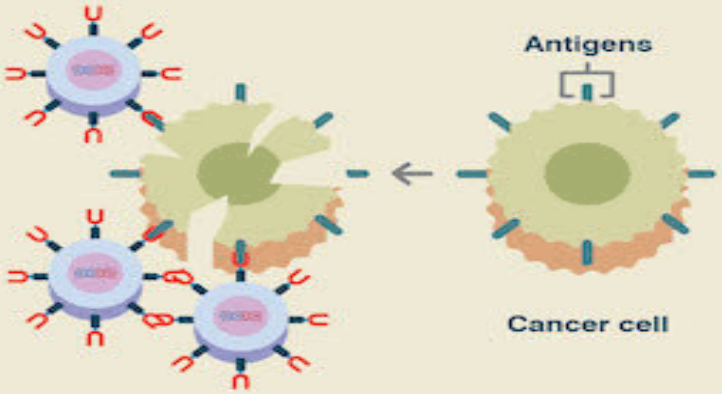
Grow many CAR T cells



Inject CAR T cells into patient



CAR T cells attack cancer cells



UTSouthwestern
Medical Center

Casgevy therapy

Context-The first therapy based on gene editing technology Crispr-Cas9 for sickle cell disease and thalassaemia has been approved in UK.

About Casgevy

- This is the first licensed therapy in the world based on the gene editing technology Crispr-Cas9 that earned its innovators a Nobel Prize in 2020.
- The therapy **edits the faulty gene that leads to these blood disorders**, potentially curing the person for life.
- So far, the only permanent treatment has been a bone marrow transplant, for which a closely matched donor is needed.

Casgevy therapy

How does the therapy work?

- Both sickle cell disease and thalassaemia are caused by errors in the gene for haemoglobin, a protein in the red blood cells that carry oxygen to organs and tissues.
- The therapy uses the patient's own blood stem cells, which are precisely edited using Crispr-Cas9. A gene called BCL11A, which is crucial for switching from foetal to adult haemoglobin, is targeted by the therapy.
- Foetal haemoglobin, which is naturally present in everyone at birth, does not carry the same abnormalities as adult haemoglobin.
- The therapy uses the body's own mechanisms to start producing more of this foetal haemoglobin, alleviating the symptoms of the two conditions.

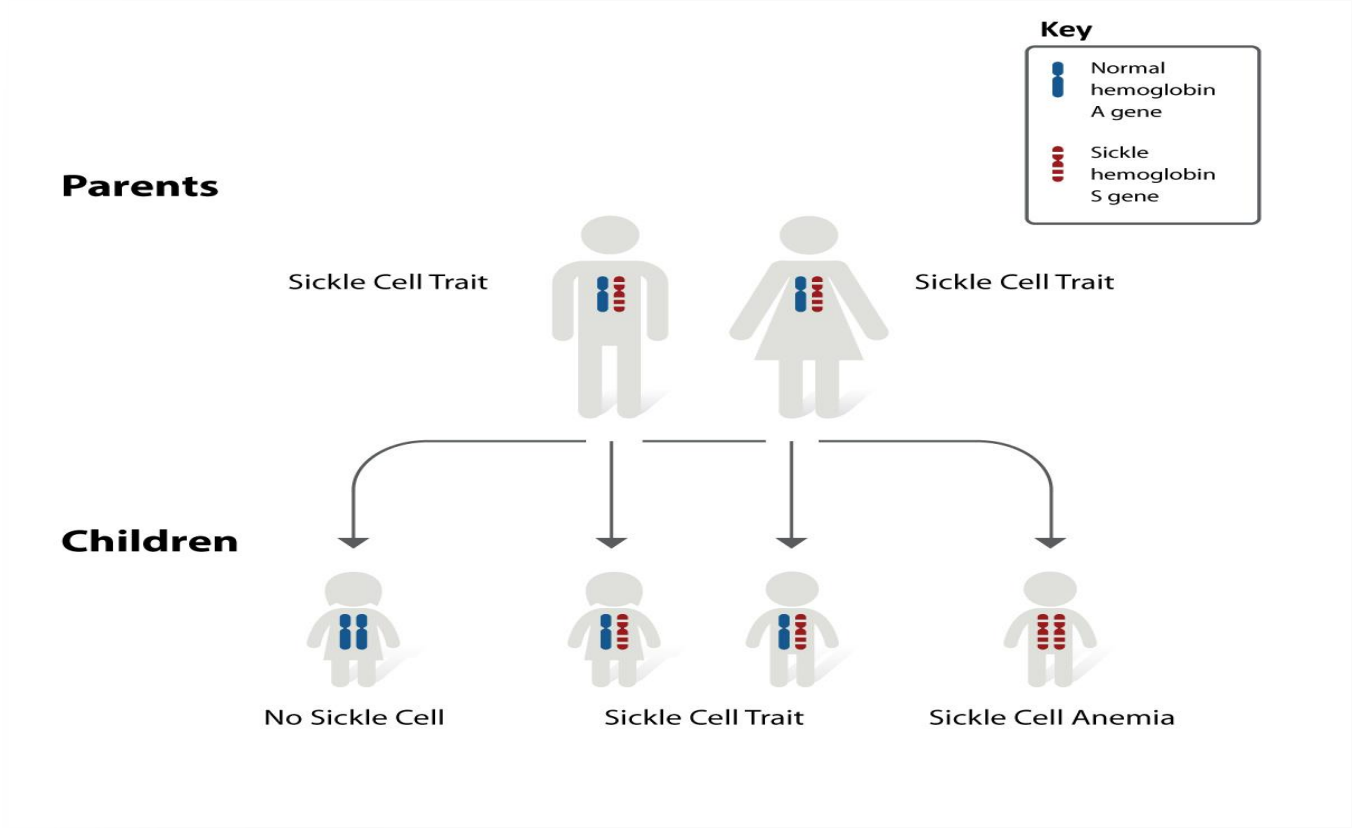
Casgevy therapy

What are sickle cell disease and thalassaemia?

- The genetic error in **sickle cell disease leads to red blood cells** assuming a crescent shape.
- Unlike the disc shaped normal cells, the **sickle-like cells cannot move around easily in the vessels, resulting in blocked blood flow**. This can lead to episodes of severe pain, life-threatening infections, anaemia, or a stroke.
- An estimated 30,000-40,000 children in India are born with the disorder every year.
- The symptoms manifest in people who inherit a pair of damaged genes from both parents.
- Those who carry only one copy of the gene from one parent can lead a normal life. This is the same as thalassaemia, in which people who inherit a pair of genes from both parents experience symptoms like severe anaemia.
- **Thalassaemia** leads to **low levels of haemoglobin**, leading to fatigue, shortness of breath, and irregular heartbeats. People with the condition need blood transfusions throughout their life. The transfusions also lead to accumulation of excess iron in the body, for which they need chelation.

Casgevy therapy

- India also has the largest number of children with thalassaemia major in the world — about 1-1.5 lakh.



Casgevy therapy

How is the therapy prepared and given?

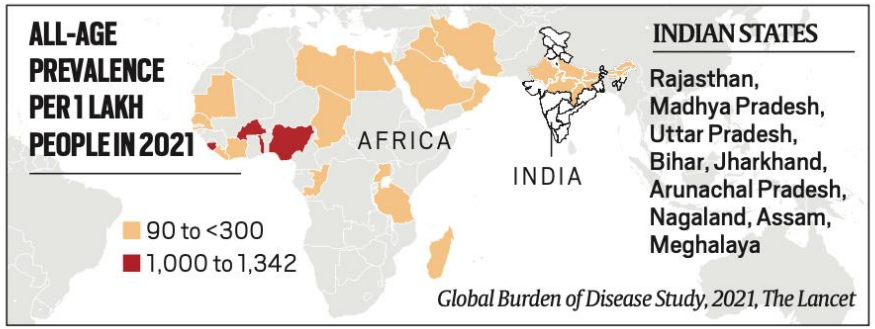
- Casgevy is a one-time treatment for which the doctor has to first collect blood stem cells from the bone marrow using a process called apheresis — used to filter out the blood for different components.
- The cells are then sent to the manufacturing site where it takes about six months for them to be edited and tested.
- Before a transplant with the edited cells, the doctor gives a conditioning medicine for a few days to clear the bone marrow of other cells that will be replaced by the modified cells.
- The patient has to stay in hospital for at least a month so that the edited cells take up residence in the bone marrow and start making red blood cells with normal haemoglobin.
- Side effects from the treatment are similar to those associated with autologous stem cell transplants, including nausea, fatigue, fever and increased risk of infection.

Casgevy therapy

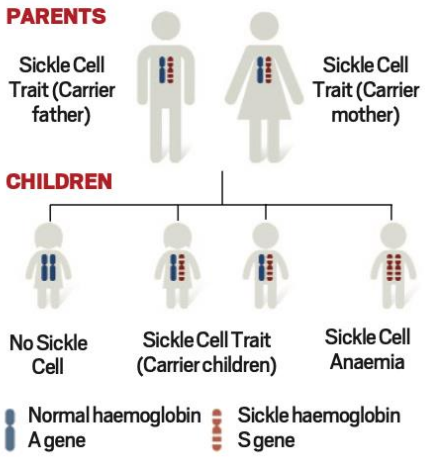
What are the challenges of this treatment?

- Although the price of the therapy hasn't been announced, it is likely to be very high. Estimates suggest it could be as much as $2 million per patient, which is in line with other gene therapies.
- Cost is one of the biggest limitations of newer gene therapies, along with the absence of local manufacturing facilities, which means that the harvested blood stem cells have to be sent across countries.
- This is extremely encouraging as this is the first Crispr-based therapy that has been approved. But the pricing will be a major challenge, especially because a high proportion of people with these conditions live in poorer countries and are unlikely to be able to afford the therapy
- However, the prices will likely come down as more and more people work on it

GLOBAL BURDEN OF SICKLE CELL DISEASE



INHERITANCE OF SICKLE CELL



ABOVE, each parent has one normal haemoglobin A gene and one haemoglobin S gene. This means each of their children has:

25% CHANCE of inheriting two normal A genes. This child will not have either sickle cell trait or sickle cell disease

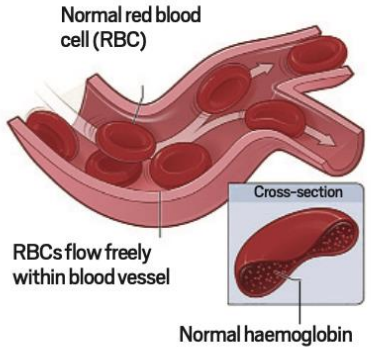
50% CHANCE of inheriting one normal A gene and one S gene. This child will have sickle cell trait, and be a carrier

25% CHANCE of inheriting two S genes. This child will have sickle cell disease

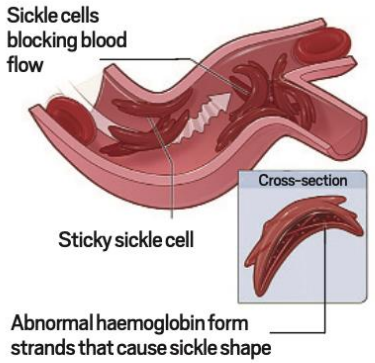
EACH TIME the couple has a child, chances of the child having sickle cell disease remain same

IMPACT ON RED BLOOD CELLS

Normal red blood cells



Abnormal, sickled, RBC (sickle cells)

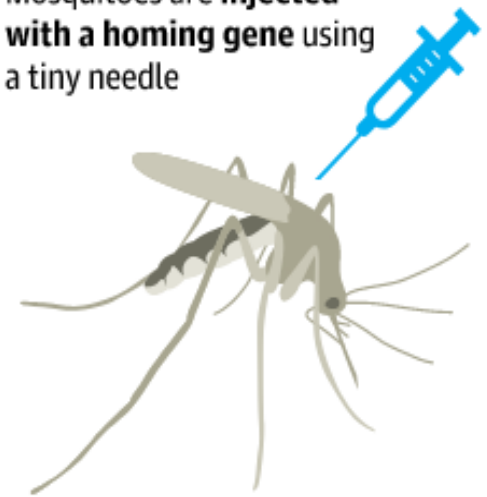


US National Institutes of Health (NIH)

GM Mosquitoes

- Aedes aegypti mosquito is the carrier of diseases such as **Zika, dengue and chikungunya.**
- Genetically modified mosquitoes involve **producing transgenic male Aedes aegypti mosquito**, which carries a **new gene fatal only to female mosquitoes**.
- After a few generations, the **female population will be drastically reduced**
- **Transgenic males do not bite** and the modified genes are said to be **harmless to humans**.

1
Mosquitoes are **injected with a homing gene** using a tiny needle



2
The gene locks on to a sequence in **the X chromosome**

3
That part of the X chromosone is **'shredded'**

4
This favours unaffected sperm-bearing Y chromosomes, meaning their **offspring become 95% male**

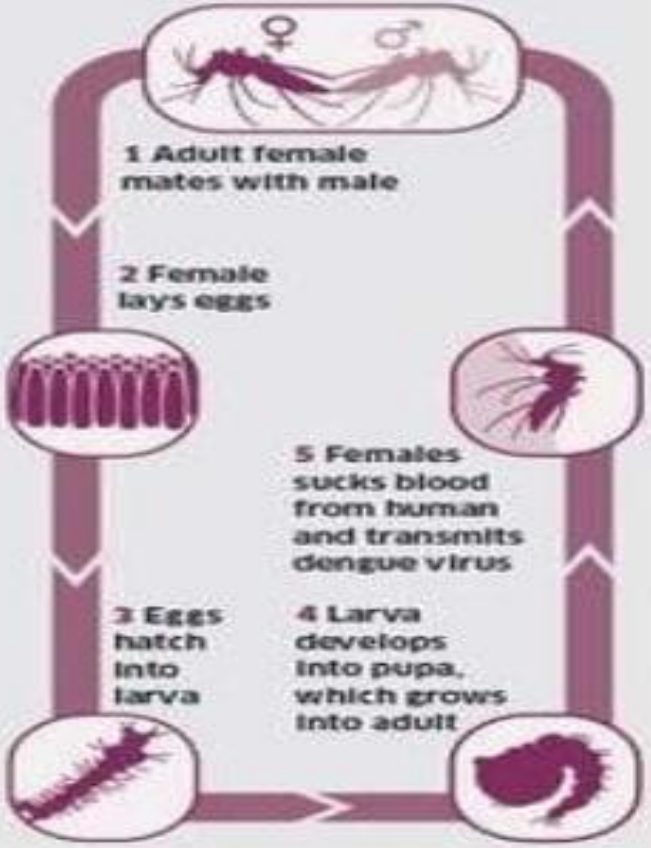
SOURCE: NATURE COMMUNICATIONS

90-3043

HOW SCIENTISTS HOPE TO TACKLE THE DISEASE

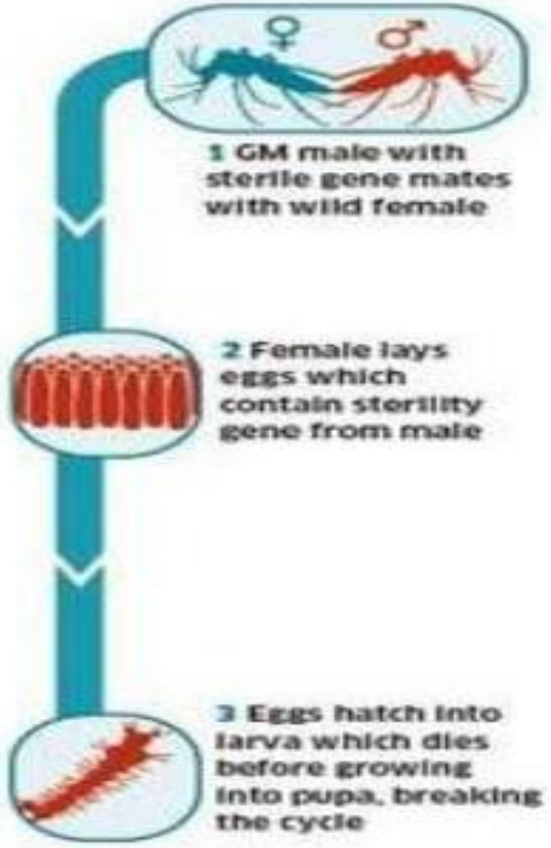
MOSQUITO LIFE-CYCLE

The normal life-cycle of the mosquito involves the production of blood-sucking females



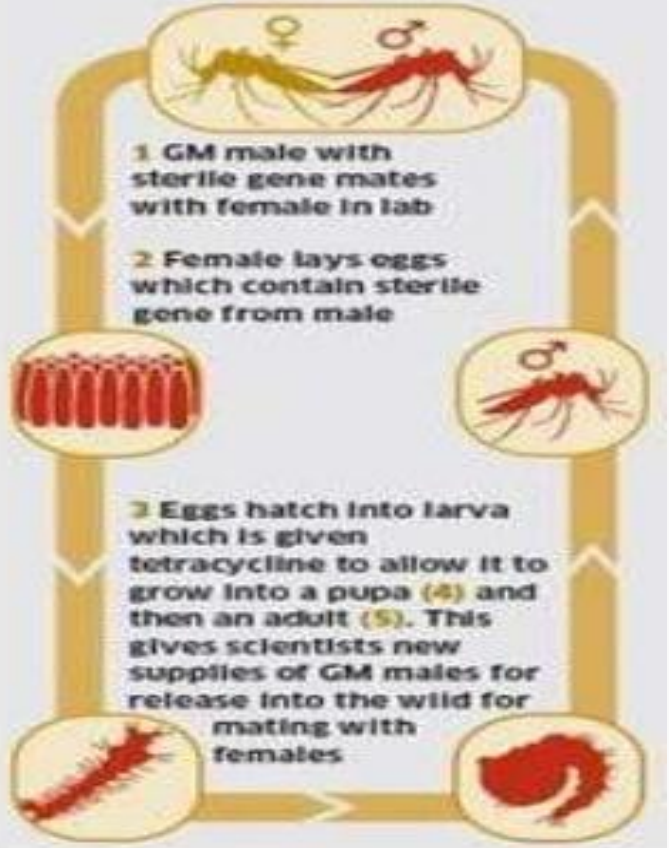
GM MALES BREAK LIFE-CYCLE

GM males contain 'sterility' gene that is passed on to offspring which die prematurely as a result



SUPPLIES OF GM MALES RENEWED

In the lab, fresh supplies of GM males are produced by adding tetracycline to allow development



COUNTRIES AT RISK OF DENGUE

GM Mosquitoes

Wolbachia Method

- Wolbachia are **extremely common bacteria** that occur naturally in **60 per cent of insect species**, including some mosquitoes, fruit flies, moths, dragonflies and butterflies
- Wolbachia are **safe for humans and the environment.**
- **Aedes aegypti** mosquitoes **don't normally carry Wolbachia,** however many other mosquitoes do.
- when **Aedes aegypti mosquitoes carry Wolbachia, the bacteria compete with viruse**s like dengue, Zika, chikungunya and yellow fever.
- This makes it **harder for viruses to reproduce inside the mosquitoes**. And the mosquitoes are much less likely to spread viruses from person to person.

GM Mosquitoes

Status of GM Mosquitoes in India

- The Department of Biotechnology (DBT) is **hesitant to permit field trials** to release GM mosquitoes to tackle certain diseases.
- The so-called —**Friendly Aedes project** launched —closed cage trials at the Oxitec facility in Maharashtra.

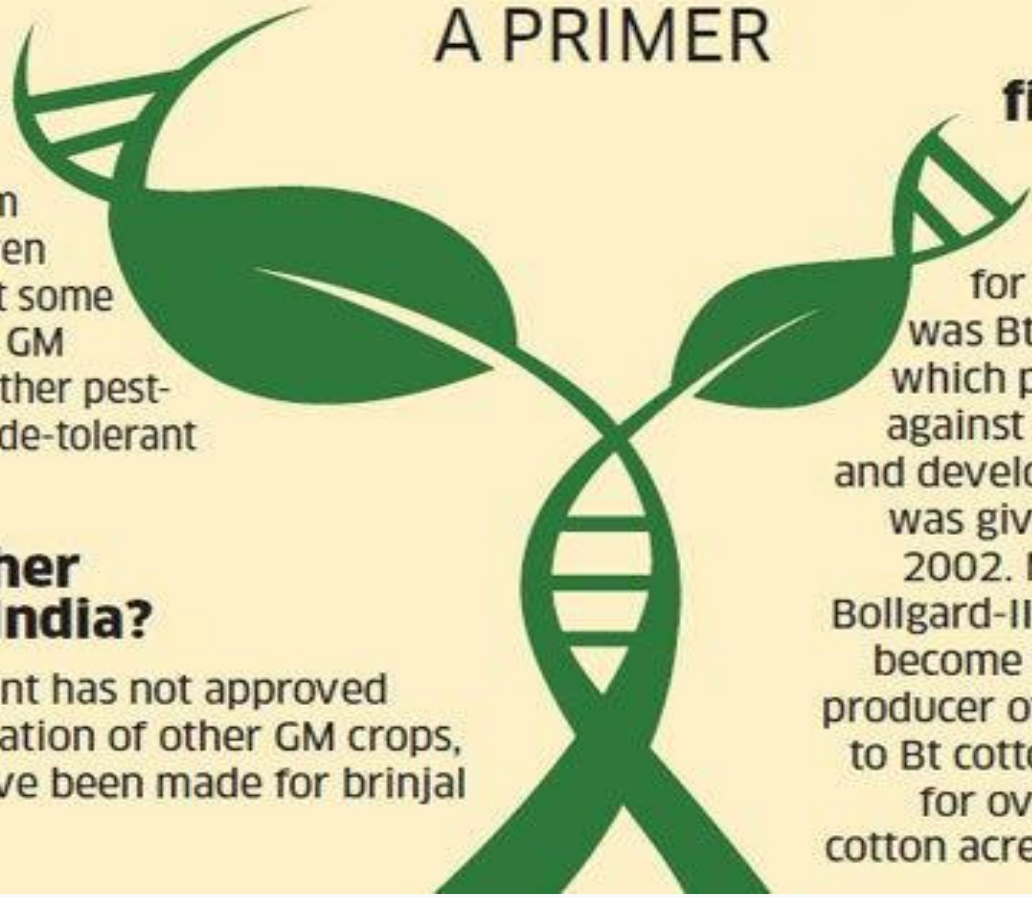
GM Mosquitoes

Reason

- It could result in **harmful consequences to the environment** or ecology.
- Aedes aegypti is part of the food chain.
- During its life cycle, it **is consumed by fishes**.
- Also, during its early aquatic phase, it is **consumed by frogs and then by birds, lizards and spiders.**
- A drastic reduction in the mosquito population could thus impact prey species

GM Crops

GM CROPS IN INDIA
A PRIMER



What is a GM crop?

A crop which has a gene artificially inserted into it from another species, even unrelated, to give it some desired properties. GM crops are mostly either pest-resistant or herbicide-tolerant

Are there other GM crops in India?

No, the government has not approved commercial cultivation of other GM crops, though efforts have been made for brinjal and mustard

When did India get its first GM crop?

The first GM crop variety approved for commercialisation was Bt cotton. Bollgard-I, which provided immunity against the pink bollworm and developed by Monsanto, was given the go ahead in 2002. Monsanto released Bollgard-II in 2006. India has become the world's largest producer of cotton partly due to Bt cotton, which accounts for over 90% of the total cotton acreage in the country

GM CROPS

- Bt cotton remains the **only GM crop allowed to be cultivated in the country**.
- Developed by **US giant Bayer-Monsanto**, it involves insertion of two genes viz **'Cry1Ac' and 'Cry2Ab'** from the **soil bacterium Bacillus thuringiensis** into cotton seeds.
- This modification codes the plant to **produce protein toxic to Heliothis bollworm (pink bollworm) thus making it resistant to their attack**.
- The commercial release of this hybrid was sanctioned by the government in 2002.

Overview
Brands
Seeds & Traits
Crop Protection
Environmental Science
Key Crops
Pest Management (non-crop)
Research and Innovation
Safety and Protection

Bayer India
India Websites
Special Interest - Bayer CropScience Ltd.

Bayer Group
Global Websites
Other Links

Social Media - India
Facebook
LinkedIn

Bollgard® & Bollgard®II

Bollgard® Bt cotton (single-gene technology) is India's first biotech crop technology approved for commercialization in India in 2002, followed by Bollgard® II – double-gene technology in mid-2006, by the Genetic Engineering Approval Committee (GEAC), the Indian regulatory body for biotech crops.

Bollgard® cotton provides in-built protection for cotton against destructive American Bollworm Heliothis Armigera infestations, and contains an insecticidal protein from a naturally occurring soil microorganism, Bacillus thuringiensis (Bt). Bollgard® II technology contains a superior double-gene technology - Cry1Ac and Cry 2Ab which provides protection against bollworms and Spodoptera caterpillar, leading to better boll retention, maximum yield, lower pesticides costs, and protection against insect resistance. Both, Bollgard® II and Bollgard® insect-protected cotton are widely planted around the world as an environmentally friendly way of controlling bollworms.

Q)3 Bollgard I and Bollgard II technologies are mentioned in the context of (2021)

a) clonal propagation of crop plants

b) developing genetically modified crop plants

c) production of plant growth substances

d) production of biofertilizers

HTBT cotton

Glyphosate herbicide → No distinction b/w weed & crop

↓

Manual - high cost

Agrobacterium tumefaciens

↓

cp4 - epsps gene

↓

cotton

↓

Herbicide resistant

HTBt cotton

Herbicide tolerant Bt (HtBt) cotton

- Addition of 'Cp4-Epsps' gene from another soil bacterium, Agrobacterium tumefaciens
- by the US giant Bayer Monsanto.
- Not cleared by GEAC

Reason

- Farmers are **not able to spray glyphosate** on normal cotton because the chemical does not distinguish between the crop and weed, but the herbicide tolerant Bt (HtBt) cotton remains unaffected by glyphosate.

HTBt cotton

Rules of Environmental Protection Act 1989

- Legally, **sale, storage, transportation and usage of unapproved GM seeds** is a punishable offence under the Rules of Environmental Protection Act 1989.

HTBt cotton

Seed Act of 1966 and the Cotton Act of 1957

- Also, sale of unapproved seeds can attract action under the **Seed Act of 1966 and the Cotton Act of 1957.**
- The **Environmental Protection Act** provides for **a jail term of five years and a fine of Rs 1 lakh for violation** of its provisions, and cases can be filed under the other two Acts.

Centre restricted the use of glyphosate

The Union **Agriculture Ministry has restricted the use of glyphosate, a widely used herbicide**.

- This comes even as the **Supreme Court on November 10 is about to take up a plea seeking a ban on all herbicide-tolerant crops,** including transgenic hybrid mustard and cotton.

What is glyphosate?

- It is a **herbicide used to kill weeds — undesirable plants** that compete with crops for nutrients, water and sunlight.
- Since **weeds basically grow at the expense of crops,** farmers remove them manually or spray herbicides.
- Glyphosate is a **broad-spectrum herbicide** that can control a wide range of weeds, whether broadleaf or grassy.

Centre restricted the use of glyphosate

- It is also **non-selective, killing most plants**.
- When applied to their leaves, **it inhibits the production of a protein '5-enolpyruvylshikimate-3-phosphate synthase (EPSPS)'.** This enzyme, produced **only by plants and microorganisms, synthesise aromatic amino acids that are necessary for their growth.**

Centre restricted the use of glyphosate

Use in India

- There are **nine glyphosate-based formulations** containing different concentrations of the chemical registered for use under the **Insecticides Act, 1968**
- These are **approved largely for weed control in tea gardens and non-crop areas** such as railway tracks or playgrounds.
- Farmers also **apply glyphosate on irrigation channels and bunds to clear these of weeds,** making it easier for water to flow and to walk through them.
- Weeds growing on bunds are, moreover, hosts for fungi, such as those causing sheath blight disease in rice.
- In general, though, the **scope for glyphosate use is limited for the very reason that it is non-selective**.

Centre restricted the use of glyphosate

- Designed to kill all plants coming into contact with it, the chemical cannot ordinarily distinguish between crop and weed. Hence, **it can be used in tea or rubber plantations, but not in fields where the crops and weeds are at almost the same level.**

What exactly has the government now done?

- The Ministry of Agriculture and Farmers Welfare, on October 21, issued a notification stating that "**the use of glyphosate involves health hazards and risk to human beings and animals**".
- It has, however, **not banned and only "restricted" its use**. The spraying of glyphosate and its derivatives shall henceforth only be permitted through "**pest control operators".**

Centre restricted the use of glyphosate

Why has this been done?

- As earlier noted, the **scope for glyphosate is already restricted in normal agricultural crops** by virtue of it being a non-selective herbicide.
- Glyphosate application has **increased only with the advent of genetic modification (GM) or transgenic technology.**
- In this case, it has **involved incorporating a 'cp4-epsps' gene**, isolated from a **soil bacterium Agrobacterium tumefaciens**, into crop plants such as cotton, maize and soyabean.
- This **alien gene codes for a protein that does not allow glyphosate to bind with the EPSPS enzyme**.
- The said GM crop can, therefore, "**tolerate**" the spraying of the herbicide, which then kills only the weeds.

Centre restricted the use of glyphosate

- In 2019 alone, **some 81.5 million hectares were planted worldwide with herbicide-tolerant (HT) GM crops**.
- The global glyphosate market is annually worth $9.3 billion, with over 45 per cent of use on account of GM crops
- As far as **India goes, the only GM crop officially under commercial cultivation today is Bt cotton**. This has **two alien genes ('cry1Ac' and 'cry2Ab') from the soil bacterium Bacillus thuringiensis**, that code for proteins toxic to the American bollworm, spotted bollworm and tobacco caterpillar insect pests.
- In the 2022 kharif planting season, about 39 million Bt cotton packets — each containing 450 gm of seeds — were sold at a notified maximum retail price of Rs 810/packet.

Centre restricted the use of glyphosate

- But industry estimates suggest sales of an additional 5 million packets of "illegal" GM cotton seeds at prices ranging from Rs 1,100 to Rs 1,350/packet.
- These seeds harbour both insect-resistance and HT traits, coming from the two Bt genes and the glyphosate-tolerant 'cp4-epsps' gene.
- **Neither the Centre nor state governments have succeeding in stopping the cultivation of illegal HT cotton.**
- The fact that their **seeds (1.5 to 2 packets are sown on every acre) are selling at a premium is proof of farmers** themselves wanting them.
- Given the high cost of manual weeding and non-availability of labour when required, they clearly see the value in spraying glyphosate and planting HT cotton.
- Having failed to curb the illegal sales of seed, the **Centre is trying to nip the problem in the bud — by cutting the access of farmers to glyphosate** and allowing its use only through pest control operators.

Centre restricted the use of glyphosate

How valid are the health concerns over glyphosate?

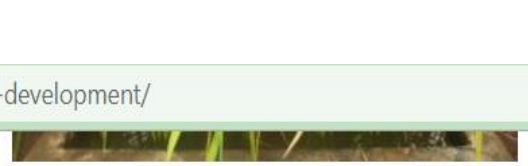
- The **World Health Organisation's International Agency for Research on Cancer (IARC),** in March 2015, classified glyphosate as "**probably carcinogenic to humans**" . But this was based on evidence for cancer in experimental animals from "**pure" glyphosate**, as opposed to that in humans from real-world exposures through **diluted formulations** (which is how the chemical is actually sold and used).
- The **US Environmental Protection Agency**, on the other hand, has held that there are "**no risks of concern to human health from current uses of glyphosate" and "no evidence**" of it causing cancer.
- The **European Chemicals Agency**, too, has concluded that "**classifying glyphosate as a carcinogenic, mutagenic** (causing DNA changes)
- For now, what's not in doubt is the demand for herbicides and crops that can withstand their application among Indian farmers.

Centre restricted the use of glyphosate

- The Union Environment Ministry's **Genetic Engineering Appraisal Committee (GEAC)**, on October 18, **recommended the commercial release of Delhi University's GM hybrid mustard.**
- This crop can **also tolerate the spraying of glufosinate ammonium, a non-selective herbicide similar to glyphosate**.
- GEAC is further **set to take a call on approving glyphosate-tolerant Bt cotton**, whose illegal cultivation is an open secret.
- All eyes are **next on the Supreme Court**, scheduled to hear a plea challenging the GEAC's nod for the transgenic hybrid mustard and also seeking a ban on all HT crops.

Bt brinjal

- Major brinjal producing states include: West Bengal (30% production share), Orissa (20%), and Gujarat and Bihar (around 10% each)
- Bt brinjal incorporates the ***cry1Ac* gene** expressing insecticidal protein to confer **resistance against (Fruit & shoot borer)FSB.**
- The *cry1Ac* gene is sourced from the soil bacterium ***Bacillus thuringiensis* (Bt)**.
- When ingested by the FSB larvae, **the Bt protein is activated in the insect's alkaline gut and binds to the gut wall**, which breaks down, allowing the Bt spores to invade the insect's body cavity. The FSB larvae die a few days later.



Insect Resistance

Mahyco's research focuses on developing insect resistance as a value added trait in crops such as rice, brinjal and okra. The products contain one or more genes – cry genes from Bacillus thuringiensis – that have proven efficacy in the management of specific target insect pests. India's first insect-resistant transgenic product Bollgard® cotton was commercialized in 2002, followed by a two gene product Bollgard II™ in 2006. Mahyco has developed products such as B rice, Bt brinjal and Bt okra which show excellent control of specific target insect pests in regulatory trials. Bt brinjal with cry1Ac gene has passed through all regulatory testing stages and is awaiting approval for commercialization. Mahyco's aim is to equip products with good insect control that will eventually boost the profitability of the farmers while minimizing pesticide use and environmental contamination.

Left – Bt brinjal after harvesting, Right – Non-Bt brinjal after harvesting

Abiotic Stress Tolerance

Rapid population and economic growth in India in the last 50 years have placed significant pressure on the country's fragil environment and water resources. India's population is expected to reach 1.4 billion by 2024. In order to feed the ever

Bt brinjal

- Bt Brinjal was developed by the **Maharashtra Hybrid Seeds Company (Mahyco).**
- Mahyco also generously **donated the Bt brinjal technology to the Tamil Nadu Agricultural University (TNAU),** Coimbatore and University of Agricultural Sciences (UAS), Dharwad.
- Mahyco also donated the technology to public research institutions in the **Philippines and Bangladesh**.

GM MUSTARD

Barstar-Barnase system

- Problem with mustard is that its **flowers contain both female and male reproductive organs**, making the plants largely self-pollinating.
- When the **egg cells of one plant cannot be easily fertilised by the pollen grains from another**, the scope for developing hybrids through crossing of parents from divergent genetic pools is restricted.
- This is where GM technology comes in. The **Barnase gene alluded to earlier, codes for a protein that impairs pollen production**. The plant into which it is incorporated, then becomes male-sterile, and capable of receiving pollen from another parent.

GM MUSTARD

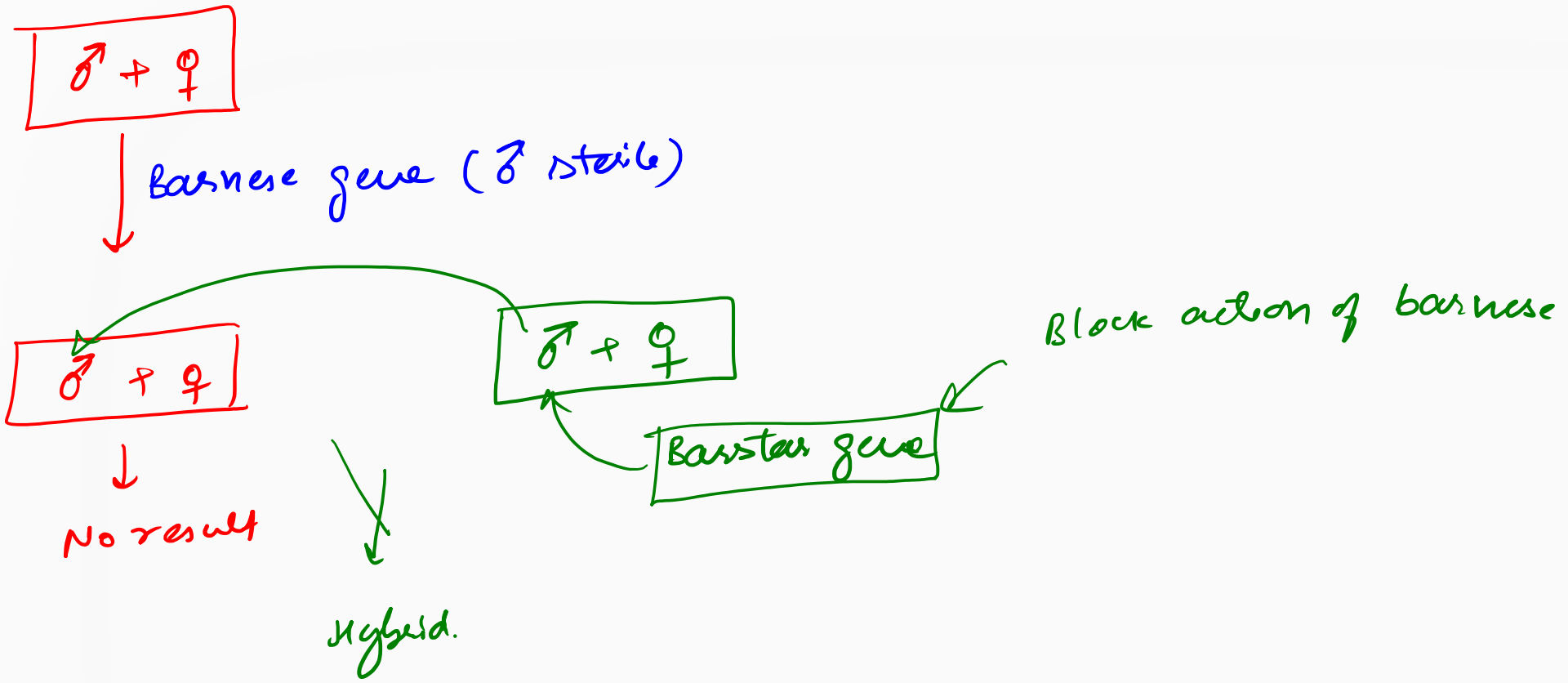
- That plant, in turn, contains the Barstar gene, which blocks the action of the Barnase gene.
- The resultant F1 progeny is both high yielding and can also produce seed/grain, thanks to the Barstar gene in the second male-fertile line.
- Using this technology, the **Delhi University scientists bred DMH-11, a GM hybrid obtained from crossing an Indian mustard variety, Varuna ('Barnase' line), with Early Heera-2 ('Barstar').**
- DMH-11 has reported a roughly 30% yield advantage over the Varuna 'check' variety in the bio-safety research level field trials carried out between 2010-11 and 2014-15.

GM Mustard

Hybrid → Issue - ♂ & ♀ same flower

↓

self pollination



GEAC

- The Genetic Engineering Appraisal Committee (GEAC) functions in the Ministry of Environment, Forest and Climate Change (MoEF&CC).
-

> Chairman- Special Secretary/Additional Secretary, Ministry of Environment, Forest and Climate Change (MoEF&CC); Co-Chairman - Representative of Department of Biotechnology.

> Members: Representative of concerned Agencies and Departments, namely, Ministry of Industrial Development, Department of Biotechnology and the Department of Atomic Energy.

GEAC

The functions of GEAC as prescribed in the Rules 1989 are as follows:

- To appraise activities involving large scale use of hazardous microorganisms and recombinants in research and industrial production from the environmental angle.
- To appraise proposals relating to release of genetically engineered organisms and products into the environment including experimental field trials.
- The committee or any persons authorized by it has powers to take punitive action under the Environment Protection Act.

Gene-edited mustard

Context-Indian scientists have developed the first ever **low-pungent mustard** that is pest and disease-resistant.

- It is based on CRISPR/Cas9 gene editing, while being **non-GM and transgene-free.**

Problem in Mustard seed

- Mustard seeds have high levels of **glucosinolates,** a group of sulphur and nitrogen-containing compounds contributing to the characteristic pungency of their oil and meal.
- While that limits the oil's acceptability among consumers – especially those preferring cooking medium having less strong flavour and odour – the problem is even more with the meal.
- Rapeseed meal is unpalatable to poultry and pigs, while having to be mixed with fodder grass and water for giving to cattle and buffaloes.
- Besides reducing their feed intake, **high glucosinolates are also known to cause goiter (swelling of neck)** and internal organ abnormalities in livestock.

Gene-edited mustard

Challenges

- The dry seeds from the normal mustard (*Brassica juncea*) cultivated in India contain **120-130 parts per million (ppm or mg/kg) of glucosinolates.** This is as against the **sub-30 ppm levels in canola seeds**.
- By **lowering the glucosinolate** content to the same dry seed weight concentration, the scientists have bred mustard lines whose oil and meal match the standard of canola-quality rapeseed (*Brassica napus*) in terms of pungency.
- However, large-scale cultivation of these canola-quality low-glucosinolate mustard lines hasn't taken place, a major reason being their **vulnerability to pests and diseases**.

Gene-edited mustard

- The same **glucosinolates that limit the palatability of the meal** and the exploitation of its true protein potential are also key arsenals of the *Brassicaceae* family crops – from mustard and canola to cabbage, cauliflower and broccoli – against invading pests, pathogens and termites.
- While the lowering of glucosinolate levels in seed is desirable for oil and meal, a concomitant reduction in the whole plant weakens its defence. The protection provided by glucosinolates to the plant should not be compromised

Gene-edited mustard

Gene Editing breakthrough

- **Glucosinolates are synthesised in the leaves and pod walls** of mustard plants. Their translocation and accumulation in the seeds happens through the action of **glucosinolate transporter or GTR** genes.
- There are 12 such genes under two distinct classes of GTR1 and GTR2 with six copies each.
- What the researchers have done is to "**edit" 10 out of the 12 GTR** genes in 'Varuna', a high-yielding Indian mustard variety.
- For this, they **used CRISPR/Cas9 – a gene-editing tool** deploying an enzyme, which acts as a "molecular scissors" to cut the DNA at precise targeted locations of the gene, and then letting the natural DNA repair process to take over.
- By doing this, their **encoded proteins, responsible for transport of the glucosinolates to the seeds**, were rendered non-functional

Gene-edited mustard

- The **seeds of the resultant targeted genes-edited Varuna mustard variety had glucosinolate content well below the 30 ppm canola-quality** threshold.
- At the same time, the **other plant parts, especially the leaves and pod walls enclosing the seeds, had significantly higher glucosinolate** accumulation.
- The GTR-edited low-seed **high-leaf glucosinolate** lines were tested for resistance against the virulent fungal pathogen *Sclerotinia sclerotiorum* and the insect pest *Spodoptera litura*.
- The edited lines **displayed defence response** against these at par with or better than that of the wild-type mustard.
- The higher glucosinolate concentration in the leaves and pod walls, due to their impaired transport to the seeds, clearly had a role

Gene-edited mustard

Genome Editing and Genetic Modification

- The new **GTR genes-edited mustard lines** are transgene-free or **non-genetically modified** (GM).
- They **contain no foreign genes** like those of the *Bacillus thuringiensis* bacteria in cotton or Bar-Barnase-Barstar (isolated from other soil bacteria) in the GM hybrid mustard (DMH-11**)**
- The low-seed high-leaf glucosinolate mustard lines are genome edited or GE, as opposed to GM or transgenic plants.
- While the Cas9 enzyme, derived from the *Streptococcus pyogenes* bacteria, was used to cut the DNA of the targeted genes in the first-generation plants, this protein is segregated out in the subsequent generations. The final GE lines **contain no Cas9 protein and are transgene-free.**

Gene-edited mustard

- **GM crops** are currently subjected to stringent "**environmental release" regulations** in India, not just for commercial cultivation but even field trials and seed production.
- Such release is contingent upon clearance from a special **Genetic Engineering Appraisal Committee (GEAC)** under the Ministry of Environment, Forest and Climate Change (MoEFCC). The GEAC's green signal is itself not binding on the Union Government, which gives the final nod.
- On March 30, 2022, an office memorandum from the MoEFCC **exempted GE plants "free of exogenous introduced DNA" from the requirement of GEAC approval** for open field trials leading to commercial release.
- Such clearance is now necessary **only at the level of an Institutional Bio-safety Committee (IBSC),** comprising scientists from the institutions engaged in the GE crop development and from the DBT.

Gene-edited mustard

Significance

- India is a **huge importer of edible oils**. These imports were valued at $20.84 billion (Rs 167,270 crore) during the fiscal year ended March 2023, while meeting over 60% of the country's consumption requirement.
- Given the massive foreign exchange outgo on account of imports, there is a dire need to **boost domestic oilseeds production** through focused breeding for improving crop yields, pest and disease resistance, and product quality.
- Mustard and soyabean are India's most widely-cultivated oilseed crops, planted annually on 9 million and 12.5 million hectares area respectively. Its higher average oil extractable content (38% versus 18% for soyabean) makes mustard the bigger "oilseed" crop, while a source of both fat for humans and protein for animals.

Gene-edited mustard

- GM hybrid mustard and the new GE low-seed high-leaf glucosinolate lines are major plant breeding advancements – from Indian scientists – that can go some way towards **bringing down the dependence on imported vegetable oils.**

Sleepy Classes IAS
Awakening Toppers

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Genome sequencing

Researchers at the **Indian Institute of Science Education and Research (IISER) Bhopal** have carried out whole genome sequencing of **banyan (*Ficus benghalensis*) and peepal (*Ficus religiosa*)** from leaf tissue samples.

Key Findings

- The work helped in i**dentifying 17 genes in the case of banyan and 19 genes of peepal** with **multiple signs of adaptive evolution (MSA)** that play a pivotal role in long-time survival of these two *Ficus* species.
- The genes with multiple signs of adaptive evolution came about in response to **population bottleneck** faced by both trees around 0.8 million years ago.

Genome sequencing

- Genes showing multiple signs of adaptive evolution in **banyan were** mainly associated with **root development, leaf formation, metabolism, pollen tube and seed development** and other developmental processes.
- The MSA genes of **peepal trees** were mainly associated with **root development, reproduction, metabolism.**
- In the case of **banyan tree**, 15 of 17 MSA genes were also associated with **tolerance against environmental stress —** drought, oxidative stress, and pathogens.
- In **peepal trees**, 17 out of 19 MSA genes were associated with stress tolerance activities.
- In addition, the researchers identified seven genes involved in two pathways that produce **volatile organic compounds in floral scents which attract wasps for pollination.**

Genome sequencing

- **Both plants** show genes with signatures of multiple adaptive evolution involved in **phytohormone signalling pathways**. These pathways function to **regulate plant developmental senescence and ageing processes**. This could be one more reason why **banyan and peepal trees have a long lifespan.** Both banyan and peepal trees have select plant disease resistance gene families that have been expanded through gene duplication events in the course of evolution which confers greater longevity.

Why banyan, peepal trees live long

Genes with multiple signs of adaptive evolution arose in response to population bottleneck faced around 0.8 million years ago

- Genes showing multiple signs of adaptive (MSA) evolution in banyan tree were mainly associated with root development, leaf formation, metabolism, and reproduction
- Genes with multiple adaptive evolution in peepal were mainly associated with root development, reproduction, metabolism
- Disease resistance gene families showed gene expansion as well as high gene expression in these two trees
- For banyan, 15 of 17 MSA genes were also associated with tolerance against environmental stress
- In peepal trees, 17 out of 19 MSA genes were associated with stress tolerance activities

Sequencing: Whole genome sequencing was carried out from leaf tissue samples

- The adaptive evolution in genes in two cellular mechanisms explains the well-developed aerial roots of banyan trees, which protect them from environmental challenges
- Both plants show genes with signatures of multiple adaptive evolution involved in phytohormone signalling pathways that regulate plant developmental senescence and ageing

Genome sequencing

Genome

- It refers to all of the genetic material in an organism, and the human genome is mostly the same in all people, but a very small part of the DNA does vary between one individual and another.
- Every organism's genetic code is contained in its DNA, the building blocks of life.

Genome sequencing

- Genome sequencing is a state-of-art, robust and high throughput technique to sequence the entire genome of an organism. It enables scientists to study the entire genetic composition of an organism.

Gene vs genome sequencing:

Gene sequencing	Genome sequencing
Sequence a gene of only some thousand base pairs.	Sequence the entire genome of an organism.
Provides information of a protein-coding gene and related alterations.	Provides information regarding different genes, non-coding regions, introns, exons, transposons and other genomic components.
Technically a more straightforward process includes DNA extraction, amplification, sequencing and reading.	Technically more complex processes including DNA extraction, amplification, library preparation, adapter ligation, sequencing, conting and reading.
Handy and cost-effective process.	Complex, costly, laborious and tedious process.

Bio-computers

Scientists at **Johns Hopkins University (JHU**) recently outlined a plan for a potentially revolutionary new area of research called "**organoid intelligence", which aims to create "biocomputers"**

- In a quest to develop systems that are more relevant to humans, scientists are building 3D cultures of brain tissue in the lab, also called **brain organoids**. These "mini-brains" (with a size of up to 4 mm) are built using human **stem cells** and capture many structural and functional features of a developing human brain. Researchers are now using them to study human brain development and test drugs to see how they respond.
- However, the **human brain also requires various sensory inputs** (touch, smell, vision, etc.) to develop into the complex organ it is, and brain organoids developed in the lab aren't sophisticated enough. The **organoids currently also don't have blood circulation**, which limits how they can grow.

Bio-computers

What is the new 'bio-computer'?

- The JHU researchers' scheme will **combine brain organoids with modern computing methods to create "bio-computers"**. They have announced plans to couple the **organoids with machine learning by growing the organoids inside flexible structures** affixed with multiple electrodes (similar to the ones used to take EEG readings from the brain).
- These structures will be able to record the firing patterns of the neurons and also **deliver electrical stimuli, to mimic sensory stimuli**. The response pattern of the neurons and their effect on human behaviour or biology will then be analysed by machine-learning techniques.
- Recently, scientists were able to grow human neurons on top of a microelectrode array that could both record and stimulate these neurons. Using positive or negative electric feedback from the sensors, they were able to train the neurons to generate a pattern of electrical activity that would be generated if the neurons were playing table tennis.

Bio-computers

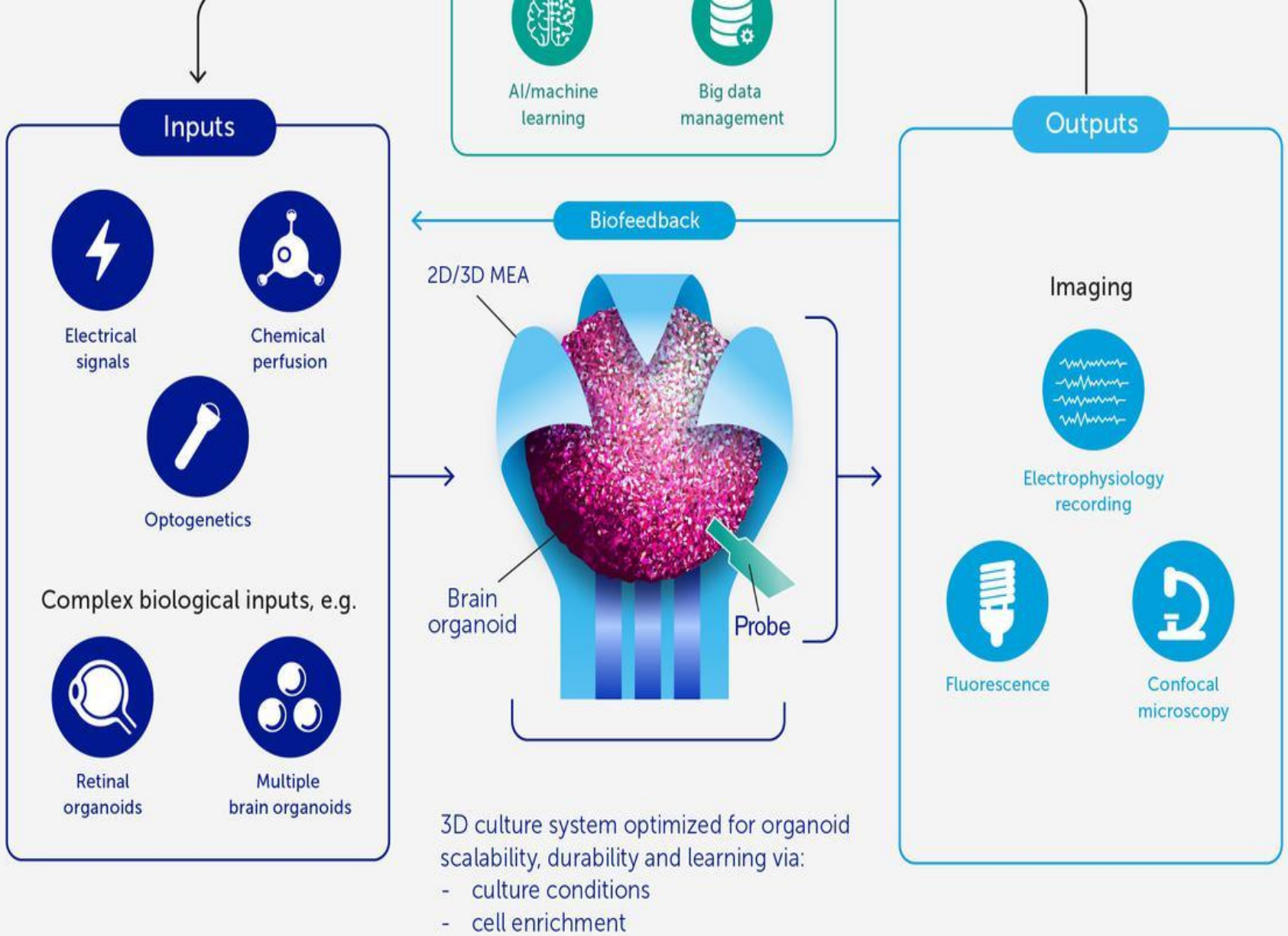
What are the opportunities for 'bio-computers'?

- While human brains are slower than computers at, say, simple arithmetic, they outshine machines at **processing complex information.**
- Brain organoids can also be developed using stem cells from **individuals with neurodegenerative diseases or cognitive disorders**. Comparing the data on brain structure, connections, and signalling between 'healthy' and 'patient-derived' organoids can reveal the biological basis of human cognition, learning, and memory.
- They could also help decode the pathology of and drug development for devastating neurodevelopmental and degenerative diseases such as Parkinson's disease and microcephaly.

Bio-computers

Are 'bio-computers' ready for commercial use?

- Currently, **brain organoids have a diameter of less than 1 mm and have fewer than 100,000 cells** (both on average), which make it roughly three-millionth the size of an actual human brain. So **scaling up the brain organoid is key to improving** its computing capacity – as will incorporating non-neuronal cells involved in biological learning.
- Second, researchers will also **have to develop microfluidic systems to transport oxygen and nutrients**, and remove waste products.



Genome India Project

The Genome India Project, a Centre-backed initiative to **sequence 10,000 Indian human genomes** and create a database, **by year-end**

- The Department of Biotechnology, Ministry of Science and Technology has sequenced close to **7,000 genomes and 3,000 of these are already available for public access.**

Genome india project

- Taking inspiration from the **Human Genome Project**, the Department of Biotechnology (DBT) initiated the ambitious "**Genome India Project" (GIP) on 3rd January 2020**.
- The GIP aims to **collect 10,000 genetic samples from citizens** across India, to build a reference genome. This is no mean feat, given that the genome contains all the genetic matter in an organism, i.e., the complete set of DNAs.
- Countries including the **United Kingdom, China, and the United States** have launched similar programmes to sequence at least 1,00,000 of their population's genomes.

Genome India Project

What is the significance of the Genome India project?

- India's 1.3 billion-strong population consists of over **4,600 population groups**, many of which are endogamous.
- Thus, **the Indian population harbours distinct variations**, with disease-causing mutations often amplified within some of these groups.
- Findings from **population-based or disease-based human genetics researc**h from other populations of the world cannot be extrapolated to Indians, . But despite being a large population with diverse ethnic groups, **India lacks a comprehensive catalogue of genetic variations**.
- Creating a database of Indian genomes **allows researchers to learn about genetic variants unique to India's population** groups and use that to customise drugs and therapies.

Genome India Project

- The Centre's Department of Biotechnology notes that the project will help "**unravel the genetic underpinnings of chronic diseases currently on the rise in India, (for) example, diabetes, hypertension, cardiovascular diseases, neurodegenerative disorders, and cancer**".

Genome India Project

Human genome project

- **In 1990**, a group of scientists began to work on determining the whole sequence of the human genome under the Human Genome Project.
- The Human Genome Project is an **international research project** with the primary goal of deciphering the chemical **sequence of the entire human genetic material** (i.e., the entire genome).
- It identifies **all 50,000 to 100,000 genes contained within the genome and provides research tools** to analyse all of this genetic information
- The **first results** of the complete human genome sequence were given in **2003 by sequencing the entire human genome of 3.3 billion base pairs**.
- However, some percentage of repetitive parts were yet to be sequenced. The Human Genome Project released the **latest version of the complete human genome in 2023, with a 0.3% error margin**.

Genome India Project

Genome

- The genome is the entire set of **DNA instructions found in a cell**. In humans, the genome consists of 23 pairs of chromosomes located in the cell's nucleus, as well as a small chromosome in the cell's mitochondria. A genome contains all the information needed for an individual to develop and function.

What is genome sequencing?

- The human genome is the entire set of deoxyribonucleic acid (DNA)residing in the nucleus of every cell of each human body.
- It carries the complete genetic information responsible for the development and functioning of the organism.
- The DNA consists of a double-stranded molecule built up by four bases – **adenine (A), cytosine (C), guanine (G) and thymine (T).**

Genome India Project

- Every base on one strand pairs with a complementary base on the other strand (A with T and C with G) In all, the **genome is made up of approximately 3.05 billion such base pairs. .**
- While the sequence or order of base pairs **is identical in all humans,** compared to that of a mouse or another species, there are **differences in the genome of every human being that makes them unique**.
- The process of deciphering the order of base pairs, to decode the genetic fingerprint of a human is called genome sequencing.

Test tube rhinos

Context-Recently scientists announced the first-ever rhino pregnancy achieved by transferring a lab-made rhino embryo into a surrogate mother.

- It took 13 attempts for the breakthrough with a southern white rhino, a closely-related subspecies that branched away from the northern whites about a million years ago.
- The **death of the last male in 2018 made the extinction of the northern white rhino an inevitability.** But already in 2015, a group of 20 scientists from five continents had launched an audacious and expensive project to rebuild the subspecies through in vitro fertilisation (IVF).

Test tube rhinos

Why Surrogacy

- In 2009, four northern white rhinos were brought from a zoo in the Czech Republic to a conservancy in Kenya in the hope that they might breed in their natural environment.
- The **two males — Suni and Sudan — have died since, and the two females — Najin and her daughter Fatu** — turned out to be incapable of reproduction for pathological reasons.
- This meant surrogacy_ was the only option to produce a northern white calf through IVF.

Test tube rhinos

Challenges

Difficult process

- The first step is to isolate her and put a protocol in place to guard against bacterial infections. The real challenge, though, is to spot when the animal is in oestrus — the fertile window for implanting the embryo.
- This requires the services of a 'teaser' — a scrubbed and sterilised rhino bull to check when the designated surrogate mother gets interested.
- Mating also triggers an array of **hormonal reactions** that primes the female for the embryo implant

Test tube rhinos

Issue of genetic viability

- In this case, since the embryos are all from eggs harvested from two females and sperm taken from a few deceased zoo males, **even multiple successes with IVF and surrogacy cannot build a gene pool large enough for a viable northern white population**.
- One solution is to broaden the breeding pool by **creating sperm and eggs from stem cells** extracted from preserved tissue samples stored in zoos. The science has worked in lab mice, but it **may not be easily replicable in rhinos.**
- But even favourable outcomes from experiments with stem cell techniques cannot stretch the northern white rhino gene pool beyond 12 animals
- **Crossbreeding the northern and southern subspecies is not a solution** since this will result in the loss of certain unique attributes, such as hairier ears and feet, that make the northern white better adapted for swampy habitats.

World's first nano liquid urea

Indian Farmers Fertiliser Cooperative Limited (IFFCO) recently launched the Nano Urea Liquid

- Indigenously developed at Nano Biotechnology Research Centre, Kalol, Gujrat

Indian Farmers Fertiliser Cooperative Limited (1967)

- **Cooperative societies** which is **wholly owned by Indian Cooperatives**.
- To enable Indian farmers to prosper through timely supply of reliable, high quality agricultural inputs and services in an environmentally sustainable manner

Nano Urea Liquid-a nutrient to provide nitrogen to plants as an alternative to the conventional urea		
Advantages	Requirement	curtail the requirement of conventional urea by at least 50%
	Impact	Nano Urea liquid (40,000 ppm of nitrogen in a 500 ml bottle)= 1 bag of Conventional urea
	Price	10% cheaper than conventional Urea
	Effectiveness (delivering nitrogen to plants)	conventional Urea-30-40% Nano Urea liquid >80%
	Yield	8% increase (Tested on wheat & rice)

#IFFCONanoUrea

IFFCO
पूर्णतः सहकारी स्वामित्व
Wholly owned by Cooperatives

Sleepy Classes IAS
Awakening Toppers

IFFCO NANO UREA LIQUID

IFFCO NANO TECHNOLOGY
NANO UREA

Introducing World's First Nano Urea for Farmers

Reduces Input Cost

Increases Farmers' Income

Environment-friendly

Enhances Crop Productivity

Improves Nutritional Value

Cheaper than Conventional Urea

Nano liquid urea Efficacy

Context-A two-year field experiment on the efficacy of nano urea by scientists from Punjab Agricultural University (PAU) has found a substantial **decrease in rice and wheat yields when compared to conventional nitrogen (N) fertiliser application.**

- The study was done in 2020-21 and 2021-22 by Rajeev Sikka, senior soil chemist and Anu Kalia, assistant professor, nanoscience, at PAU.

Background

- Nano liquid urea was launched in June 2021 by the **Indian Farmers and Fertiliser Cooperative (IFFCO),** which claimed a **500-millilitre spray bottle of nano urea** can **substitute a full 45-kilogramme bag of the conventional fertiliser**. The central government has heavily promoted the fertiliser since its development.

Nano liquid urea Efficacy

Key Highlights

- There was a **21.6 per cent decrease in wheat yield** and a **13 per cent decrease in rice** yields with the use of nano urea, the researchers found.
- A **decline in grain nitrogen content**, which is essential for protein production, was also observed.
- Along with the decrease in yield, there was also a **17 and 11.5 per cent decrease in grain N content of rice and wheat,** respectively, with the combined application of nano urea and N to to soil.
- A decrease in grain N content **reflected a lowered protein content**. This, the scientists say is **worrisome for India** where these two cereals form the staple food source for protein and carbohydrates and low protein content will deplete the protein energy requirements of the population.
- Therefore, even if 100 per cent use efficiency is achieved by this nano formulation, the requisite nitrogen nutrient could not be provided to the growing crop compared to nitrogen provided by 45 kg of conventional urea

Nano liquid urea Efficacy

- Moreover, the **cost of nano urea formulation was 10 times higher** than that of granular urea and will add to the cost of cultivation for farmers.
- In terms of yield, the scientists also pointed out that the **magnitude of its reduction increased in the second year**, indicating that the **decrease in yield can be sequential,** meaning the production may lower year after year if the application of nano urea is continued.
- The soil pool of nitrogen is limited and is diminishing, so year after year, **if you follow foliar spray with nano urea and do not replenish the soil with nitrogen**, the reduction would be sequential,

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Nano DAP

Sleepy Classes IAS
Awakening Toppers

Context-Finance Minister recently announced the expansion of the application of Nano DAP on various crops in all agro climatic zones.

- After the successful adoption of Nano Urea, application of Nano DAP, on various crops, will be expanded in all agro-climatic zones

DAP, or di-ammonium phosphate

- It is the **second most commonly used fertiliser** in India after urea.
- It is **high in phosphorus (P)** that stimulates root establishment and development — without which plants cannot grow to their normal size, or will take too long to mature.
- It is thus applied just before, or at the time of sowing.

Nano DAP

DAP vs Nano DAP

- Indian Farmers Fertiliser Cooperative's (IFFCO's) Nano DAP, **containing 8% Nitrogen and 16% Phosphorus** by volume.
- Unlike **conventional DAP,** which comes in granular form, IFFCO's Nano DAP is in liquid form.
- IFFCO's website says that this formulation has advantage in terms of **surface area to volume**, as its particle size is less than 100 Nanometre (nm)
- This tiny particle size makes Nano DAP more efficient than its conventional counterpart, enabling the fertiliser to enter easily inside the seed surface or through stomata and other plant openings.
- **Better assimilation of the fertiliser inside the plant system** in turn leads to higher seed vigour, more chlorophyll, photosynthetic efficiency, better quality and increase in crop yields

Nano DAP

Benefits of Nano DAP

In addition to being more efficient than conventional DAP, Nano DAP has a few other benefits.

- **First**, it is more pocket-friendly than its conventional counterpart. A **500 ml bottle of Nano DAP, equivalent to a 50-kg bag** of conventional DAP, is priced at only Rs 600 (compared to Rs 1,350 for the bag).
- Since the government provides significant subsidies on DAP, the adoption of a more inexpensive fertiliser will likely be a significant relief to the government's subsidy burden.
- **Second**, for farmers, Nano DAP is also significantly more convenient. Simply put, **500 ml bottles are easier to transport, store, and use than 50kg bags.**
- The fertiliser is sprayed on crops, with a 250-500 ml of DAP, dissolved in water, required per spray, per acre.

Nano DAP

- **Third**, India currently **imports significant quantities of fertiliser** to meet domestic demand. The adoption of domestically-produced Nano DAP — produced in Kalol, Gujarat — is set to significantly reduce this import burden.
- **Fourth**, This revolutionary step will not only take Indian agriculture forward in foodgrain production but it will also **make India self-reliant in fertiliser production**
- **Fifth**, adoption of Nano DAP will help in achieving **self-sufficiency in fertilisers** and greatly benefit our farmers

Ethereum Merge

- Ethereum, the world's second most valuable cryptocurrency, has **completed a significant software overhaul** which promises to ramp up security of the cryptocurrency while claiming **to cut down on its carbon footprint, nearly entirely.**

The Merge

- The revamp, known as 'The Merge,' will cast aside the need for crypto miners and gigantic mining farms, who had **previously driven the blockchain under a mechanism called 'proof-of-work' (PoW). Instead, it has now shifted to a 'proof-of-stake' (PoS) mechanism** that assigns 'validators' randomly to approve transactions and earn a small reward.
- The move to PoS will **reduce ethereum's energy consumption** by nearly 99.95 per cent, according to the Ethereum Foundation, a non-profit organisation dedicated to supporting the cryptocurrency and its related technologies.

Ethereum Merge

What has exactly changed?

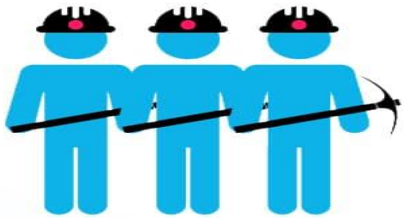
- Ethereum is a **decentralised cryptocurrency**, meaning that it does not have institutions like banks approving the transactions that happen on its network – the approvals were **earlier happening under the PoW consensus mechanism** which was essentially done by miners.
- **Miners** would **compete to solve complex mathematical puzzles** using a massive infrastructure of cutting edge computer hardware, and the first one to solve the puzzle would be chosen as the **validator**.
- This method was almost entirely dependent on crypto farms, which are massive warehouses lined with rows of computers which would solve the puzzles.
- There was, however, **one big problem** – these mining farms were **energy guzzlers**, leading to one of the biggest criticisms of the crypto industry that they sometimes consumed more electricity than entire countries, and were therefore a **big concern in terms of environmental sustainability.**

Blockgeeks

Proof of Work vs. Proof of Stake

To add each block to the chain, miners must compete to solve a difficult puzzle using their computers processing power.

In order to add a malicious block, you'd have to have a computer more powerful than 51% of the network.



The first miner to solve the puzzle is given a reward for their work.

There is no competition as the block creator is chosen by an algorithm based on the user's stake.

In order to add a malicious block, you'd have to own 51% of all the cryptocurrency on the network.

There is no reward for making a block, so the block creator takes a transaction fee.

Ethereum Merge

- Enter 'The Merge' and the **shift to the PoS consensus mechanism**. Ethereum is still a decentralised platform, but under the new concept, it would **not need miners and mining farms to authenticate transactions anymore.**
- Instead, a validator will be **randomly assigned using an algorithm** from a **pool of people who 'stake' their coins,** which essentially means **pledging at least 32 Ethereum tokens on the network**. This would entirely eliminate the need for miners on the Ethereum network.

Ethereum Merge

Why is the 'Merge' important?

- The Merge dramatically **increases the security of Ethereum**. An attacker needs **51% of the blockchain's value to [take control]**.
- With **Proof of Work, you need on the order of $5 billion**, which allows you to buy enough computers and transformers, connect all of them to the grid, and then carry out an attack.
- With **Proof of Stake, we will have about $20 billion** in economic security today – and this is a number I expect will grow dramatically."
- Apart from that, it is also being seen as an **environmentally conscious** move as Ethereum is expected to now consume 99 per cent or so less energy.
- Given that some of the most popular applications of cryptocurrencies such as **non-fungible tokens (NFTs)** and **decentralised finance** (DeFi) are based on the Ethereum network, the overhaul could have far-reaching consequences in the future.

What's next for Ethereum?	
Surge	• This refers to the addition of Ethereum sharding, which promises to process transactions on the network much faster than now. • Sharding basically means **dividing transactions across several different chains** in a way that will decrease fees and speed up transactions. "By the end, ethereum will be able to process **100,000 transactions per second**
Verge	• Called "Verkle trees" and "stateless clients," which will allow **users on the network to become validators without having to store extensive amounts of data** on their machines.
Purge	• Involve purging old network history. • The purge: trying to actually **cut down the amount of space you have to have on your hard drive**, trying to simplify the Ethereum protocol over time and not requiring nodes to store history
Splurge	• It aims at making sure that the **network continues to run smoothly** and that the updates to the protocol in the previous sections do not cause any issues.