

## Biology Class 07

7th June, 2023 at 9:00 AM

### PREVIOUS YEAR'S QUESTION ANALYSIS (9:00 AM):

With reference to recent developments regarding 'Recombinant Vector Vaccines', consider the following statements (**Prelims 2021**) :

1. Genetic engineering is applied in the development of these vaccines.
2. Bacteria and viruses are used as vectors.

Which of the statements given above is/are correct?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

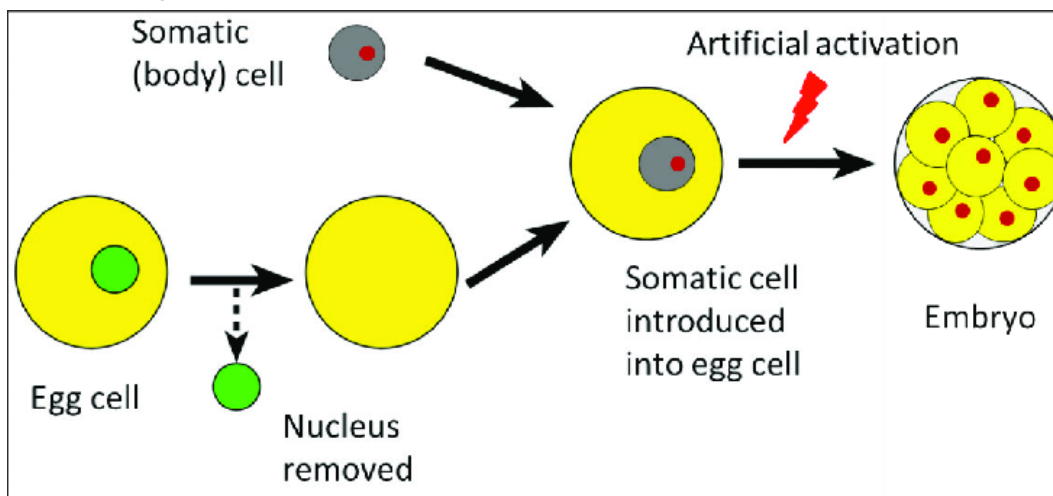
**Answer: (c)**

#### **Cloning:**

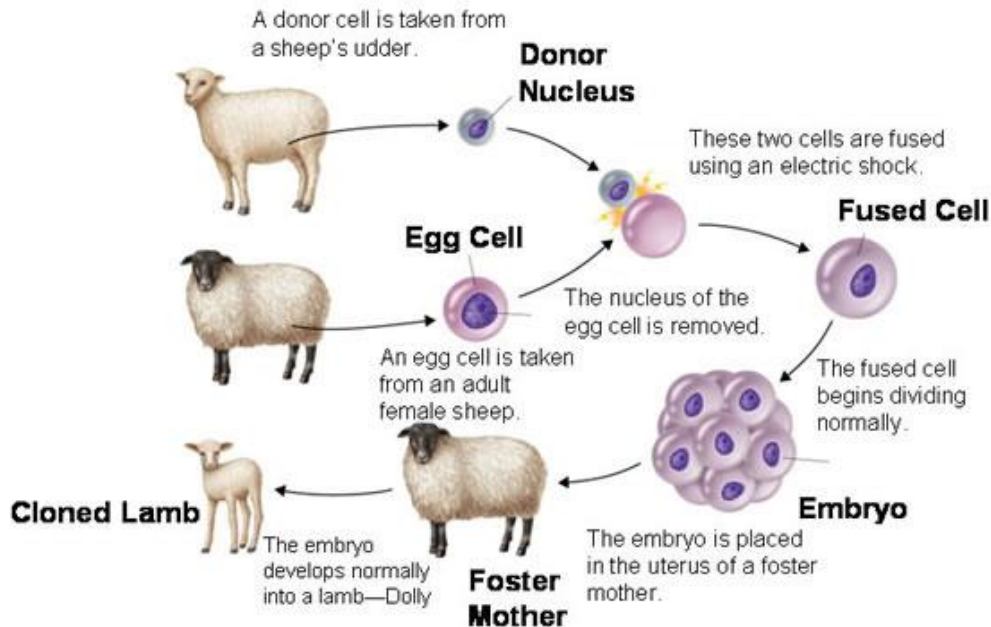
- In normal reproduction, both parents provide half of the genetic material to the offspring.
- In **cloning**, a single parent provides the complete genetic material.
- **Gametes** have half the number of chromosomes, while **somatic cells** have the complete set of chromosomes.

#### **Animal Cloning:**

- We need to take the somatic cell of the animal we wish to clone.
- The presence of an egg is essential for the further development of the zygote.
- A different **donor** would provide the egg.
- Since we do not need any genetic characteristics of the donor, we must do the process of **Enucleation** for the removal of the nucleus.
- We will keep the somatic cell nucleus of the animal to be cloned, and we will keep the empty egg of the donor without the nucleus.
- Through **Somatic Cell Nuclear Transfer**, we will have the egg of the donor with the somatic cell nucleus of the animal.
- This new egg can be stimulated to form an embryo, which can be later transplanted into the uterus.
- The offspring will be an exact copy of the somatic cell donor animal.



- The process needs no sperm cells.
- If we need to clone a female, we can take the somatic cell and egg from her, and then implant the embryo in herself.
- The offspring will be genetically identical.
- Cloned animals (like **dolly sheep**) have shown very small life spans.



### Purposes of Cloning:

- The main motive behind animal cloning is to preserve a species.
- It can also be used for the continuation of desired characteristics.
- **For example-** If a sheep has a very good milk yield, and it reproduces naturally, then the baby will also have the characteristics of another parent.
- So the natural baby might have a lesser milk yield.

### Cloning of Amitabh Bachchan :

We would need his **somatic cell**; any cell other than the sperm cell.

We must then remove the nucleus of the somatic cell that will have all 46 chromosomes.

We can then source an egg cell from any interested woman.

If we wish the baby to be an exact replica of Mr. Bacchan, we must remove the nucleus from the donor egg cell and replace that with the nucleus from Mr. Bacchan's somatic cell.

The new egg cell will be fertilized into an embryo.

The resultant embryo can be implanted in any other willing woman.

This will not be a "fertilization " process as such, and in layman's language, the process can be taken similarly to **photocopying**.

- Unlike females, males cannot do the process alone because the egg is needed for the process.
- **Human cloning** is still in the theoretical stages.
- **Some issues with cloning:**
- The success rate of fertilization and survival of such offspring is very low.
- Around 200 embryos had to be discarded before Dolly.
- Even IVF technology has around a 15% success rate.

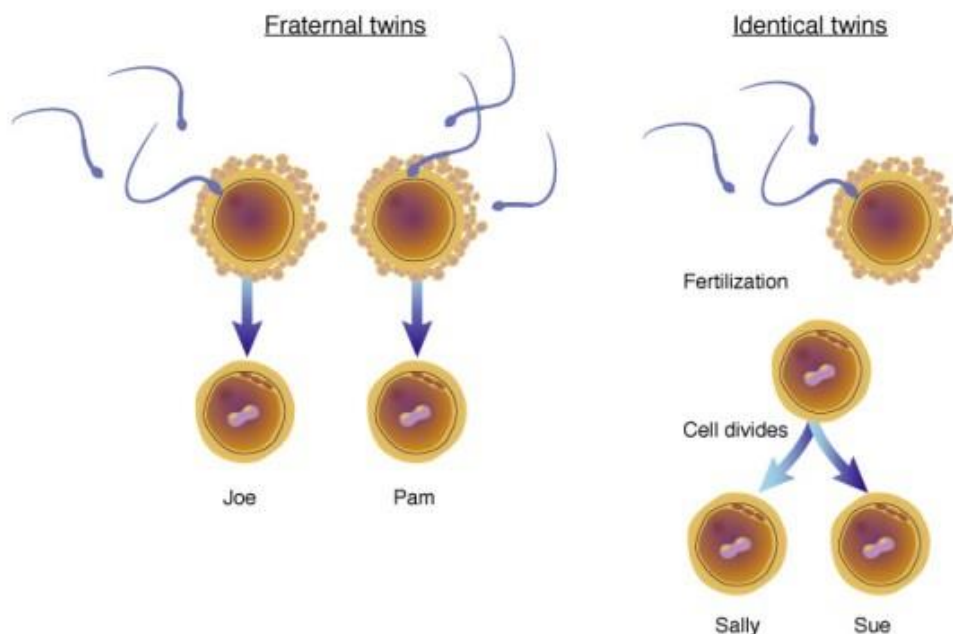
### Twins:

#### For identical (monozygotic) twins:

- The zygote can create a copy of itself.
- Hence the twins will have the same genetic material from both parents.
- Monozygotic twins are natural examples of cloning.

#### For non-identical (dizygotic) twins:

- Normally, one egg cell is produced per month.
- Sometimes, two egg cells can be produced, or even both ovaries produce an egg cell each.
- Two zygotes will be fertilized and they will be genetically different.
- They would be as similar to two siblings born with a gap of some time.

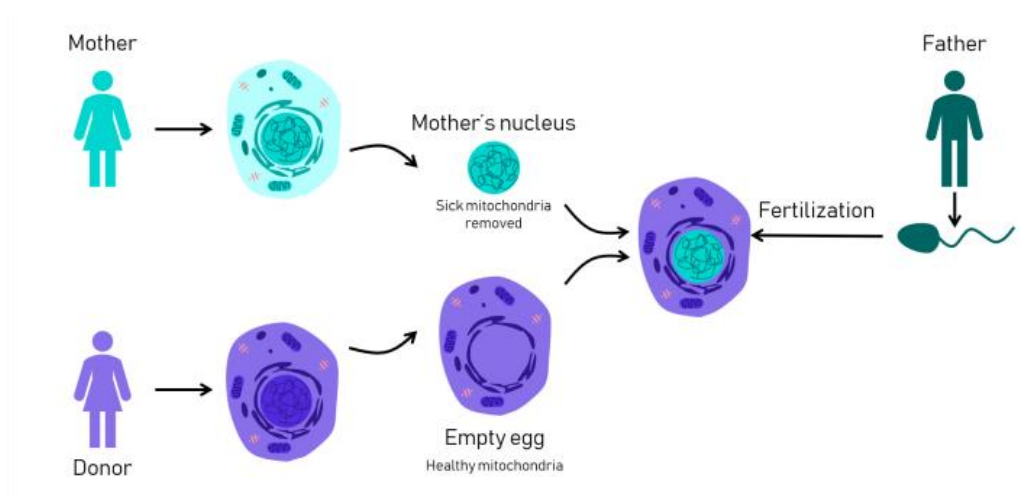


### THREE-PARENT BABY (9:35 AM):

- Mitochondria have their own DNA (**mt DNA**) with only 37 genes, so it makes no difference in the overall personality traits of the individual.
- Defective mtDNA can cause various diseases like **Leigh disease**.
- Nuclear DNA comes half each from both the parents but mt DNA is inherited only from the **mother**.
- This means any female with defective mt DNA will definitely transfer it into the offspring.

#### Mitochondrial replacement/ Pronuclear transfer technology:

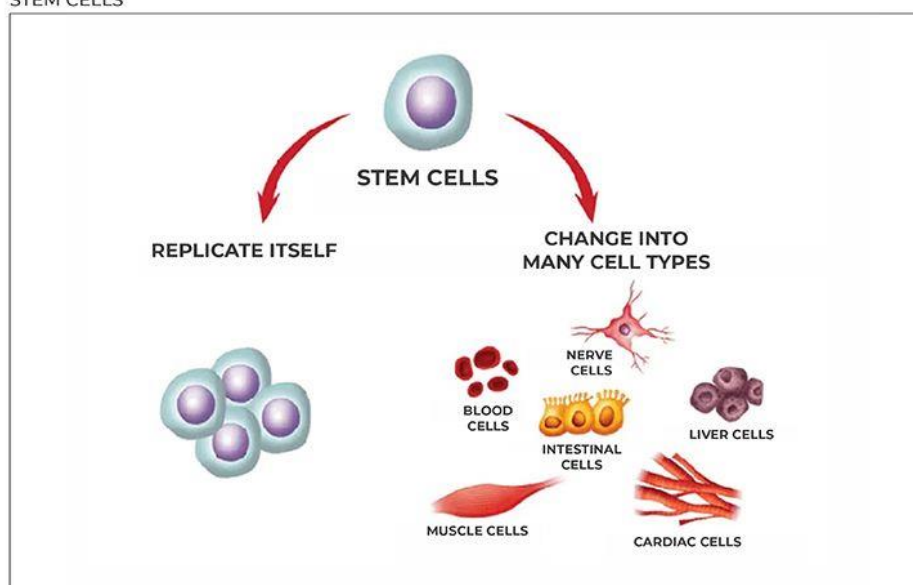
- If the mother's mtDNA is defective, we would need an egg donor.
- We need to remove the donor egg's nucleus because we do not need the characteristics of the donor.
- In the new egg, there would be the mother's nucleus with the donor's normal mtDNA.
- This egg would be then fertilized with the sperm cells from the father.



## STEM CELL TECHNOLOGY (10:00 AM):

- Stem cells are unspecialized cells that can divide and grow into different types of cells.

STEM CELLS



## Pluripotency/Pluripotent cells:

- They can form any cell in the body, except those needed to support and develop the fetus (extra-embryonic membranes).

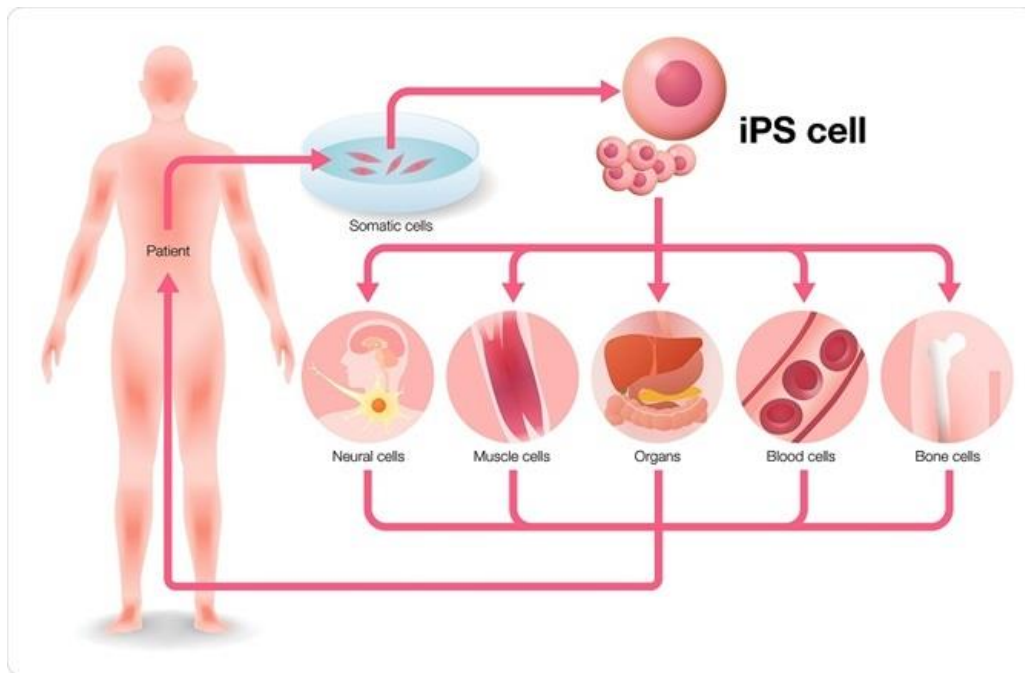
## Three types of stem cells:

### Embryonic stem cells:

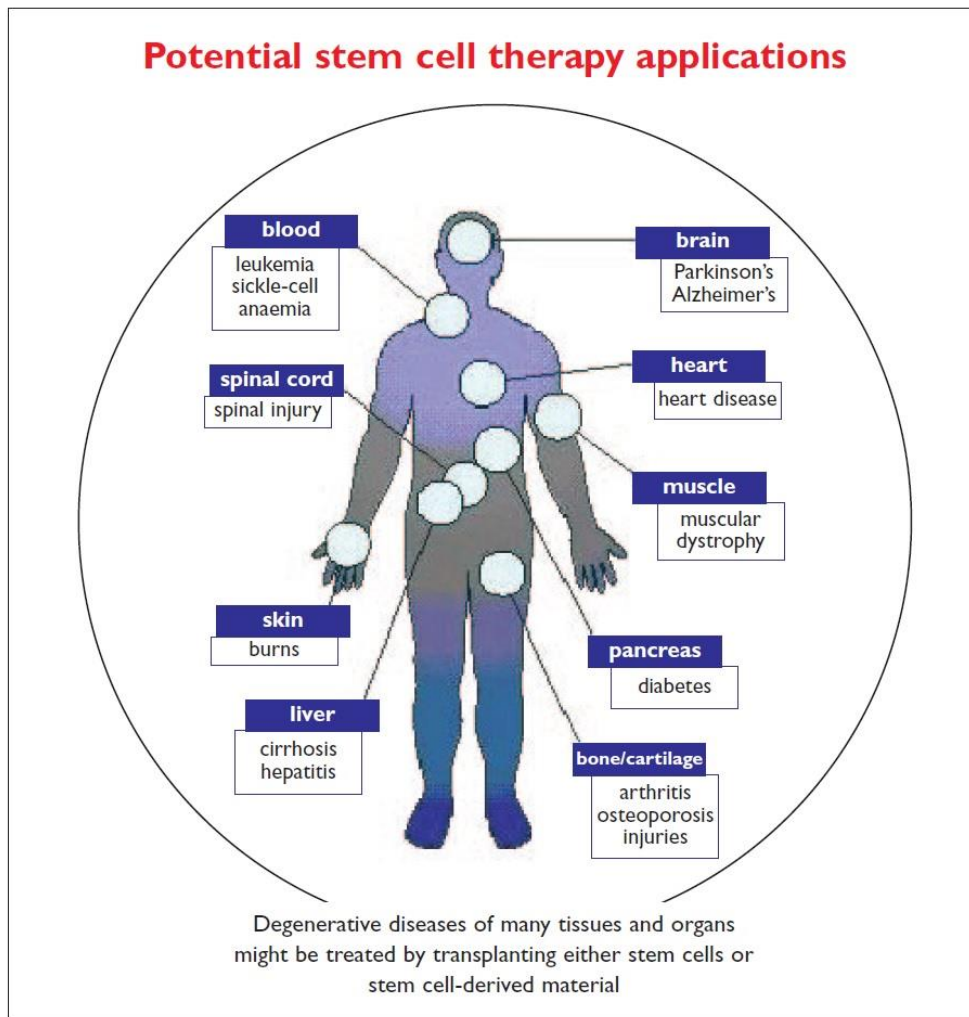
- They exist at the early stages of life and can change into any type of cell.
- Adult stem cells are present in different tissues like the skin, brain, and bone marrow, and create new cells specific to that tissue.

### Induced pluripotent cells:

- They can be induced to divide and become undifferentiated.
- For example**, we can treat the muscle cells to make them pluripotent cells to give rise to blood cells/liver cells, etc.



- **Potential applications of stem cell technology:**
  - There can be multiple uses of stem cell therapy like the treatment of organ failure.
  - As of now, most stem cells are derived from adults, which poses difficulties in the extraction of specialized cells.
  - **For example-** for an issue with the brain, it must take the stem cells of the brain of the adult, which would be difficult to react to.
  - Nowadays, there has been a focus on obtaining embryonic stem cells that can be sourced from the **umbilical cord** after birth.
  - The cord has a special liquid that has embryonic stem cells, that can be preserved under cryogenic conditions.
  - This program will be having very high rates because the resultant organ will be of the baby's own.
  - Even using these stem cells for replacing the organs of another family member will have a much higher success rate.



**Figure 1** Degenerative diseases of different tissues/organs amenable to cell therapies

Source: MRC, London: stem cell therapy

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## VARIOUS USES OF BIOTECHNOLOGY (10:45 PM)

- **Blue biotechnology:** Marine.
- **Green biotechnology:** Agriculture.
- **Red biotechnology:** Medical.
- **White biotechnology:** Industrial.
- **Grey biotechnology:** Environment.
- **Genetically Modified Crops:**
  - Genetic Modification of Crops involves adding a specific stretch of DNA into the plant's genome, giving it new or different characteristics.
  - The process involves adding a specific stretch of DNA into the plant's genome, giving it new or different characteristics.
  - This could include changing the way the plant grows or making it resistant to a particular disease.
  - The new DNA becomes part of the GM plant's genome which the seeds produced by these plants will contain.
  - **Transgenic crops** are those which involve transfers of genes from different species.
  - **For example- *Bacillus thuringiensis*** bacteria for BT cotton.

### **Objectives of Genetically Modified Crops:**

- Productivity- GM Mustard.
- Pest resistance- Bt Cotton.
- High shelf life- Flavr Savr tomato
- Fortification/Adding nutrients- Golden rice ( Vitamin A).

### **GM Crops in India:**

- As of now, only Bt Cotton is under cultivation.
- Various other crops are at different stages of experimentation and approval, most notably **Bt Brinjal**.

### **Concerns associated with GM crops:**

- Environmental/biodiversity challenges can lead to environmental disbalances.
- Economical concerns: farmers can be forever dependent on MNCs.
- Like the case of American MNC Monsanto-to **terminator/terminal seeds**- seeds that will give rise to crops with sterile seeds.
- Unforeseen harm to the human body.

### **The legal framework in India:**

- The procedures regarding genetic editing are regulated by many laws as:
- Biological Diversity Act, 2006.
- Drugs and Cosmetics Act, 1947.
- Seed Act, 1947.
- Protection of Plant Varieties & Farmer Rights (PPVFR) Act 2009.
- Food Safety & Standards Act 2006.
- Disaster Management Act 2005.

### **Materials for reading:**

Department of Biotechnology Act website.

Yojana, Kurukshetra magazines( only selective reading).

PT 365, Mains 365, and Monthly Current Affairs magazines.

### **Industrial applications of biotechnology:**

- It may be used for the production of a wide range of products like dyes, detergents, etc.

### **Environmental applications of biotechnology:**

- **Oil zappers bacteria**- a couple of bacteria modified to digest oil)could mitigate marine oil spills.

### **Challenges to biotechnology:**

- Lack of infrastructure.
- High cost.
- Less research and development.
- Lack of trained manpower.
- Lack of awareness and public reception.
- Lack of academia-industry linkages.

### **ETHICAL CONCERNS OF BIOTECHNOLOGY (11:10 AM):**

- Concept of **Designer Babies**.
- Issue of the consent of the unborn baby and animals.
- Different nations are differently placed with respect to adopting and implementing the technology.
- The gap might be widened further.
- Similar equity issues between the poor and rich.



- Interference with the natural scheme of things.
- Wastage of genetic materials that could be murder- Around 200 zygotes had to be destroyed before Dolly.
- Bio-Weapons.
- **Biopiracy**- Using biological resources without permission.
- The situation can get complicated if MNCs secure IPR protection on traditionally continued knowledge.

### SELF-STUDY FROM NCERTS (11:35 AM):

Class	Chapters
6 (Must be Read)	1,4,5,6
7(Must be Read)	1,2,6,7,8
8(Must be Read)	2,6,7
9	5,
10	5,7,8
11	8,9,19 (selective reading only)
12	4,5,8, 9,10 (selective reading only)

- Beyond these, Yojana, and Kurukshetra magazines can give very useful points from the **Mains'** perspectives.
- Also, the materials provided to the students are very comprehensive.

### Gene Silencing:

- Gene silencing is the interruption or suppression of the expression of a gene at **transcriptional or translation levels**.
- An example of this is **post-transcriptional gene silencing**( Nobel Prize 2006).
- This technology uses **I-RNA or** RNA interference to inhibit protein synthesis in target cells by attacking the m-RNA formed after transcription.
- I-RNA is also a double-stranded protein
- This I-RNA can be sourced both naturally and artificially.
- I-RNA attacks the M-RNA to stop protein synthesis.
- M-RNA can get formed from DNA but it cannot form the targetted proteins further.

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- The **Flavr Savr** tomato uses the technology to silence the gene responsible for ripening, hence the shelf-life gets extended.

### Cell Division:

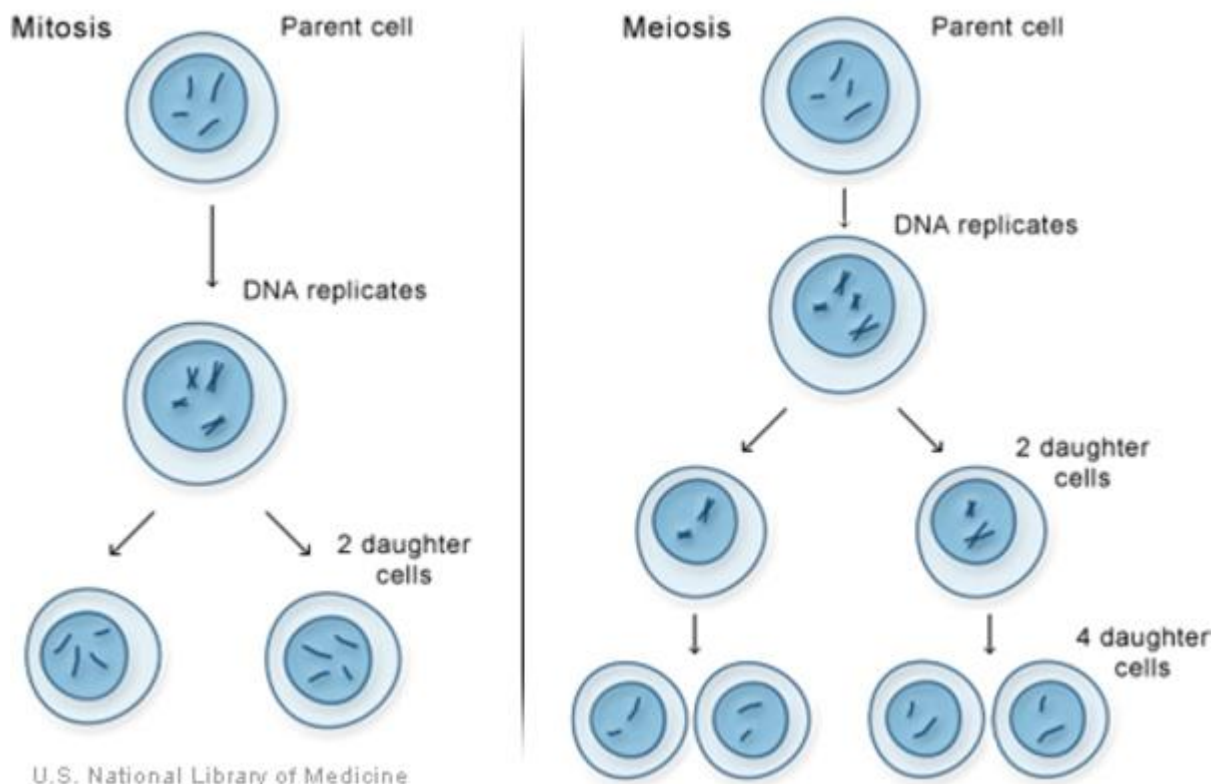
- Cell division is a continuous process that happens in all cells.
- There are two major kinds of cell division-Mitosis & Meiosis.

### Mitosis:

- Mitosis is the normal cell division where a cell divides to create two cells with the same number of chromosomes.
- This is seen when the process of normal growth and development happens in the body.

### Meiosis:

- This is a special process for creating reproductive cells(**gametes**).
- The result cells will have half the number of chromosomes.



### Food Fortification:

- It is the practice of adding vitamins and minerals to commonly consumed foods during processing to increase their nutritional value.
- We have examples like **Golden Rice** which is richer in Vitamin A than normal rice.

### Hidden Hunger:

- It is a condition where we see multiple micronutrient deficiencies (particularly iron, zinc, iodine, and vitamin A).
- This can occur without a deficit in energy intake as a result of consuming an energy-dense, but nutrient-poor diet.

### Balanced Diet:

- A balanced diet provides all the nutrients a person requires, without going over the recommended daily calorie intake.
- It has the proper proportion of vitamins, proteins, carbohydrates, fibers, calories, fats, etc.

**The syllabus for Biology has been completed.**