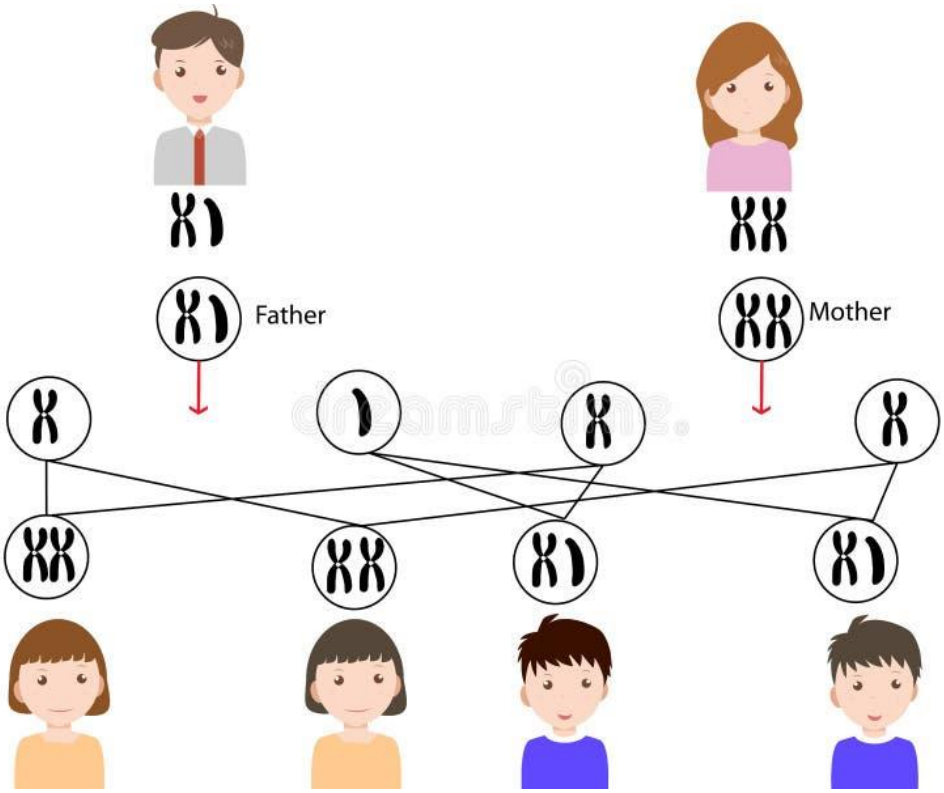
Biology Class 06

6th June, 2023 at 9:00 AM

ANALYSIS OF PREVIOUS YEAR QUESTION(9:00 AM):

- Consider the following statements **(Prelims 2021):**
- (1) Adenoviruses have single-stranded DNA genomes whereas retroviruses have double-stranded DNA genomes.
- (2) Common cold is sometimes caused by an adenovirus, whereas AIDS is caused by a retrovirus.
- Which of the statement(s) given above is/are correct?
- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2
- **Answer: (b)**
- **Approach:** Adenoviruses have double-stranded DNA genomes whereas retroviruses have single-stranded RNA genomes.
- Genome simply refers to the complete set of genes in a cell or living thing.

Sex determination:

- Humans typically develop as either male or female, depending on the combination of sex chromosomes that they inherit from their parents.
- The human sex chromosomes, called X and Y, are structures in human cells made up of tightly bound deoxyribonucleic acid, DNA, and proteins.
- 

- The phenotype ratio here is 1:1 as we see an equal number of sons and daughters.
- This means we have an equal probability of having a boy or a girl child.
- Humans who inherit two X chromosomes typically develop as females, while humans with one X and one Y chromosome typically develop as males.
- Hence, it can be said that the sex of the child is always determined by the genetic inheritance of the father, unlike the patriarchal norms that blame women for it.
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Son Meta-Preference:

As per the **Economic Survey 2017-2018,** many families tend to have girls until they get the desired number of boys born.
Such couples might have more girl children than boys, but that is due to the preference for boys and not per preference for girls.

Genetic abnormalities:

- Genetic disorders occur when a mutation affects the genes of the baby or when the baby has the wrong amount of genetic material.

Genetic disorders are classified on the basis of:

The number of chromosomes:

Klinefelter's syndrome- XXY.

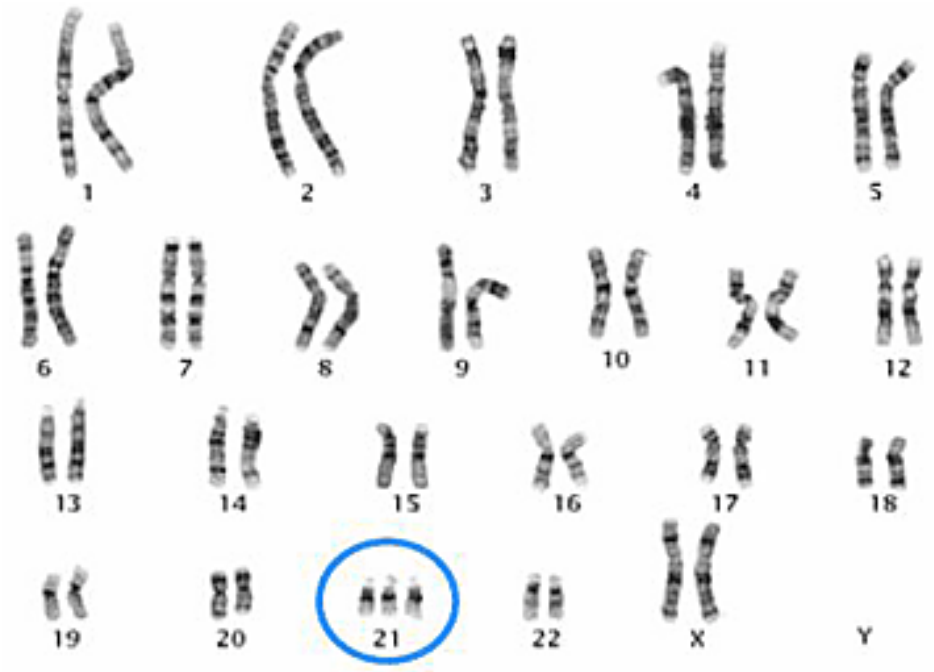
- The baby boy will have 47 chromosomes.
- This results in a male with the development of feminine characteristics.
- They are sterile in most cases.

Turner's syndrome-XO.

- It is a condition that affects only females when one of the X chromosomes (sex chromosomes) is missing.
- The girl will have only 45 chromosomes.
- She will be a reproductively sterile female.

Down Syndrome:

- It sees the presence of an extra chromosome called **Trisomy 21.**
- The child will have a total of 47 chromosomes.
- The child is born with a small round head, partially open mouth, and mental retrardation



- **MORE EXAMPLES OF GENETIC DEFECTS / AUTOSOMAL DISEASES (9:30 AM):**
- **Sickle Cell Anaemia**- Deficiency of hemoglobin.
- When the Red Blood Cells(RBCs) become sickle-shaped, they are not able to hold a sufficient amount of hemoglobin.
- This happens due to a defect in one gene present on one of the **autosomes** (one of the numbered chromosomes, as opposed to the sex chromosomes).
- Let the normal gene composition be HbHb and the diseased composition be Hb^sHb^s.
- We can have a heterozygous gene composition of the offspring as HbHb^s.
- In most cases, the defective gene effect is regressive, so the above-case offspring (HbHb^s) will be a normal person.
- This is because the normal gene Hb will dominate.
- So even if the defective gene is transferred in successive generations, they will not show the disease because the disease gene is recessive

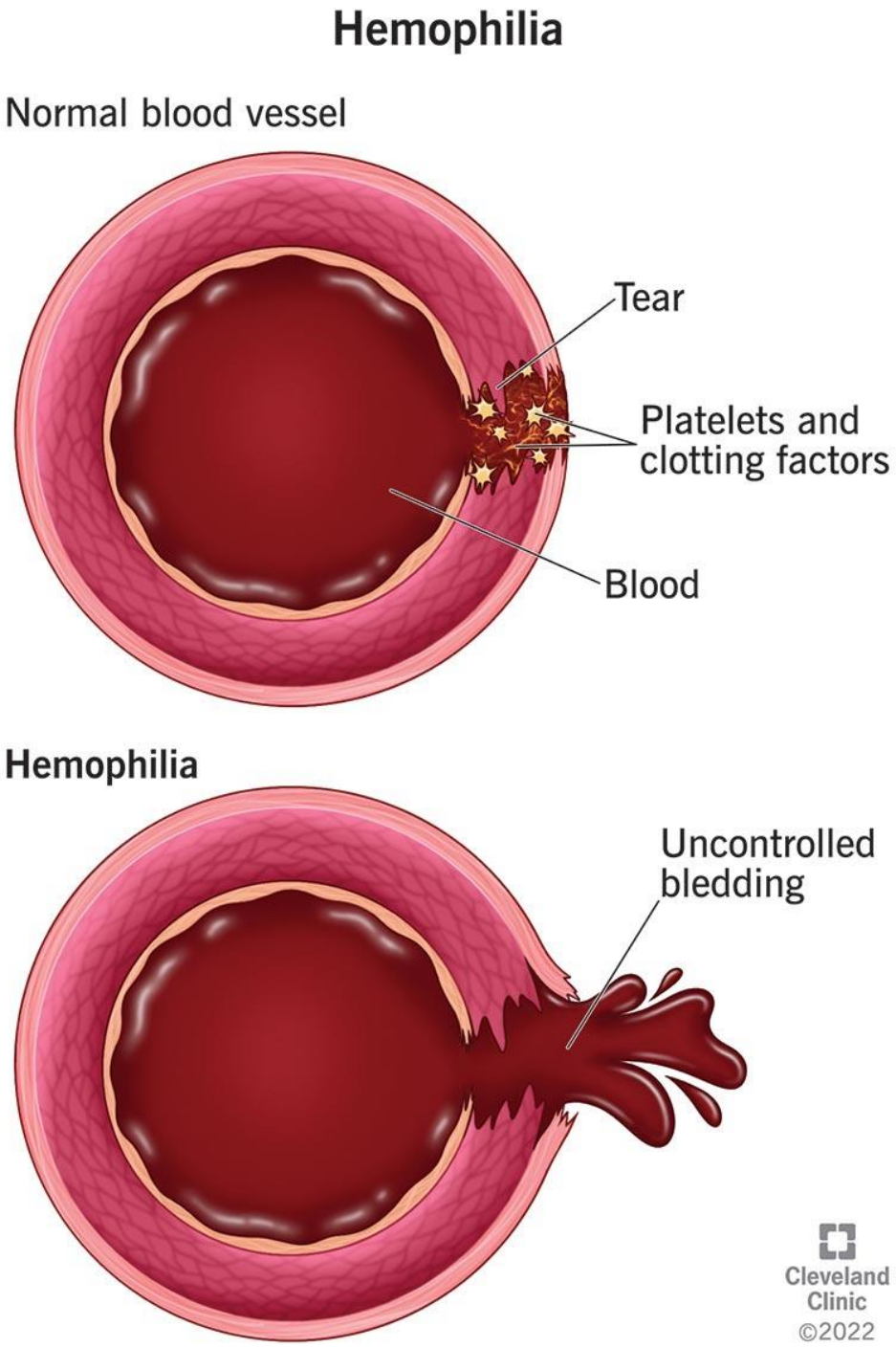
Marriage among siblings/close relatives:

- They can be **Carriers -** they can be normal themselves, but they can still carry the disease to the next generation.
- HbHb^s & HbHb^s can have offspring -Hb^sHb^s which will definitely have the disease.
- Such marriages can cause offspring with physical, mental genetic defects.

Sex-chromosome-linked diseases:

Hemophilia:

- Hemophilia is a rare disorder in which the blood doesn't clot in a typical way because it doesn't have enough blood-clotting proteins.



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- The British Royal family has this disorder.
- This disease is also a recessive disease.
- Normal- XX & XY.
- Let us assume the diseased female to be represented by X^hX^h.
- Let us assume the parents as XY & X^hX^h.
- Since this is a recessive disease, the offspring will be either :
- **I.** XX^h (Normal/Carrier female child).
- **II.** X^hY(Diseased male child)

- For sex-linked diseases, either the man will be normal or he can be diseased, but he will never be a carrier.

Color Blindness:

- The gene responsible for color blindness is located on the X chromosome.
- If a female inherits one normal color vision gene and one mutated gene, she won't be red-green color blind, because it's a recessive trait.
- But if she inherits two mutated color vision genes, she'll be color-red-green blind.
- Since boys have only one X chromosome, their chance of inheriting red-green color blindness is much greater.
- Boys always inherit their X chromosome from their mother, so if the mom has red-green color blindness, or if the mom's dad is red-green colorblind, her son will be too.
- Normal- XX, XY
- Disease X^hX^h, X^hY
- Normal carrier XX^h.
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Question: In the context of genetic disorders, consider the**following(Prelims 2009):**
A woman suffers from color blindness while her husband does not suffer from it.

They have a son and a daughter.

In this context, which one of the following statements is most probably correct:

(a). Both children suffer from color blindness.
(b). Daughter suffers from color blindness, while the son does not.
(c) Both children suffer from color blindness.
(d). Son suffers from color blindness while the daughter does not.
Answer: (d)
Approach:
Let the mother be X^cX^c (diseased) and the father be XY (healthy).

The offspring will be:

XX^c(daughter) , XX^c(daughter), X^cY,(son) X^cY(son).

GENOME (10:00 AM):

- It is the complete set of DNA of an organism.
- It includes all the chromosomes which contain all the genes.

Genome Sequencing:

- It means describing the exact order of base pairs in an individual.
- This helps to understand the function of various genes, identify changes and explore how these changes impact the gene function.

DNA Test/Fingerprinting:

- 99.9 % genome(complete set of DNA) is same for all humans.
- The 0.1 % variation is unique for all humans.

Variable Number Tandem Repeats(VNTR):

- These are the unique repetitions of genetic sequence which is used for DNA fingerprinting.
- VNTR serves no other special function other than identification.
- VNTR can have **two variations** in the base of the number of units that get repeated:
- **Minisatellites:** 6 to 100 base pairs which will repeat.
- They are mostly at the ends of the chromosomes.
- **Microsatellites:** Less than 7 pairs which will repeat.
- All the cells of the body will have DNA.

Some uses of the technology:

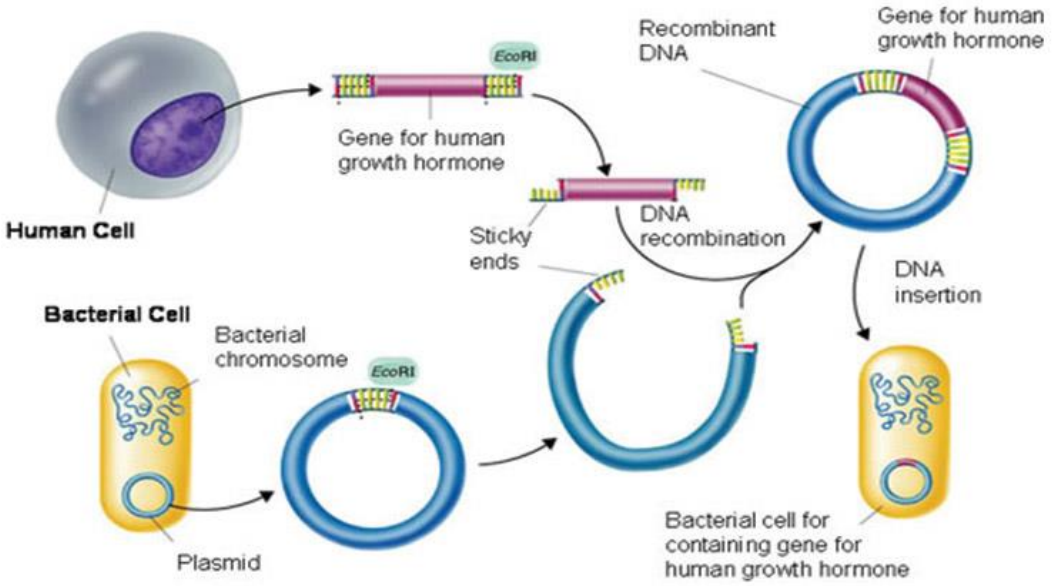
- Paternity(N.D. Tiwari) cases can be solved because sections of the VNTR will match with our parents, grandparents, siblings, etc.
- Identification of Genes that cause hereditary diseases.
- Helps to identify racial groups, their origin, historical migration, and invasion.

DNA Barcoding:

- DNA barcoding is a technique in which species identification is performed by using DNA sequences from a small fragment of the genome.
- The unique gene repetitions are used to catalog the genetic identity of the species.
- This can be used to get information regarding the identity and other genetic information of the specimen.

RECOMBINANT DNA TECHNOLOGY (10:35 AM):

- Recombinant DNA technology comprises altering genetic material outside an organism to obtain enhanced and desired characteristics in living organisms or as their products.
- This technology involves the insertion of DNA fragments from a variety of sources, having a desirable gene sequence via the appropriate vector.



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Steps:

- Isolation of the desired gene.
- The nucleases enzyme will help in cutting the desired gene from the DNA.
- **Vector** is the DNA that acts as a carrier for the desired gene.
- **A plasmid** is an independent circular DNA in bacteria and viruses.
- For the vector, bacterial cells are chosen.
- **Ligase** enzyme is used for joining.
- The desired gene is joined to a vector to give the recombinant DNA.

Viral Vector Vaccines :

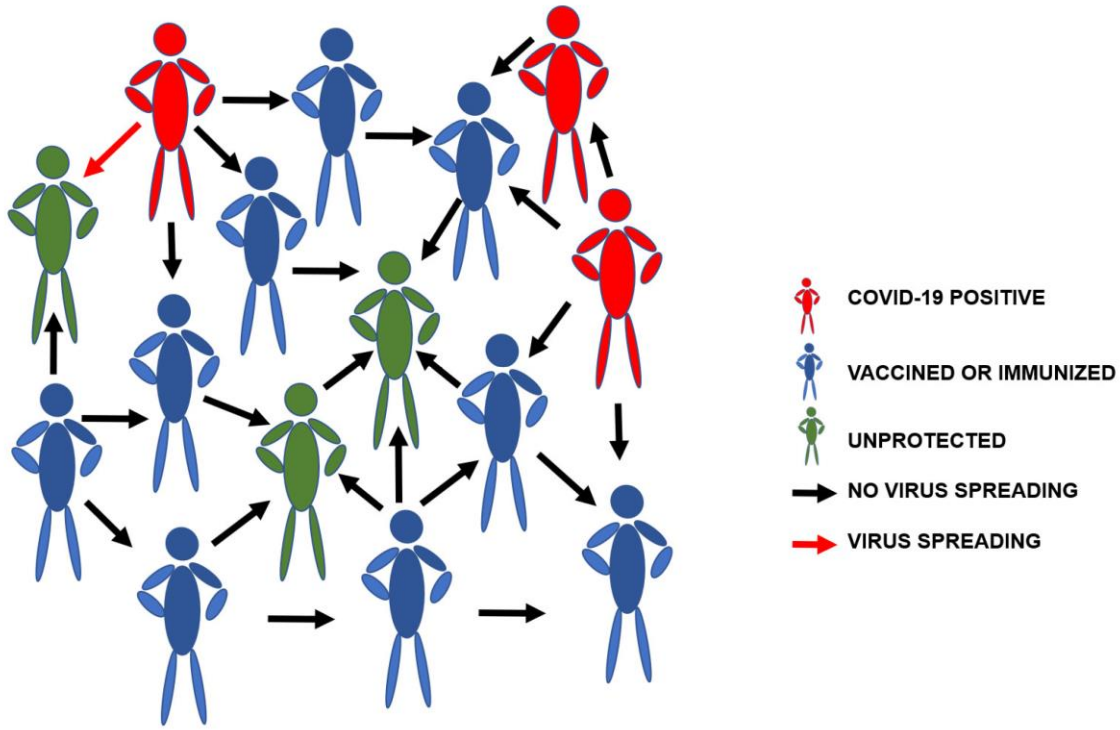
- They are made from a virus that got altered in the laboratory and cannot cause disease.
- We need to use the gene coding for the antigen which will help the Human **B Cells** to produce the desired immune response through antibodies.
- **Viral vectors** are that virus which has been designed as tools to deliver genetic material into cells.
- The Viral Vector is mainly sourced from adenovirus from some other species (commonly chimpanzees) because human B cells will not identify them as a threat.
- As the disease virus is not administered fully, but only a gene of the virus, combined with a viral vector, the B cells will produce antibodies for that, and the body will acquire a disease resistance memory without actually getting the disease.
- **Live attenuated vaccines** contain a version of the living virus that has been weakened so that it does not cause serious disease in people with healthy immune systems.
- Viral vector vaccines- Covishield and Sputnik.
- The side effects of the vaccine- fever, headache, etc are due to our immune system.

AUTOIMMUNE DISEASE (11:00 AM):

- This is a disease that is caused when the immune system malfunctions and attacks healthy cells, tissues, and organs.
- **Rheumatoid arthritis** is a good example of such a disease.

Herd Immunity:

- It is the indirect protection from an infectious disease that happens when a population is immune either through vaccination or immunity developed through previous infection.



- Recombinant DNA technology (Genetic Engineering) allows genes to be transferred (**Prelims 2013)**
  1. Across different species of plants.
  2. From animals to plants.
  3. From microorganisms to higher organisms.

  Which of the above statement/s is correct?

  (a) 1 only

  (b) 2 and 3 only

  (c) 1 and 3 only

  (d) 1, 2 and 3

  Answer: (d)

  Approach:

  DNA is the same everywhere for all organisms.

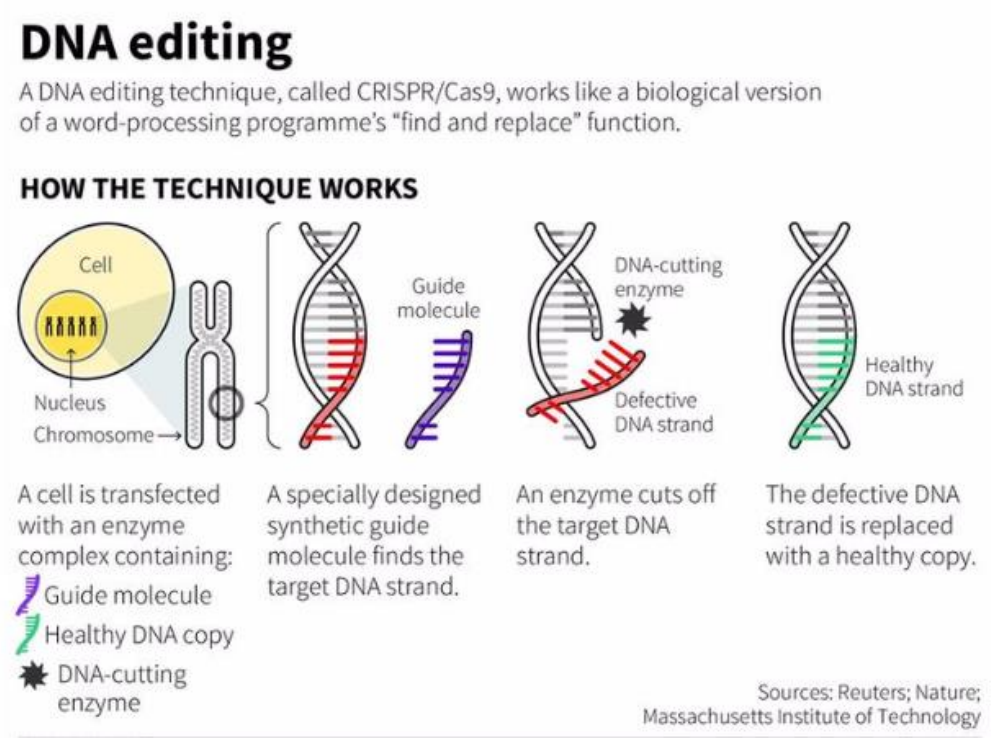
  Whether the result is useful/feasible or not in all cases is a different issue.

  But inter-species transfers are certainly possible.

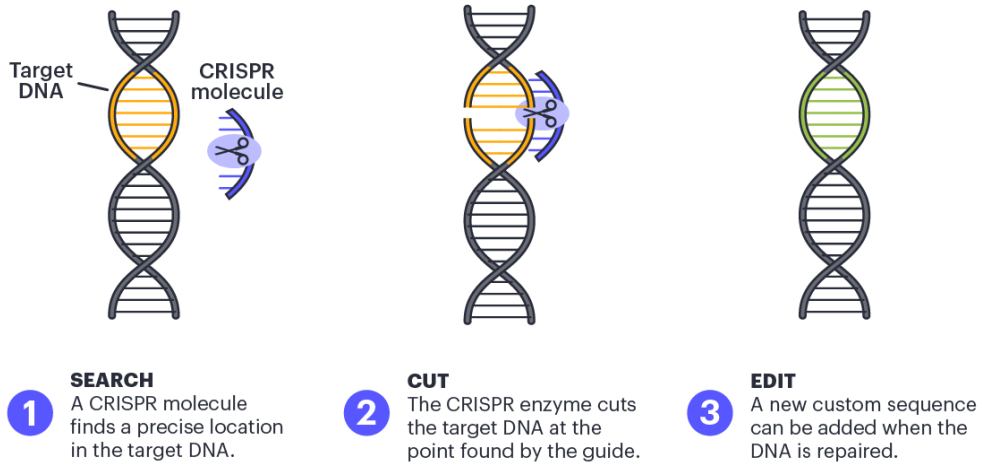
  For example- BT Cotton has a soil bacterium in the cotton plant.

GENE EDITING(11:25 AM):

- It is a process by which genes can be added, deleted, or replaced by the use of genetic engineering.



- **CRISPR- Clustered Regularly Interspaced Short Palindromic Repeats:**
- It is also called a gene editing tool, molecular scissors, etc.



- **The process includes:**
- **Single-guided RNA- Sg RNA** is used as the guidance molecule.
- This is unique as this is double-stranded.
- **Cas9 protein/enzyme**- is used as the Nuclease which is used for DNA cutting.
- Sg RNA guides CRISPR to the specific parts of the genome where the CAS 9 enzyme cuts the DNA.
- The technology is in an experimental state and it is not been applied as of now.
- The **Ligase** enzyme is used for joining the cut gene.

Designer babies:

- A designer baby is a baby genetically engineered in vitro for specially selected traits, which can vary from lowered disease risk to gender selection, and even enhanced physical traits.
- It has various ethical issues associated with it, so as of now, a consensus-based moratorium is imposed on it.

Gene Therapy:

- It is the addition of a normal corrective gene into the genome.
- In the case of genetic diseases, a normal corrective gene can be added to take over the function to compensate for the non-functional gene.

In-Vitro Fertilization :

- This process of embryo fertilization happens outside of the human body under monitored conditions.
- Mature eggs are retrieved from the ovaries and fertilized with sperm.
- After fertilization, the embryo(s) is/are transferred to the uterus of another woman.
- The birth then happens normally.
- The baby will have no characteristics of the host woman, but only of the parents whose sperm and eggs were taken.
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Sources for self-study:

- Ncert Science textbook Class 10- chapters 8.

The topic for the next classis Biotechnology