

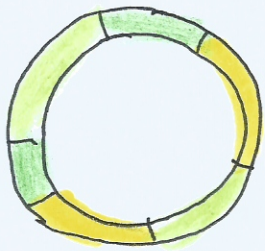
3.2 CHROMOSOMES

PROKARYOTIC GENETICS

- They do not have a nucleus
- Genetic material is found free in the nucleoid
- The genetic material consists of a single chromosome consisting of a circular DNA molecule (genophore).

PLASMIDS

- can be used for gene manipulation
- They are small circular DNA molecules that contain only few genes and are capable of self-replication.

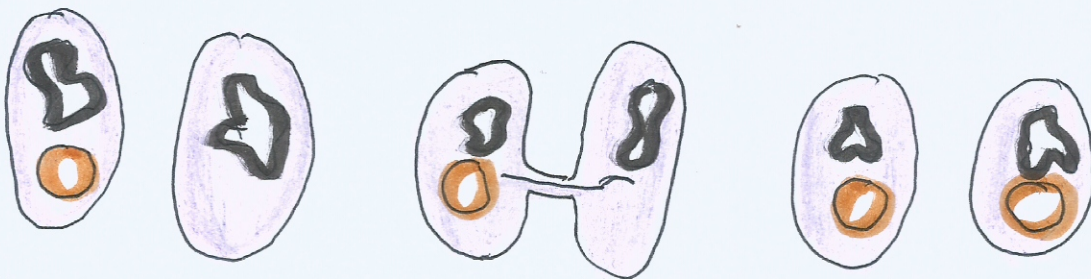


- They are present in some of the prokaryotes but are unusual in eukaryotes.

- Plasmids aren't always replicated at the same time and rate as the chromosomes of a prokaryote do.

- Copies of plasmids can be transferred from one cell to another and can cross species as well.

- Bacterial cells can exchange plasmids via the sex pili in a process known as bacterial conjugation.



Bacterial conjugation.

EUKARYOTE CHROMOSOMES

They are linear DNA molecules associated with histone proteins.

- The chromosomes are composed of DNA and protein.
- There are many histones molecules in a chromosome with the DNA molecule wound around them.

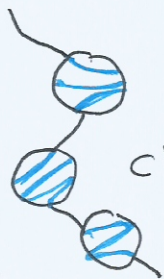
Organisation of chromosomes:



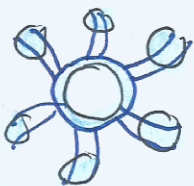
DNA



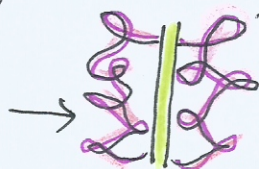
nucleosome



chromatin

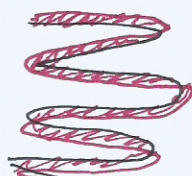


solenoid

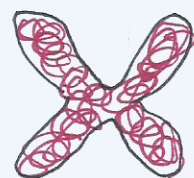


fibre

Interphase
chromatin



metaphase
chromosome



- DNA is complexed with 8 histone proteins to form a **nucleosome**.

- **Nucleosomes** are linked by H1 histone to form a string of **chromatin**.

- **Chromatin** coils to form a **solenoid** structure which condenses to form a **30nm fibre**.

- The fibres are compressed and folded around a protein scaffold to form **chromatin**.

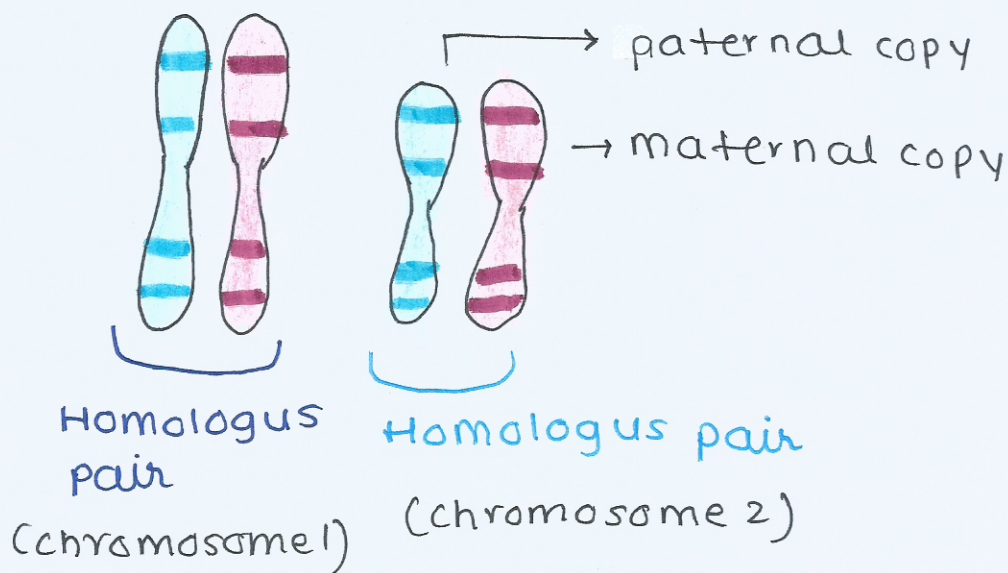
- **Chromatin** is supercoiled during cell division to form **chromosomes**.

HOMOLOGOUS CHROMOSOMES

They carry the same sequence of genes but not necessarily the same alleles.

- Homologous chromosomes have the same structural features.
- They have the same genes at the same loci.

They must be separated in gametes before the process of reproduction so that the chromosomes do not double with each generation.



HAPLOID AND DIPLOID

Diploid ($2n$)

- nuclei possessing pairs of homologous chromosomes
- they possess two gene copies for each trait
- Diploid nuclei in humans contain 46 chromosomes.
- when 2 haploid gametes fuse together, a zygote with a diploid nucleus is produced.

Advantage:

- The effects of harmful recessive mutations can be avoided if a dominant allele is also present.
- organisms are more vigorous if they have 2 different alleles of genes instead of one. This is known as **hybrid vigour**.



diploid
(2n)



haploid
(n)

Haploid (n):

- nuclei possessing only one set of chromosomes are haploid.
- they have a single gene copy for each trait.

→ all gametes in the organism are haploid and are derived from diploid cells via meiosis.

→ Human gametes contain 23 chromosomes.

CHROMOSOME NUMBERS

chromosome number is a characteristic feature of members of a species.

- Organisms with different number of chromosomes are unlikely to be able to interbreed.
- Even if they do interbreed, they won't produce a fertile offspring.

HORSE

$2n = 64$

$n = 32$

DONKEY

$2n = 62$

$n = 31$

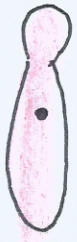
MULE (infertile)

$2n = 63$

$n = x$

SEX DETERMINATION

X chromosome



- found in males and females

- relatively larger
- centromere in the middle.

Y chromosome



- found in only males

- relatively smaller
- centromere at the end

Females have 2 copies of X chromosome (xx).

Males have one copy of X chromosome and one copy of Y chromosome (XY).

The Y chromosome contains the genes for developing male characteristics (SRY gene).

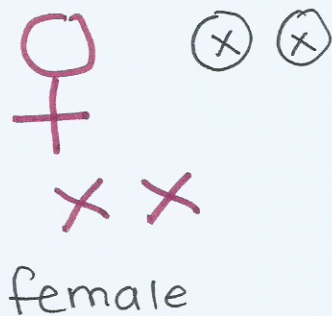
- If the Y chromosome is absent, female organs will develop.

The father is responsible for sex determination of the offspring.

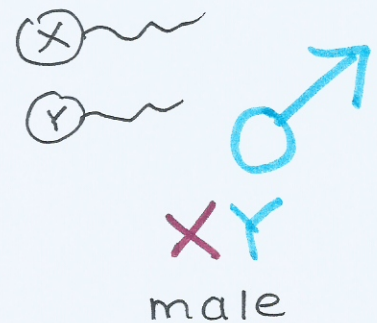
In all cases, female egg will contain an X chromosome.

- If male sperm contains X, the embryo will develop into a girl.
- If male sperm contains Y, the embryo will develop into a boy.

Autosomes: The other chromosomes (excluding sex chromosomes) in the organism.



XX	XY
XX	XY



KARYOGRAMS

A karyogram shows the chromosomes of an organism in homologous pairs of decreasing length.

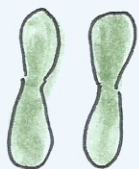
- The position of centromere and the banding on the chromosomes allow the separation of the chromosomes that are of a different type but similar size.

Uses:

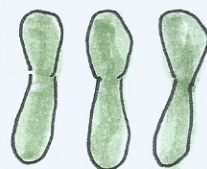
- To determine the gender of the unborn child.
- Test for chromosomal abnormalities.

Down syndrome:

- 3 copies of chromosome 21
- delayed development



normal



down syndrome