Genetics

- *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.

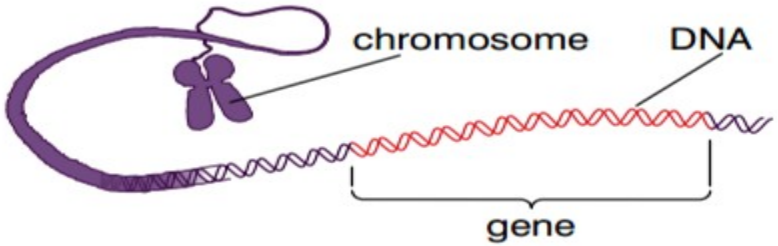
what is the relation between ?

√ *Chromosomes*

√ *Genes*

- **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
  - purpl
  - tall o

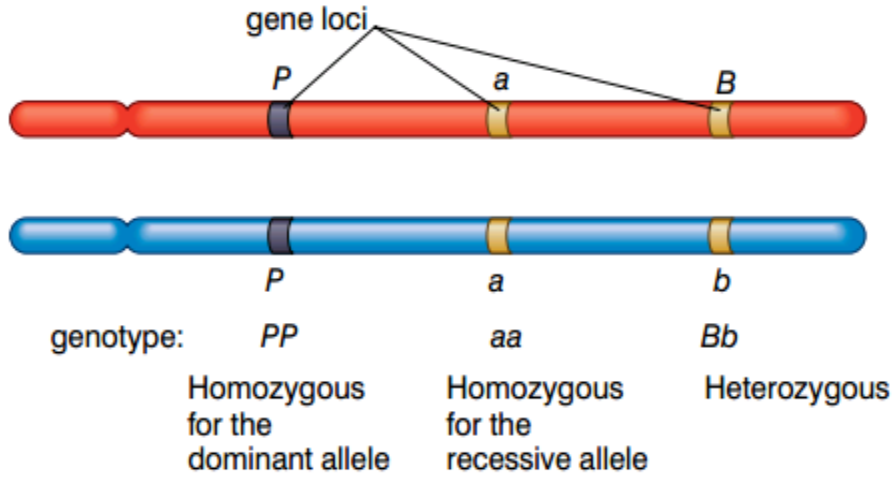


* gene is a basic physic osition(locus) on a chromosome.

- **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 chromosc eles of the sai loci.



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

  Example - PP Pp

  purple purple

  - appear in F_1 generation

- **Recessive allele**- are only expressed in homozygote

  Example - pp

  -not appear in F_1 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^AI^A, I^AI^O	A
I^BI^B, I^BI^O	B
I^AI^B	AB
I^OI^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

  √ Height → tall
  → short

  √ seed color → yellow
  → green

  √ Flower color → purple
  → white

  √ seed shape → round
  → wrinkled

  √ Flower position → axial
  → terminal

  √ pod color → green
  → yellow

  √pod shape → inflated
  → constricted

- 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**.

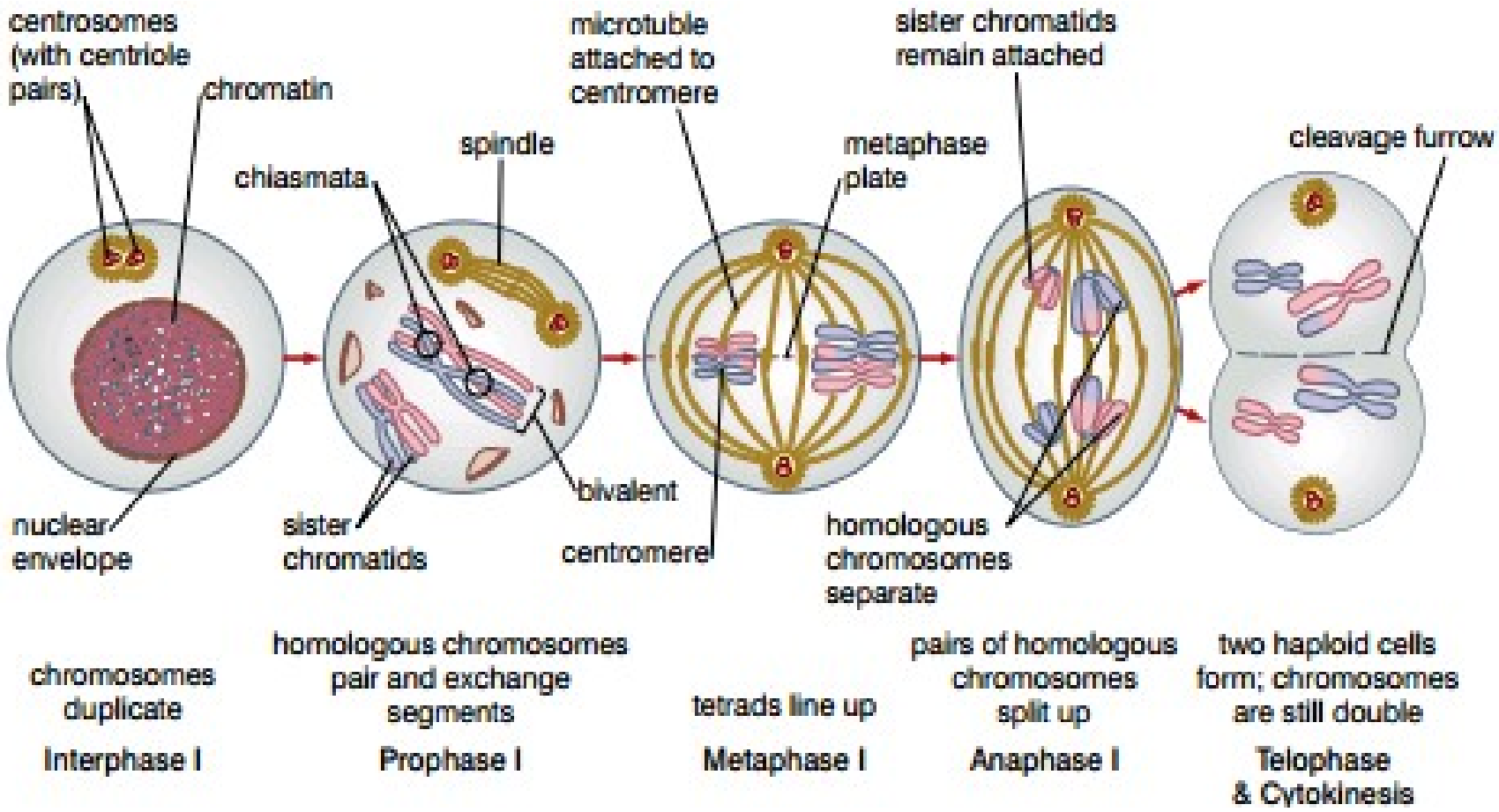
  - a special type of a cell division is sexually reproducing organisms , used to produce the gametes(sex cells). The process is **Gametogenesis.**

  Outcomes of meiosis

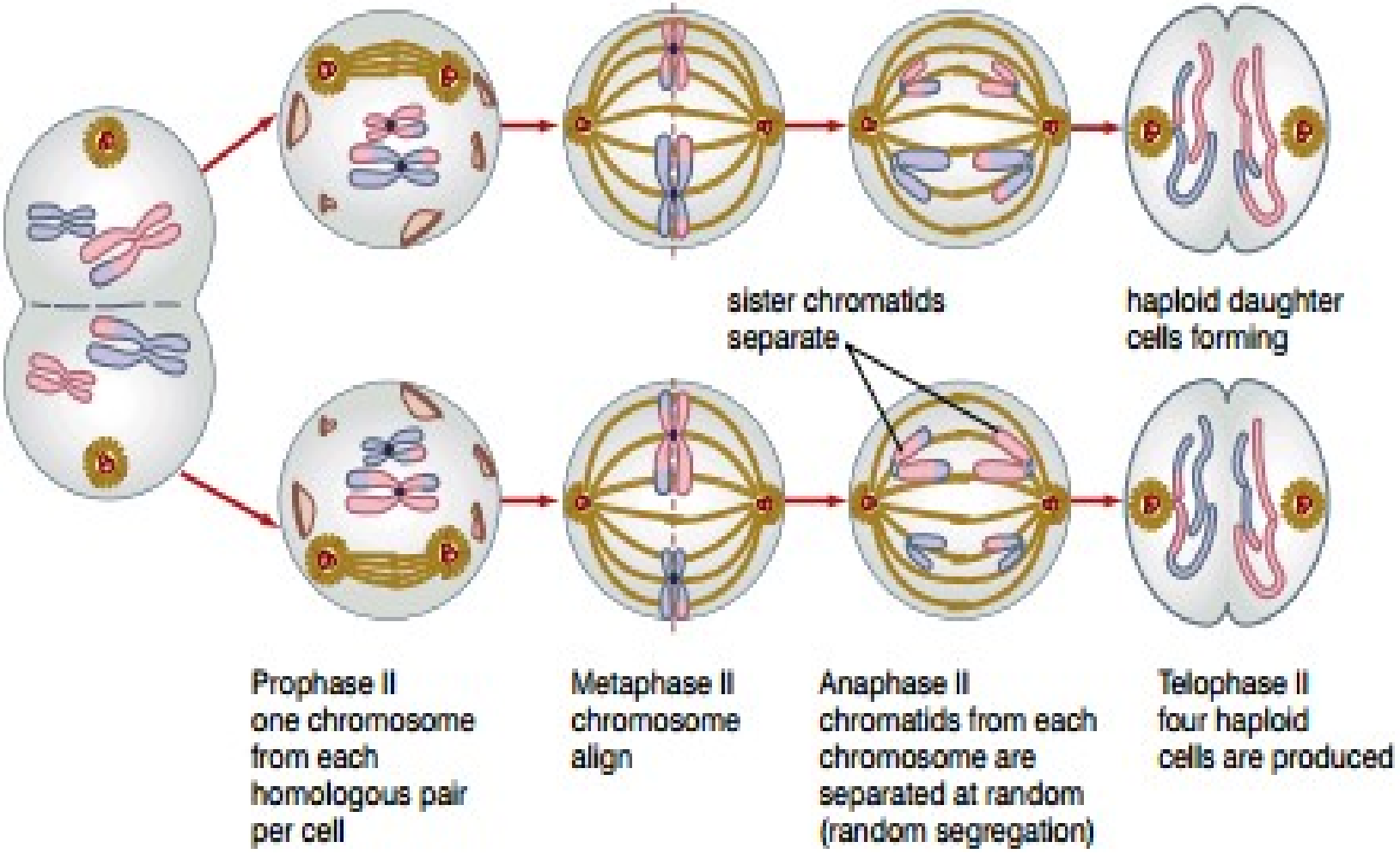
* 4 haploid daughter cells
* The daughter cells have only half the number of chromosome of original cells.
* Daughter cells show genetic variation(as a result of crossing over in prophase I)

Two division of meiosis

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



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



- **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

F1 genotype PL/pl

(self-fertilised)

Gametes male female

PL pl PL pl

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

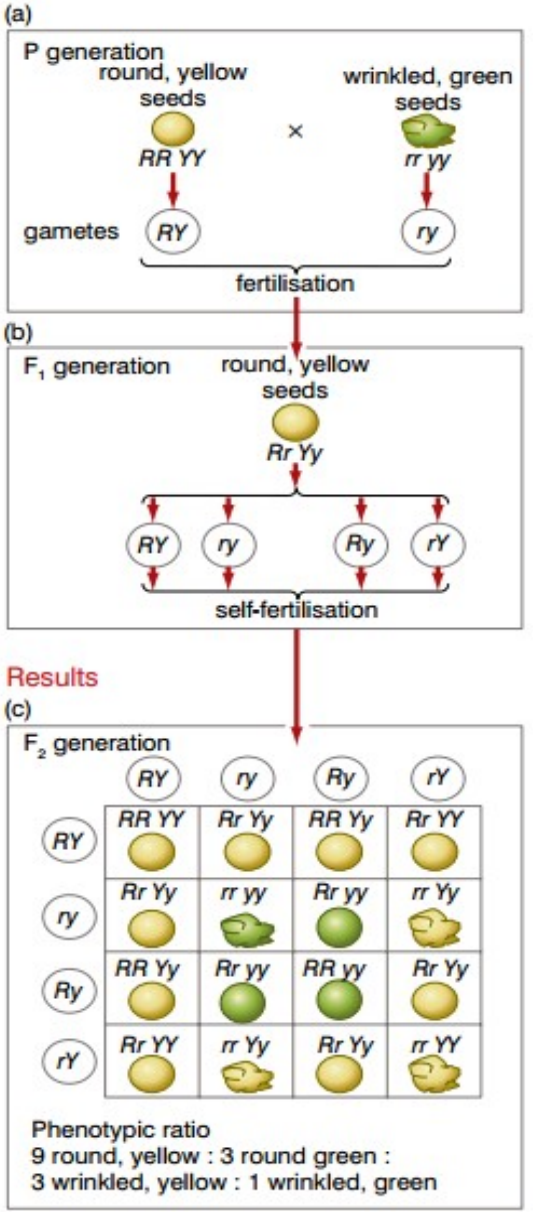
- Crossing over in meiosis produces recombinant type of the offspring. So we get four types of offspring from a cross between two plants both heterozygous for both features. But not 9:3:3:1 ratio.
- **Cross breeding** results in hybrid vigour (heterosis) and can be used to combine desirable trait in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

- **Independent assortment**

- state that the inh
of one trait is indepe
of the inheritance of

Dihybrid inheritance

– the inheritance of two characteristics at the same



- **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⟹ sterile female 45 chromosomes

* Klinefelter syndrome⟹ 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 polynucleotide strand.

- The basic unit of a DNA strand is a nucleotide

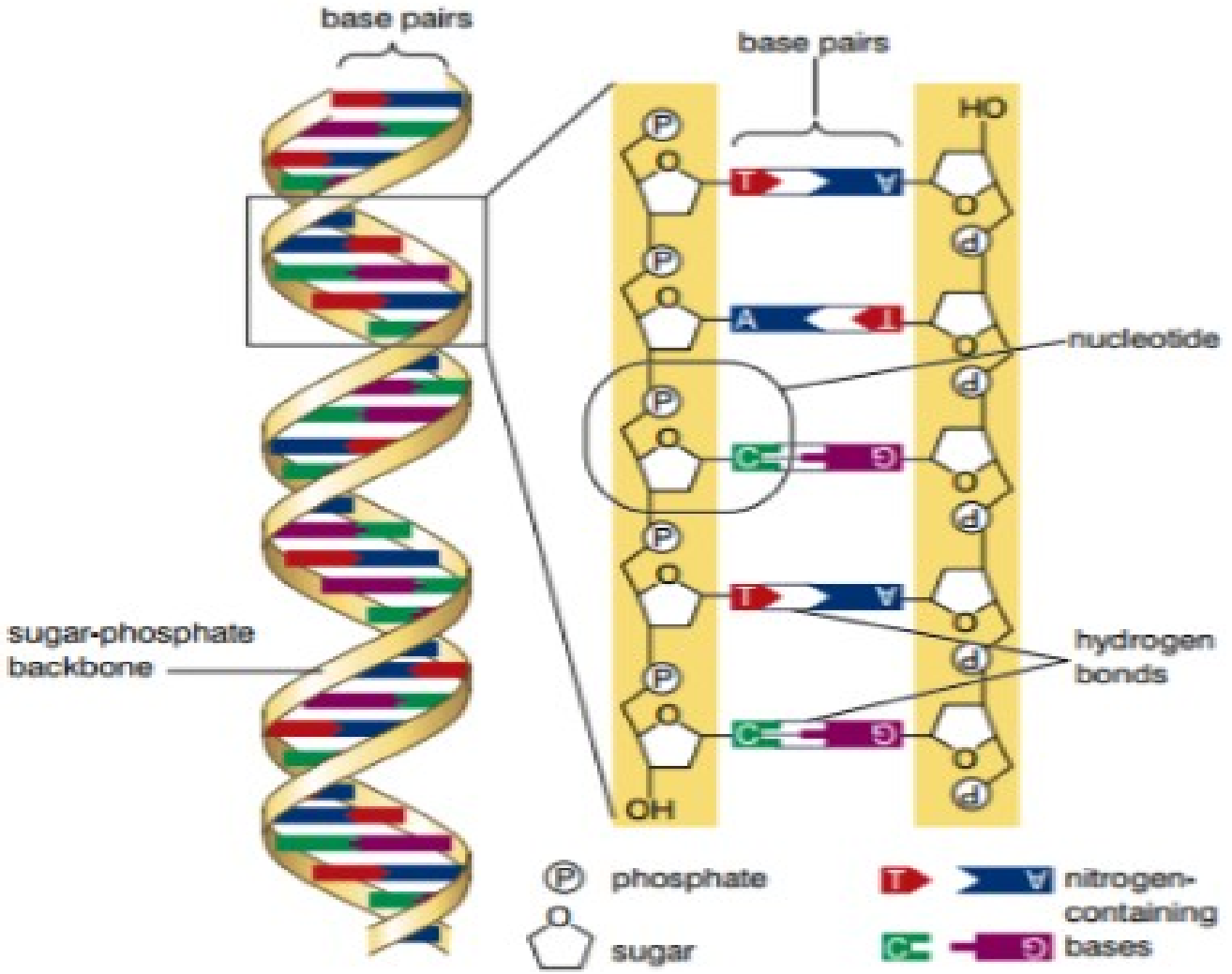
- Three components of nucleotides are

. A phosphate group

. Four nitrogenous base

. A pentose sugar

* 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.

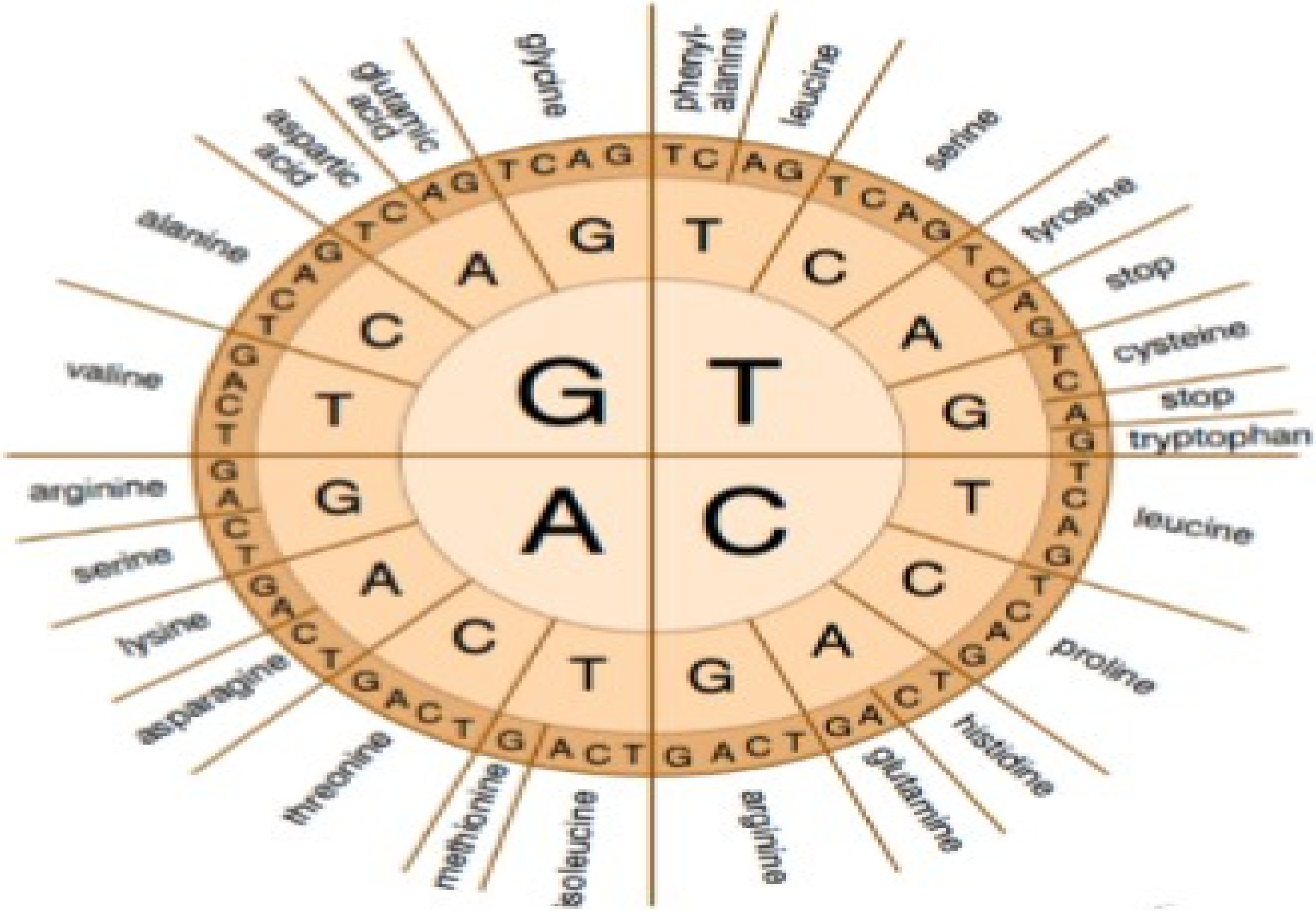
- **Protein synthesis**

  - 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.


G
T
A
C
glycine
glutamic acid
aspartic acid
alanine
valine
arginine
serine
lysine
asparagine
threonine
methionine
isoleucine
phenyl-alanine
leucine
serine
tyrosine
stop
cysteine
stop
tryptophan
leucine
proline
histidine
glutamine
arginine

- m RNA 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 in repeated.

- The protein produced have a variety of function, they may be
  structural protein - collagen keratin
  enzymes – ATP synthase, DNA helicase
  peptide hormones – insulin, adrenaline
  anti-genes - 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 interfering RNA (si RNA) can silence genes by degrading the mRNA transcribed from the genes.

  - 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.

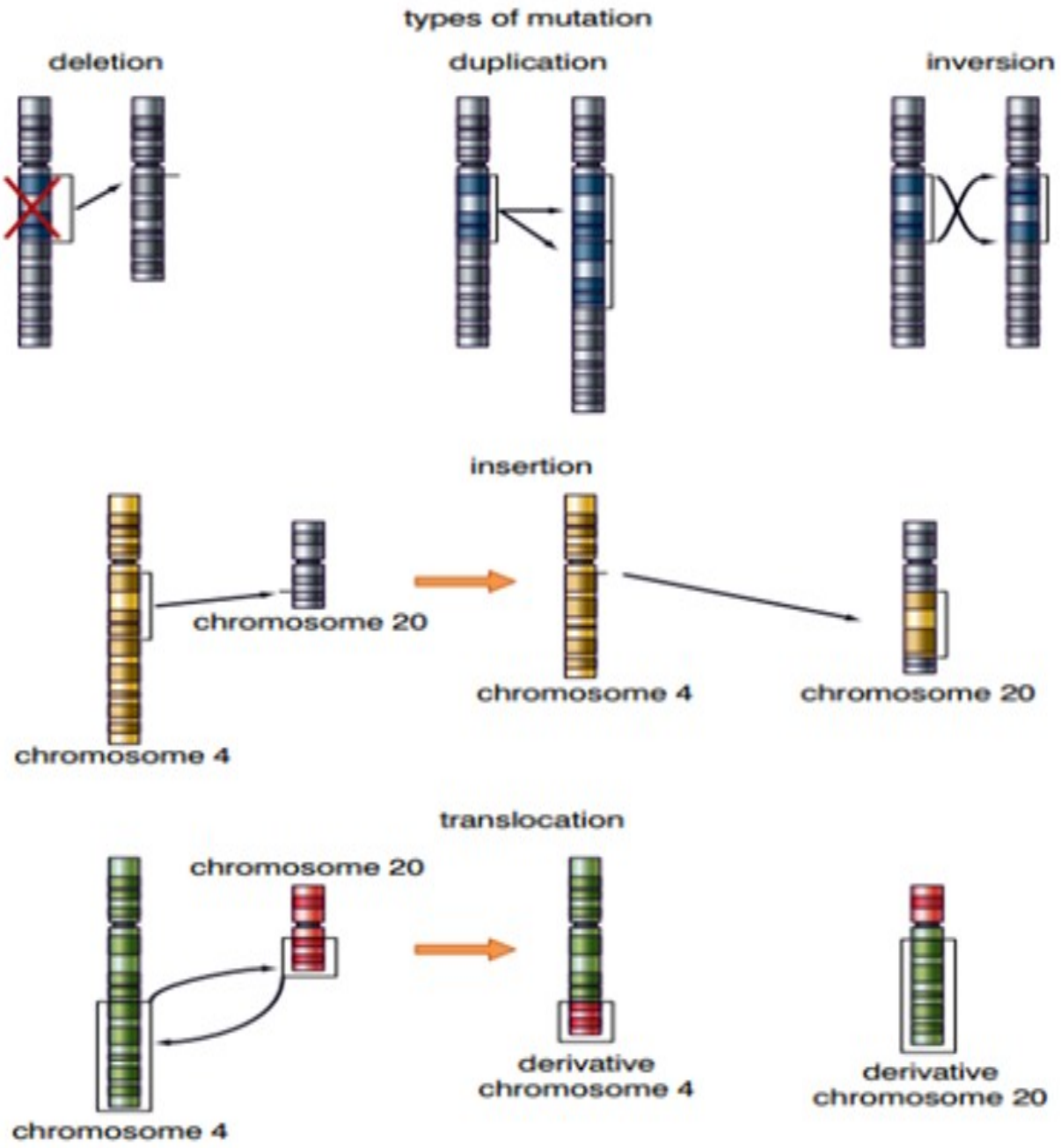
- **2 Chromosomal mutation** occur when there is any change in the arrangement or structure of chromosomes.

  example of chromosomal mutation

  √ inversion √ duplication

  √ deletion √ chromosome non-disjunction

  √ insertion √ translocation


types of mutation
deletion
duplication
inversion
insertion
chromosome 20
chromosome 4
chromosome 4
chromosome 20
translocation
chromosome 20
chromosome 4
derivative
chromosome 4
derivative
chromosome 20