

Genetic
s

- Genetics is a branch of biology concerned with the study of gene, genetic variation, and heredity in organisms.
- Heredity (biological inheritance), is the passing on of one traits from parents to their offspring.

what is the relation between ?

✓ Chromosomes

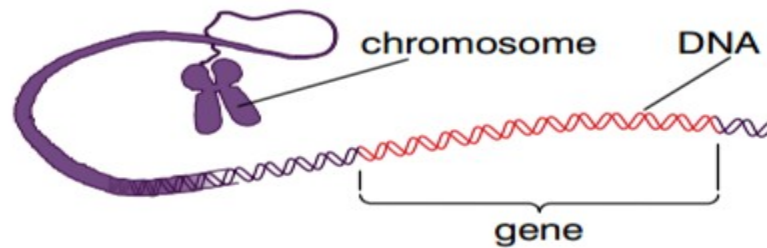
✓ Genes

✓ Alleles

- Chromosomes - are a thread-like structures located in side the nucleus of a cell.
 - made from DNA which is bound with histone protein

- Gene - is a section of DNA (therefore a section of chromosome that determines a particular feature).
For example - earlobe hang or free

* gene is a basic physic
chromosome.

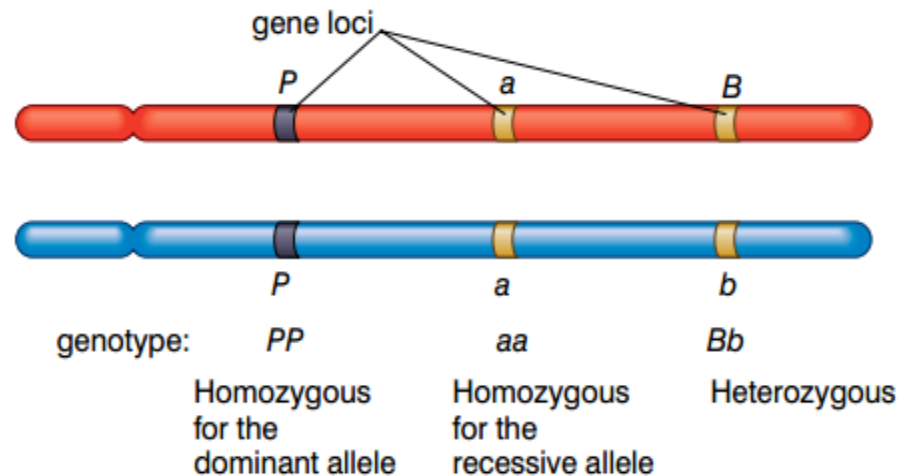


osition(locus) on a

- Alleles - are different “versions” of a gene

example a pea plant have purple and white allele.

■ Homologous chromosomes (a set of one maternal and one paternal chromosome that pair) carry alleles of the same loci.



- Dominant allele- expressed in the homozygote and heterozygote.(represented usually by capital letter)

Example - PP

Pp

purple

purple

- appear in F₁ generation

- Recessive allele- are only expressed in homozygote

Example - pp

-not appear in F₁ generation

- Co-dominant allele -both allele are expressed in heterozygote. Both allele of a gene equally expressed.

Example - flower color of snapdragons

R-red petals

RR-red flower

r-white petals

Rr-pink flower

rr-white flower

- Multiple allele inheritance - these are more than two alleles of a gene.

Example - allele involved in the inheritance of blood group.

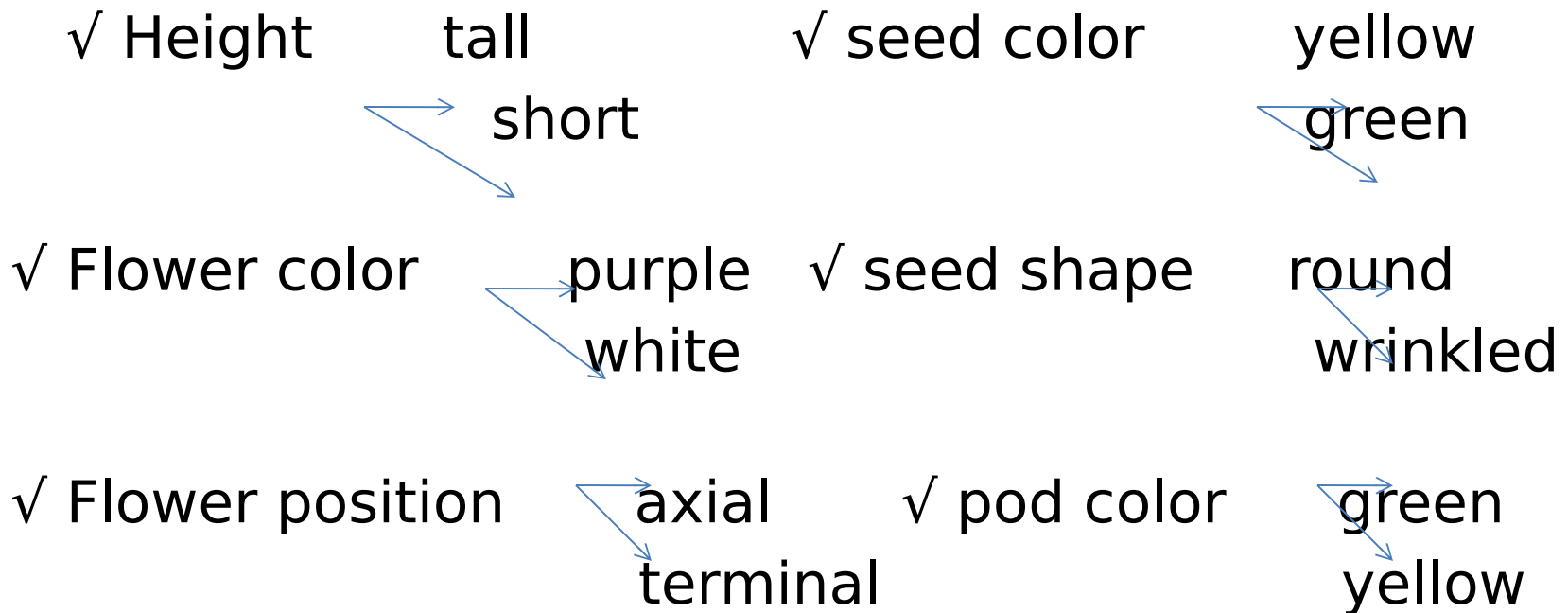
Genotype	Blood group
$I^A I^A, I^A I^O$	A
$I^B I^B, I^B I^O$	B
$I^A I^B$	AB
$I^O I^O$	O

- Monohybrid cross- is a genetic cross or breeding situation that relate to just one trait or feature.

The rule of inheritance was discovered by the Austrian monk Gregor Mendel .

- Mendel use the seven contrasting characteristics of pea plants in his experiments.

The contrasting characteristics are



- He crossed the trait following the same procedure for all contrasting characteristics .

Example

PP × Pp(white)

F1- Pp all purple

F2 – 3 purple, 1 white

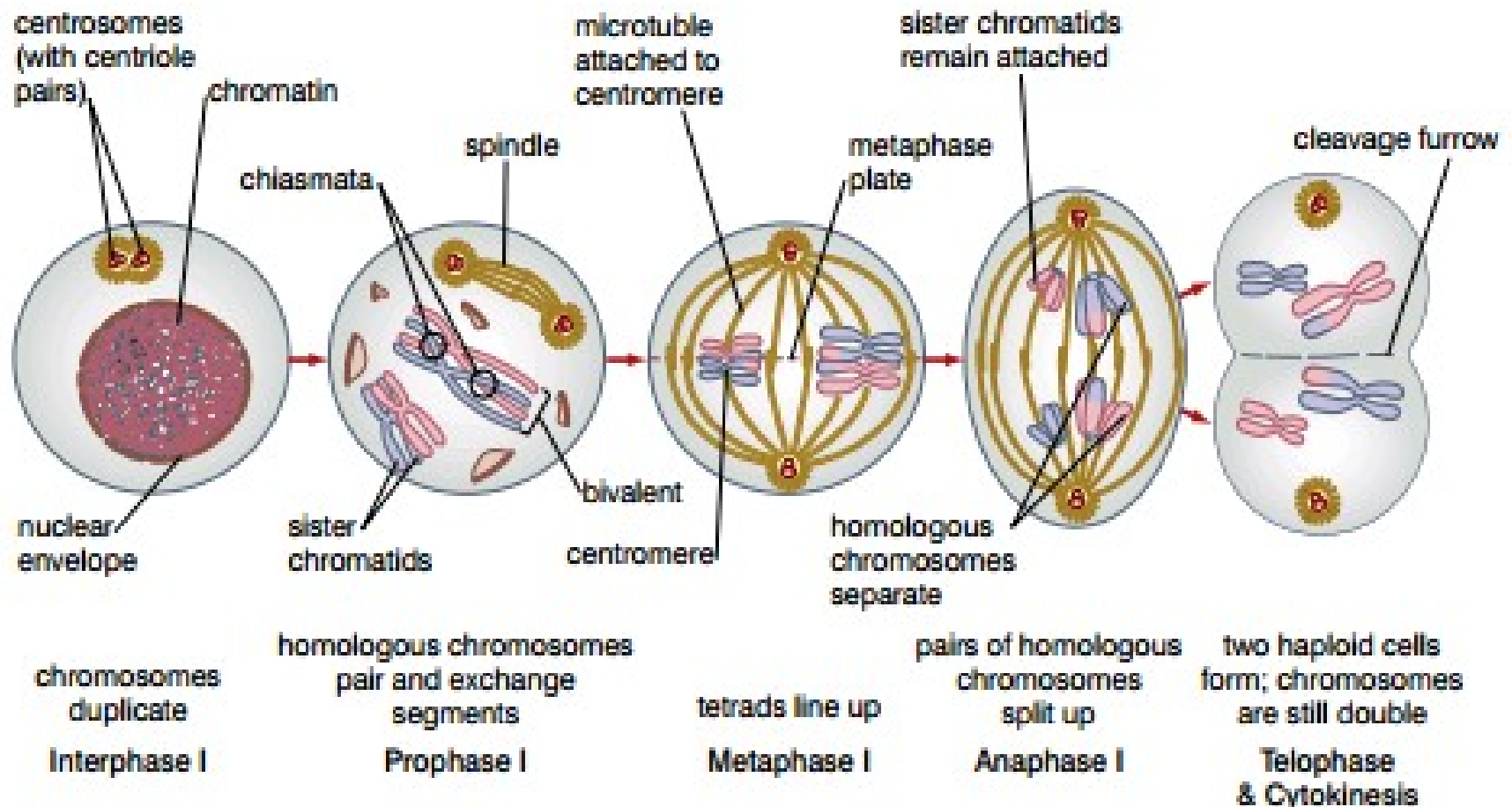
- Meiosis – For gametes to be formed special cells in the sex organ of the organism divide by a process known as **meiosis**.
 - a special type of a cell division is sexually reproducing organisms , used to produce the gametes(sex cells). The process is **Gametogenesis**.

Outcomes of meiosis

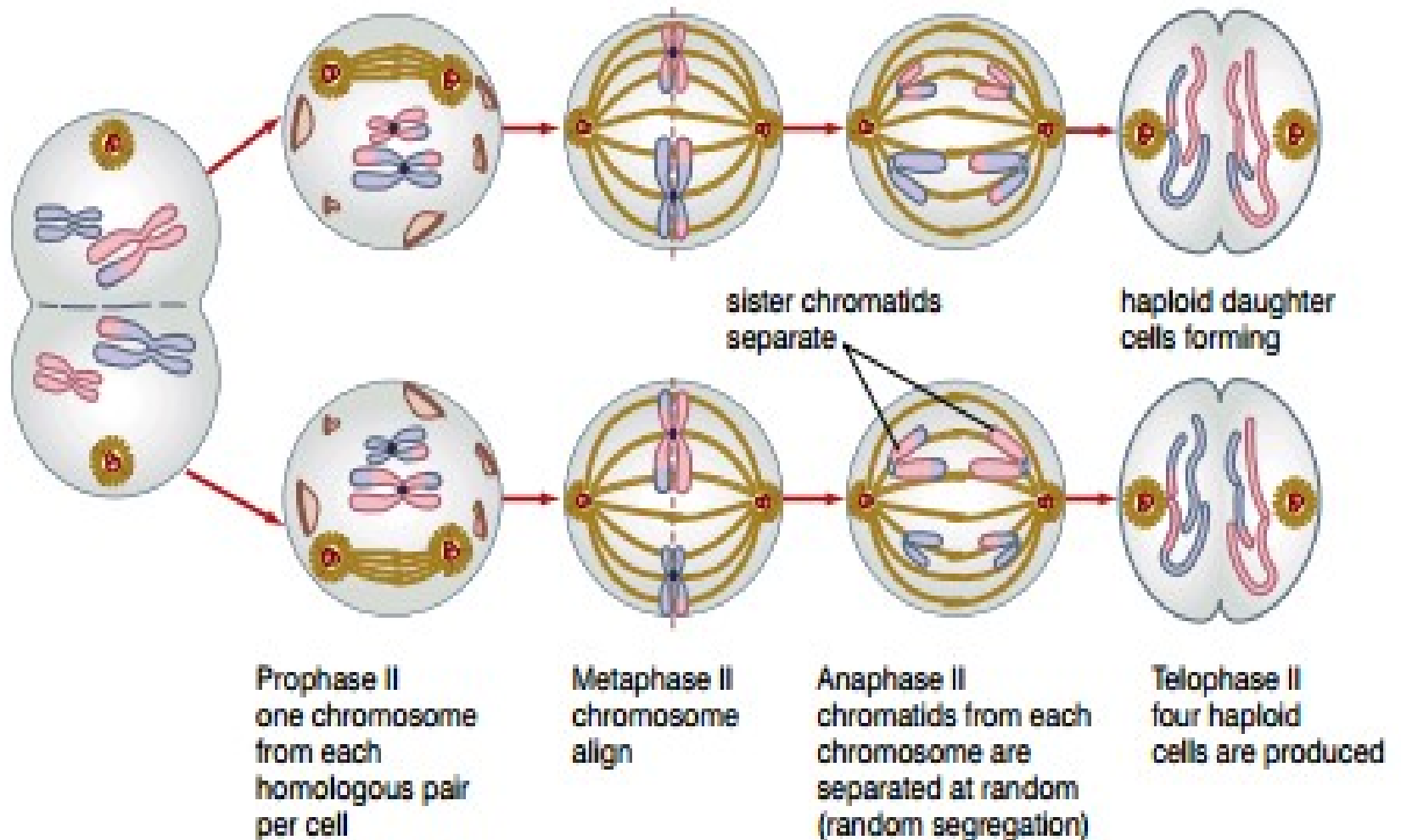
- * 4 haploid daughter cells
- * The daughter cells have only half the number of chromosome of original cells.
- * Daughter cells show genetic variation(as a result of crossing over in prophase I)

Two division of meiosis

- Meiosis I – chromosome that make up homologous pair are separated.



- Meiosis II – the chromatids that make up chromosome are separated.

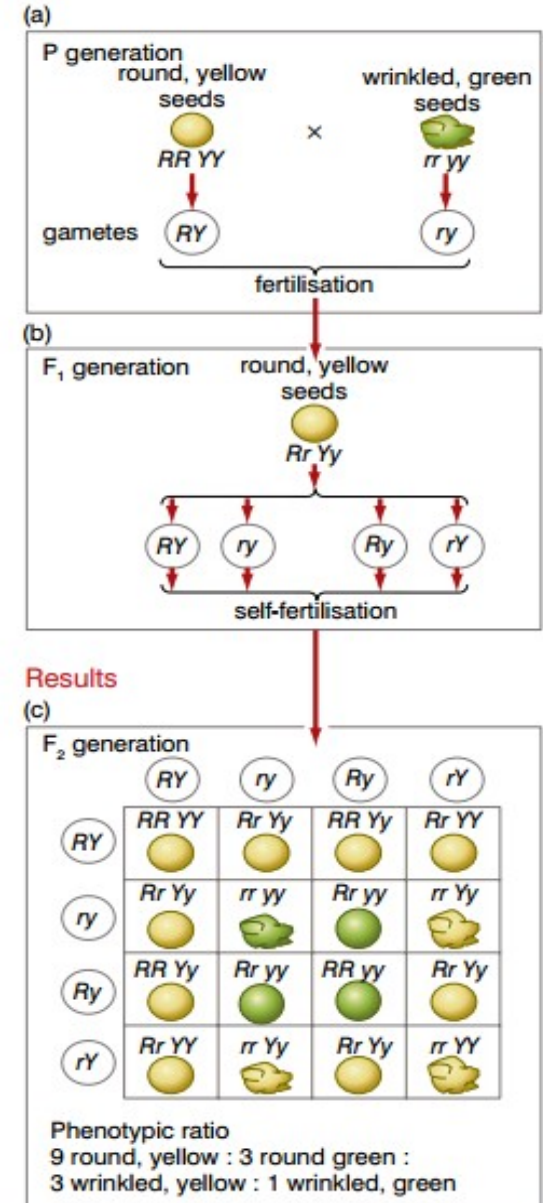


- **Independent assortment** of chromosomes at anaphase II.

- state that the inheritance of one trait is independent of the inheritance of another

Dihybrid inheritance

- the inheritance of two characteristics at the same time



- Genetic linkage

* if genes did not segregate, the genes are linked and inherited together because they are on the same chromosome. The two genes inherited as a single unit.

parent genotype PL/PL × pl/pl

Gametes

PL

	PL	pl
PL	PL/PL Purple, long	PL/pl Purple, long
pl	PL/pl Purple, long	pl/pl Red, round

F1 genotype PL/pl

(self-fertilised)

Gametes

male

female

PL pl

PL pl

- Crossing over in meiosis produces recombinant type of the offspring. So we get four types of offspring from a cross between two plants both heterozygous for both features. But not 9:3:3:1 ratio.
- Cross breeding results in hybrid vigour (heterosis) and can be used to combine desirable trait in one variety , whilst inbreeding is used to establish pure line.

- Sex determination

- . Gender in humans determine by x and y chromosomes.

- Male- xy

- Females- xx

- * The SRY gene found in x-chromosome determine sex in humans .

- * If SRY gene activated bi potential gonad develop to testes and the embryo is male.

- * If SRY gene is absent(or inactivated) bi potential gonad develop to ovary and the embryo is female.

- * Turner syndrome $\Rightarrow$ sterile female 45 chromosomes

- * Klinefelter syndrome $\Rightarrow$ sterile male 47 chromosomes



**results of non
disjunction of
sex
chromosomes
during meiosis**

- **sex- linked chromosome** - determined by alleles carried on the sex - chromosomes.
 - . Gene found on Y- chromosomes

Example retnitis pigmentosa

- . Gene found on X- chromosome

Example - red green color blindness
- haemophilia

- * Most sex-linked conditions are determined by recessive alleles on the x-chromosome , males are affected more frequently than female by these because they need only inherit one x-chromosome with recessive allele whilst females must inherit two.
- * Sex influenced and sex limited traits are expressed differently in two sexes. However the gene determines these trait.

- Sex influenced trait is more likely to occur in one sex but may sometimes occur in other sex.

Example – baldness

- Sex limited trait occur only in one sex and never occur in other sex.

example – gene that stimulate lactation.

DNA molecule – double helix in which the base sequence on the sense strand is complementary to the base sequence on antisense strand.

- DNA is a huge molecule made from two anti-parallel poly nucleotide strand.

- The basic unit of a DNA strand is a nucleotide

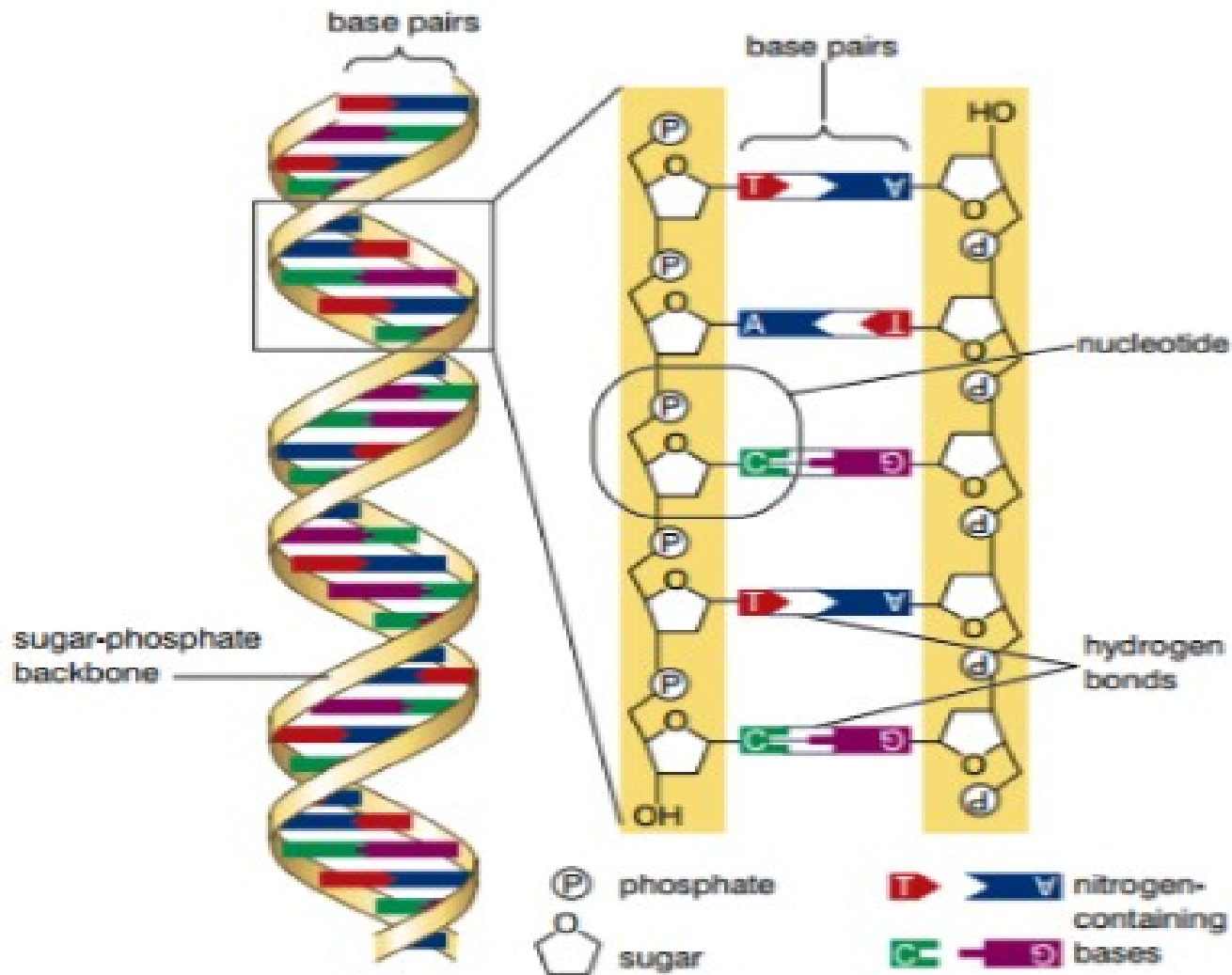
- Three components of nucleotides are

- . A phosphate group

- . A pentose sugar

- . Four nitrogenous base

* DNA must replicate semi conservatively means each new DNA molecule formed contain one strand from original DNA.

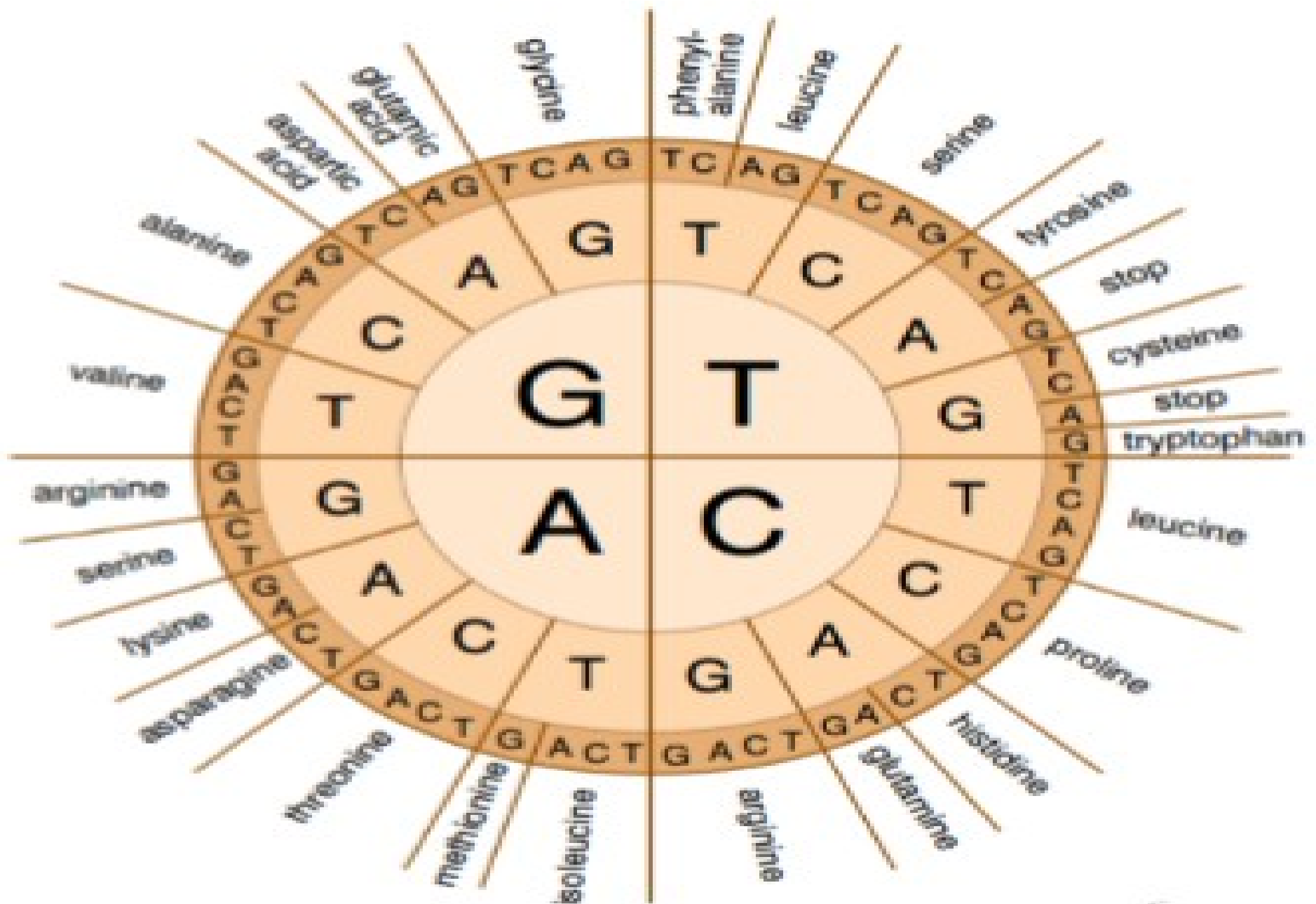


Cloning – is the process of producing genetically identical individuals of an organism either naturally or artificially.

- A clone of an organism is a group of organism that are genetically identical to each other and to organism from which they derived.
- Plants cloned using the technique of micropropagation.
- Animals have been cloned. The first mammal to be cloned was dolly the sheep.
- There are two types of cloning in vivo-cloning and in vitro-cloning.
- Genetic engineering – is a process in which the genome of an organism is altered, usually by having an extra gene from different organism added.
- A genome is an organism's complete set of DNA including all of its gene.
- A transgenic organism has had genes from a different type of organism (usually a different species) added to its genome.
- Restriction enzymes cut DNA at specific sequences, called restriction site, to leave overlapping stick ends.
- A gene inserted into a plasmid using a ligase enzyme.

- Genetically modified organisms can be used to manufacture specific products to benefit humans (for example insulin, vaccine, etc).
- Other organisms have also been genetically modified to produce increased yields.
- Genetic fingerprinting – is a technique of comparing the DNA of different people.
- The main stages in preparing genetic fingerprint
 - ✓ preparation of fragments using restriction enzyme
 - ✓ The fragments separated by gel electrophoresis.
 - ✓ DNA fragment transferred from the gel to nylon membrane (blotting DNA to membrane).
 - ✓ Hybridization with radio active probe made of single stranded DNA.
 - ✓ Autoradiography (the pattern of complementary sequence revealed using x-ray film).

- Protein synthesis
 - ribosome is the organelle of a cell that make protein.
 - the code for protein is specified by DNA.
- * Genetic code – is a triple code meaning that three bases in DNA code for amino acid in protein, only one of the strand of DNA molecules carried. The other strand is non-coding (antisense strand).
- * There are only 20 amino acids but 64 possible triplets codes.



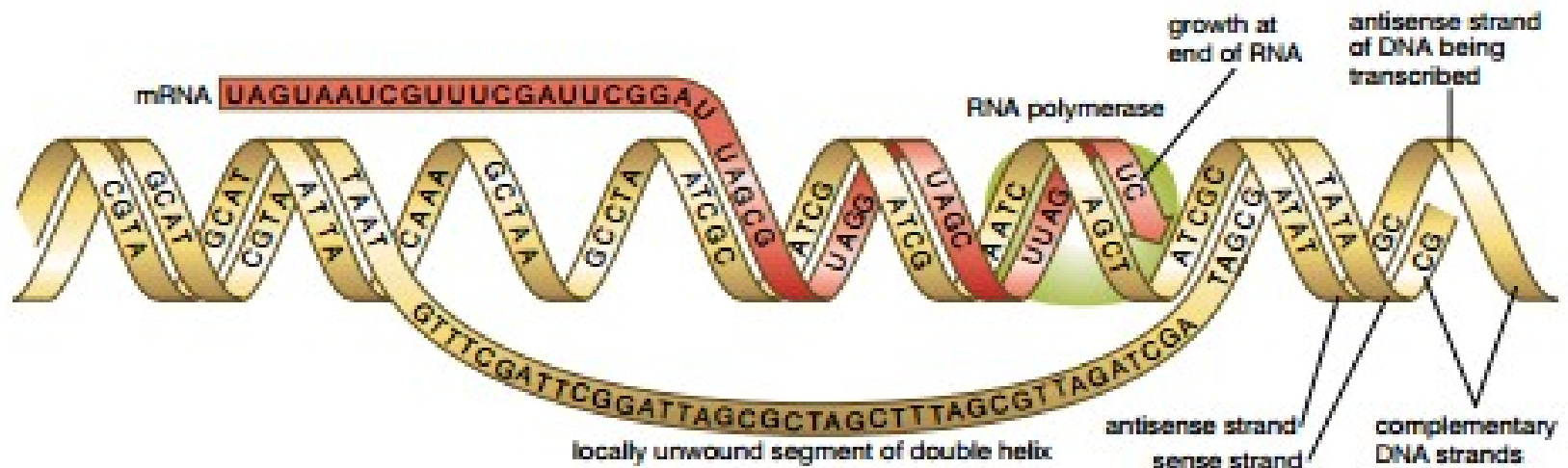
- mRNA is similar to DNA it is built from nucleotide

How ever ,it is different from DNA in the following ways

- ✓ it is much smaller molecule.
- ✓ it is single stranded.
- ✓ the base thymine is replaced by uracil.
- ✓ the sugar in the nucleotide is ribosome.
- the triple of base in m RNA that code for amino acid are called **codons** .The mRNA codons are identical to DNA triplet except that uracil is substituted for thymine.

The main events during protein synthesis are transcription and translation.

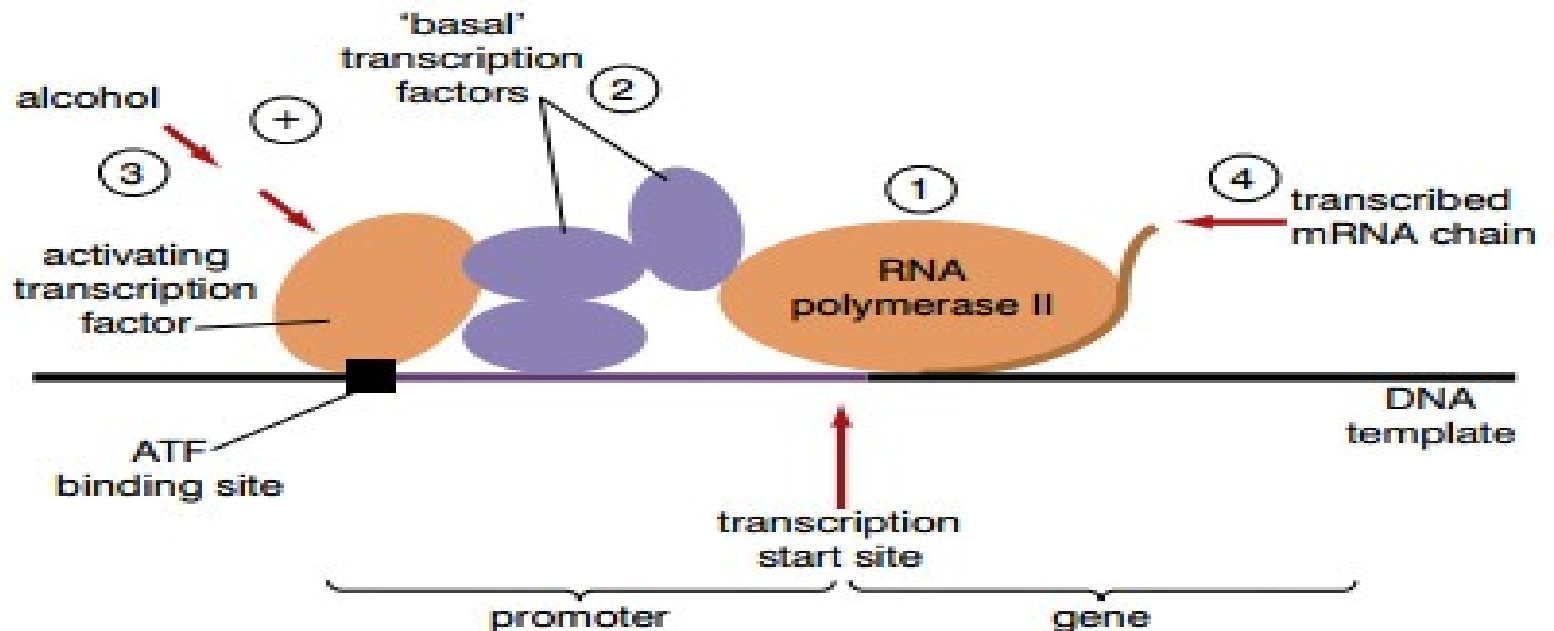
- Transcription – the mechanism by which the base sequence of a section DNA representing gene is converted into complementary base sequence of mRNA occur in the nucleus.
- In the transcription of the DNA in gene RNA polymerase uses RNA nucleotide to build the single-stranded mRNA molecule that has a base sequence complementary to the strand of DNA being transcribed.
- To form mRNA by transcription only the antisense strand transcribed.



- Translation - the mechanism by which sequence of a base in mRNA molecule converted into sequence of amino acid in a polypeptide chain. It occurs in ribosome.
 - * During translation of mRNA into polypeptide chain, tRNA molecules with anticodon complementary to mRNA ; their amino acids from a peptide bond and one of the tRNA molecules leaves and the process is repeated.
- The proteins produced have a variety of functions, they may be
 - structural proteins - collagen, keratin
 - enzymes - ATP synthase, DNA helicase
 - peptide hormones - insulin, adrenaline
 - antigens - antigen on red cells, CD4
 - antibodies - HIV antibodies

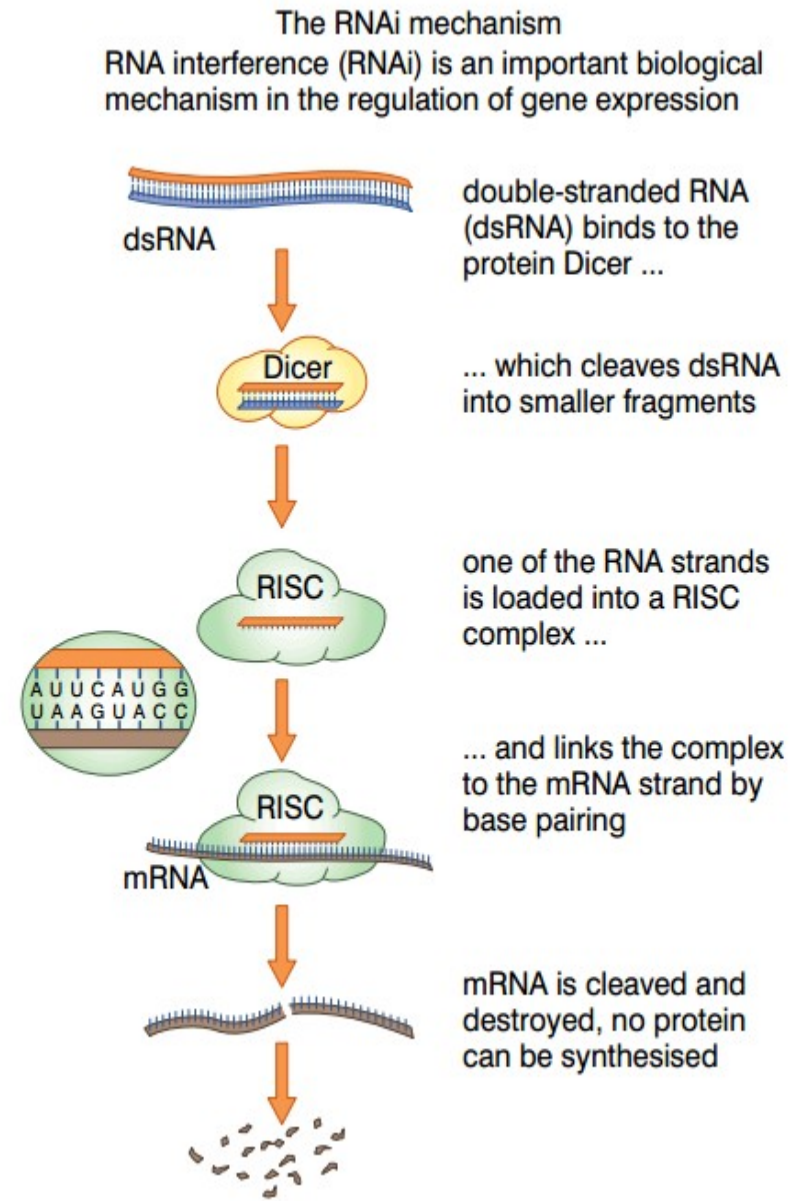
● Gene switch on

- transcription factors are necessary to activate genes, these are protein that bind the promoter regions next to a gene and allow RNA polymerase to transcribe the gene



● Gene switch off

- molecules of short inter RNA (si RNA) can silence by degrading the mRNA transcribed from the gene
- si RNA has the potential to treat condition such as AIDS by preventing replication of HIV and cancers by silencing genes that enhance cell division



● Mutation is any spontaneous change in the genetic material of organism.

• Mutation classified into two as

1. Point mutations(gene mutations) – are spontaneous changes in a single base on DNA molecule.

different types of gene mutation are

- substitution
- addition
- deletion

- Substitution replace one base with another , because the code is degenerate, there may be no change in the amino acid coded for.
- Deletion and addition both cause a frame shift, these mutations after all this point also.

- In addition mutation an extra base added
- In a deletion mutation a base missed out during replication.
- Chromosomal mutation occur when there is any change in the arrangement or structure of chromosomes.

example of chromosomal mutation

✓ inversion

✓ duplication

✓ deletion

✓ chromosome

non-disjunction

✓ insertion

✓ translocation

- the rate of mutation can be increased by the following factors
 - carcinogenic chemicals , high energy radiation
- if proto-oncogenes mutate to become active oncogenes they will stimulate the cell to divide in a control manner.
- if tumour suppressor genes mutate and fail to regulate cell division a tumour may form.
- mutation can be inherited, if a mutation is beneficial the frequency of the mutated allele will increase on