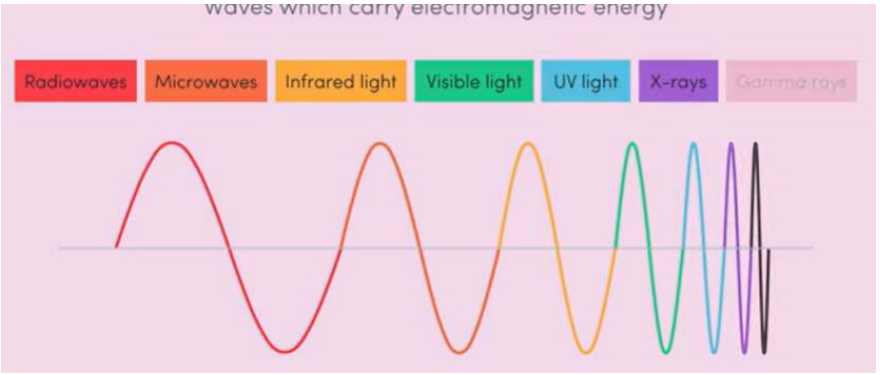
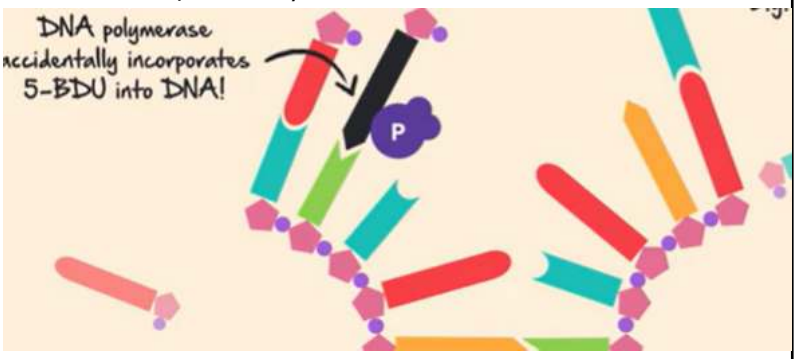
Module 6: Genetic Change

u Content: Mutations

1. Inquiry question: How does mutation introduce new alleles into a population?

1.1 explain how a range of mutagens operate, including but not limited to: a) electromagnetic radiation sources	A mutagen is an agent which can change the structure of DNA , causing a mutation'' High energy EM radiation(UV , x rays, gamma rays) cause atoms to vibrate and lose electrons . this breaks bonds, damaging DNA  uv light, x rays and gamma ray are mutagens,, this is due to the fact that the shorter the wavelength, the higher the energy waves, these cause mutations <u>SOURCES</u> 1. **The sun** is the biggest source of EM radiation in everyday life. - emits infrared , visible and **UV light,**making it strong enough to cause dangerous mutations, eg skin cancer 2. **Radioactive elements** are another source of EM radiation, eg uranium -236 this is because there release gamma rays(the most harmful natural mutagens) as they decay 3. **medical imaging machines** **eg** x ray machines , PET scanners

b) chemicals	Different chemicals cause mutations in different ways 1. chemical is accidently incorporated into DNA , instead of proper nucleotides (eg. 5-bromodeoxyuridine)  2. Chemical **inserts** itself into the DNA- this creates bulge in the DNA which prevents replication  3. Chemical **makes gaps** in the DNA, breaking bonds between hbase and the sugar  4.

c) naturally occurring mutagens	They Are mutagenic chemicals which specifically come from microbes,plants and animals <u>Microbe</u> **mycotoxins** are poisonous chemicals produced by fungi most significant mutagen to human as we are most likely to encounter them by eating contaminated food for example E.g. aflatoxin B1 – inserts itself into DNA and distorts it <u>PLANTS</u> some substances produced by plants are also mutagenic **Cycasin is** a mutagenic chemical, found in the leaves of cycad plants. when consumed it reacts with an enzyme in the stomach and breaks down into other chemicals which react with DNA, changing it's structure and causing mutations <u>Animal</u> Animal mutations are usually produced within the animal's body. eg **dimethylnitrosamine** is produced in the stomach when nitrite is consumed, examples are ham

1.2 compare the causes, processes and effects of different types of mutation, including but not limited to: a) point mutation	**definition**: only one nucleotide change **causes:** error in DNA replication **processes:**frameshift(insertion or deletion) or substitution(miss-sense, nonsense and silent) **effects:** ***frameshift*:** all codon after mutation are affected(= different amino acids) ***Mis-sense****:* different amino acid ***:non-sense;*** unfinished protein ***silent:*** no effect and example of a point mutation is **sickle cell anemia** sickle cell anemia is a genetic disorder where people have misshapen blood cells due to mutation
b) chromosomal mutation	**definition** A change in the arrangement or structure of a chromosome **causes:** error in cell division , either in meiosis one or meiosis 2 **processes:** deletion, inversion, translocation , duplication and non-disjunction **effects: ALL:** breakage in middle of gene destroys the gene ***deletion, inversion and translocation:*** genes ion another place ***duplication :***changes in amount ***nondisjunction;*** varied effect and example of this is called trisomy 21: non- dsijunction during gamete formation (fertilisation results in offspring having 3 of the 21st chromosomes)

1.3 distinguish between somatic mutations and germ-line mutations and their effect on an organism	<u>GERMLINE MUTATIONS</u> a ferm cell is any cell which can divide (by meiosis) to from sex cells a germline mutation is a change in the DNA of a **germ cell** - a germline line mutation has no effect on the organism - the mutation only affects the offspring **example** down syndrome <u>SOMATIC MUTATION</u> change in the DNA of a somatic cell(body cell)\ - **all daughter cells from** the original , mutated cell will have the mutation, only affecting the organism - no effect on offspring example lung cancer
1.4 assess the significance of 'coding' and 'non-coding' DNA segments in the process of mutation	<u>CODING</u> DNA which codes for amino acid sequence of a protein **mutation in coding DNA** The effect of a mutation in the coding DNA depends on the type of mutation. whether it's a *germline of somatic cells . or whether is an insertion deletion and substitution*

	EG sickle cell anemia <u>*NON CODING MUTATIONS*</u> non coding dna is dna which does not code for proteins non coding DNA can: - **Make function RNA :** - **regulatory sequences**(controls the amount of proteins produced by coding DNA).. this can be *promoters* that help RNA polymerase bind and *operators* where repressors bind - **repetitive sequences;** regions of DNA which are the same sequences repeated over and over(most of these repetitive sequence are introduced by viruses) SOOOO what happens when a mutations occurs in the following purposes of non coding: - **making functional rna** if a mutation occur , protein synthesis may be affects -**regulatory sequences** if a mutation occur , gene transcription levels may change, this can either decrease or increase - **repetitive sequences** if a mutation occur, nothing happens EXAMPLE lung cancer is a disease that result from uncontrolled cell growth in the lungs
1.5 evaluate the effect of mutation, gene flow and	<u>GENE POOL</u> **total collection of alleles** for **all genes** in a population

genetic drift on the gene pool of populations	- the gene pool retains all the genetic information of the populations, including the number of genes, number of alleles and the allele frequency each organism has lots of DNA = lots of genes= heaps of alleles in the population FACTORS AFFECTING GENE POOL - **gene flow** - **genetic drift** - **mutations** - **selection pressures** **Gene Flow** gene flow refers to the movement of alleles between populations, and can cause changes in the alle frequency in the gene pool **Genetic drift** genetic drift refers tot how random events occurring within the population can lead to changes of allele frequency in the gene pool **mutations** a mutation n refers to the change in an organism's DNA and acts as a source of new alleles in the gene pool **selection pressures** selection pressures refer to external factors which affect an organism's ability to survive - *positive selection pressures* **increase** allele frequency - *negative selection pressures* **decrease** allele frequency

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2. Biotechnology

Inquiry question: How do genetic techniques affect Earth's biodiversity?

2.1 investigate the uses and applications of biotechnology (past, present and future), including: –a) analysing the social implications and ethical uses of biotechnology, including plant and animal examples	As biotechnologies are developed, ethical dilemmas are faced by the scientific community and society. Some people hold strong moral and ethical views on particular practices based on their religious and cultural beliefs. Biotechnologies involving human embryos and using animals in research may be particularly offensive to some groups of people. Social implications - has the potential to influence society and change economic consolidation - the financial position,lifestyle and social position of individuals and the company = access to biotech - **Artificial Insemination** - **Benefits:** - Increase in amounts of better quality food available. - **Limitations:** - Inequality on who has access to the better quality food. - social equality,accessibility,cost.,privacy,health issues and society bewi of biotech ETHICAL USAGE OF THE BIOTECHNOLOGY - animal welfares - medical intervention and consent, legal implications as ;legislation reality keeps pace with scientific discoveries EG HUMAN EDITION OF EMBRYOS FOR NO MEDICAL REASONS.
b) researching future directions of the use of biotechnology	**Human embryo genetic editing** - the removal, insertertion or addition of genes. - designed to remove genes within the DNA of the embryo that are linked to inherited disorders and diseases, thus removing the chance that the offspring will inherit those disorders or diseases. - eases burden on health system, increase life expectancy and quality of offspring - has the potential to be used incorrectly for changing ideal physics; traits. - using crisper **personalised medicine** - - This is created through CRISPR and CAS9 - medicine is created. personalized to the individual to cure disease or medical problem based on there DBNA - - Also eases the burden on the health system as medicine will be fast acting and effective. - However, this can be economically unfair as this treatment would be rather expensive, meaning an unfair access to the technology as people within developing countries would not be able to afford.

c) evaluating the potential benefits for society of research using genetic technologies	
d)evaluating the changes to the Earth's biodiversity due to genetic techniques	initial increase in biodiversity when introducing new alleles into species but as time goes on and that trait is favored more , it will become more frequent , thus making it the dominant trait. thus in the long term- decreasing biodiversity eg - bt cotton initial increase in biodiversity through the introduction of the new pest resistant allele. but asw this crop of cotton becomes more common, it d impacts the biodiversity within the cotton specie However it also increases the biodiversity of the round ecosystems, as BT cotton was pest resistant= no pesticides, thus not harming innocent bugs. thus increasing biodiversity in surrounding ecosystems, EG.I ARTIFICIAL INSEMINATION.,

	initial increase in biodiversity as the genes from two pieces of cows from different locations with the desired trait were combined. thus increasing biodiversity in the cow genome in both local cow populations. However, due to these cows having the desired traits and producing offspring with the same traits, the4se new alleles will become more dominant within the3 cow gnome. thus decreasing biodiversity and genetic variation within the cow population.

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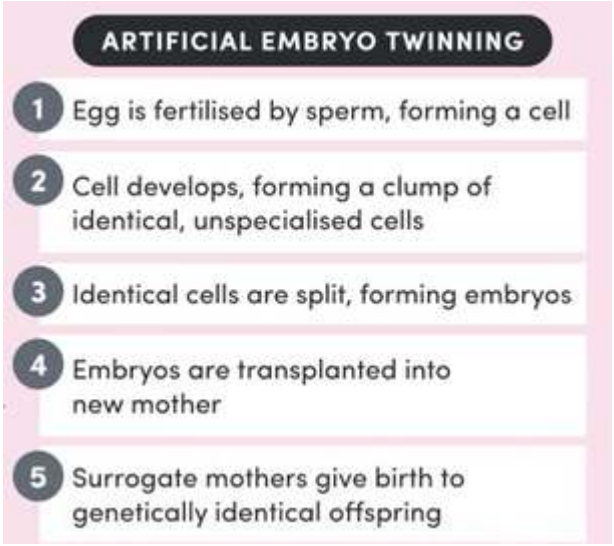
Content: Genetic Technologies

3. Inquiry question: Does artificial manipulation of DNA have the potential to change populations forever?

3.1 investigate the uses and advantages of current genetic technologies that induce genetic change	
3.2 compare the processes and outcomes of reproductive technologies, including but not limited to: a) artificial insemination	**deliberately introducing male sperm into the female reproductive tract, by a method other than sexual intercourse.The process involves collecting sperm from a male, which may be used immediately or may be frozen and stored before being inserted into the reproductive tract of a fertile female.. The sem collection usually is derived from the male specimen that has desired traits which wish to be present in offspring and future generations.** for example **Belgian Blue cattle** Important beef breed due to its exceptionally lean, highly muscled body. **Advantages:** One male can impregnate more than one female Semen can be frozen for preservation and transport Less chance of injury Permits use of older valuable stallions Semen can be evaluated each time it is collected and checked for disease **Disadvantages:** Overuse of the sperm from one male can reduce genetic diversity Can concentrate undesirable genes
b) artificial pollination	

	This involves the **transfer of pollen from the stamen** (male part) **of one flower to the stigma** (female part) **of another flower. The pollen collected from the stamen is one from a flower that usually has a desired attribute that wishes to be increased within the follower species. this can be done through either:** **Mechanical** **LARge amounts of pollen are released from aeroplanes or blowers directly onto the plants. Although this is relatively quick and doesn't require much labour, not many flowers are successfully pollinated, meaning it's pretty inaccurate.** **HAND pollination** In **hand pollination**, a person uses a small brush to transfer pollen between flowers. This is obviously super labour intensive, but it has a much higher accuracy rate than mechanical pollination. BOTH OF THESE REPRODUCTIVE TECHNOLOGIES ARE: ● **Positive outcomes of reproductive technologies include:** ○ **Offspring with more desirable characteristics,** ○ **Increased biodiversity due to the transport of genetic material across large geographical areas,** ○ **And, improved chances and rates of reproductive success.** ● **Reproductive technologies have important roles in human reproduction, agriculture and wildlife conservation.**

	• **The negative outcome for both artificial insemination and artificial pollination is reduced biodiversity.** ○ **This can reduce a species' chances of survival if the environment changes, and lead to inbreeding** • .
3.3 investigate and assess the effectiveness of cloning, including but not limited to: a) whole organism cloning	 

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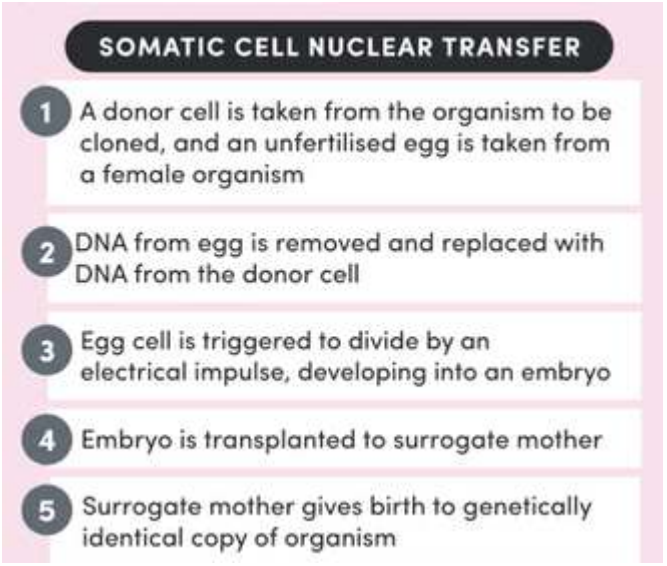
<td> 
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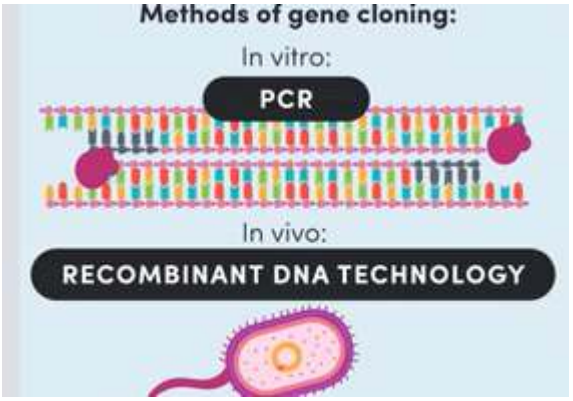
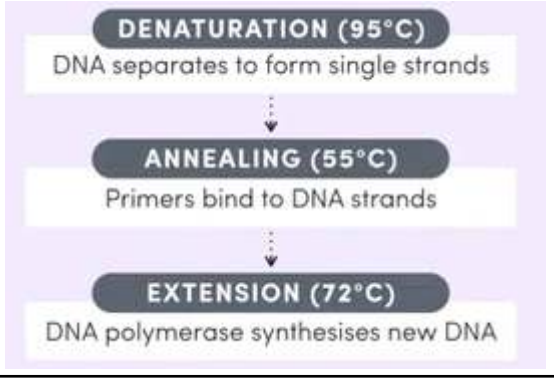
<td>b) gene cloning</td>
<td>Gene cloning is the process of making an exact copy of a particular gene. there are two methods of gene cloning

IN VITRO (in a test tube)

This is done through PCR(a technique that used to make lots of copies of a specific region of DNA
 
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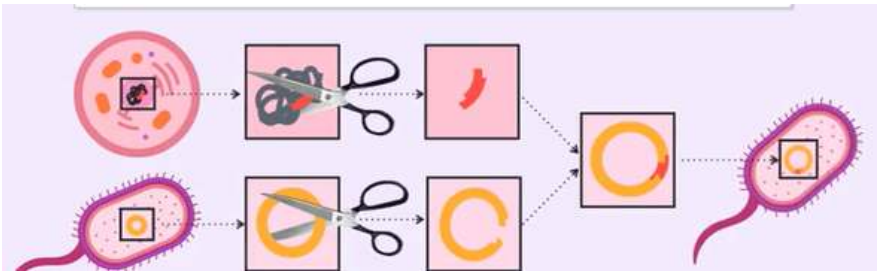
	IN VIViO(in a living thing) eg suing a bacteria to replicate a gene from us RECOMBINANT **DNA** this is DNA which contain gene from two or more different organisms  **Applications of gene cloning** Direct applications - DNA sequencing - DNA profiling Indirect applications - gene analysis - gene therapy
3.4 describe techniques and applications used in recombinant DNA technology, for example: a) the development of transgenic organisms in agricultural and medical applications	Making recombinant DNA 1. isolation 2. digestion 3. insertion 4. ligation. - isolation DNA fragments are extracted from their natural sources There are two DNA fragments **Target gene:** the desired gene for protein **scaffold DNA : Dna molecule that the target gene is going to be inserted into EG PLASMID** - Digestion DNA fragments are cut using the **same restriction enzyme out of both the target gene and scaffold gene**

	REMEMBER STICKY ENDS(- insertion **sticky end bind,** so that the target gene is inserted into the **scaffold DNA** **= RECOMBINANT PLASMID** - ligation DNA ligase seals the backbone to produce a recombinant DNA molecule AGRICULTURE **Ge salmon**= - recombinant DNA technology - growth hormone(chinook salmon) and promoter gene(eel) = faster growth **BT cotton** - soil bacterium, bacillus thuringiensis - herbicide tolerant and pest resistant - improve crop yield, reduce soil pollution, feed increasing population - MEDICAL **insulin production** human gene of insulin is put into a bacteria = recombinant plasmid - bacteria reproduced, replication human insulin gene - insulin is extracted ,purified and bottled.
3.5 evaluate the benefits of using genetic technologies in agricultural, medical and industrial applications	INDUSTRIAL **Bio remediation** Is a branch of biotechnology that employs the use of living organisms, like microbes and bacteria, in the removal of contaminants, pollutants, and toxins from soil, water, and other environments. - advantages simple , no labour=m less $ environmentally friendly

	menial physical disrupt - Disadvantages slow results need knowledge on bio rem and planning has to be specifically tailored to each pollution site MEDICAL **INsulin production** - **advantages** identical to human insulin= less likely allergy large quantities can be produced no ethical issues as no longer using bigs it's absorbed more rapidly - **disadvantages** **production cost high, limit who can afford source of insulin.** AGRICULTURAL agriculture **bt corn** - advantages improve yei;d decrease solid pollution disease free crops feed increasing population demands. - disadvantage $$$$ and plants are sterile = purchase seeds every year effect ob gene flow- could transfer to wild crops pest might become resistant
3.6 evaluate the effect on biodiversity of using biotechnology in agriculture	• **Artificial insemination and artificial pollination can be used to cross organisms from the same species that would otherwise be unable to breed due to geographical barriers.**

	● **Recombinant DNA technology can be used to move genes between species, creating transgenic organisms** - iIntensive **farming practices** which promote the growth of crops and animals with "desirable" traits can lead to populations with low biodiversity. These populations are less likely to survive sudden environmental changes. ● GMOs can also escape into the wild, where they may **out-compete non-GMOs** directly. ● It is also possible that GMOs may interbreed with closely related species to **produce hybrids**. These hybrids may out-compete other organisms, and cause issues for farmers who are unable to control them.
3.7 interpret a range of secondary sources to assess the influence of social, economic and cultural contexts on a range of bio technologies	**SOCIAL** ● They specifically concern the rights that societies protect. **Social status** and **financial standing (access)= social inequity** - **human health - GM food and gene therapy** - **privacy- some biotech involve storage of genetic information**

	ECONOMIC ● GMO are often patented, making them more expensive ● There can be unequal distribution of wealth CULTURAL DS NDS BFKL DSHM,F Values and beliefs influence opinions about biotechnologies