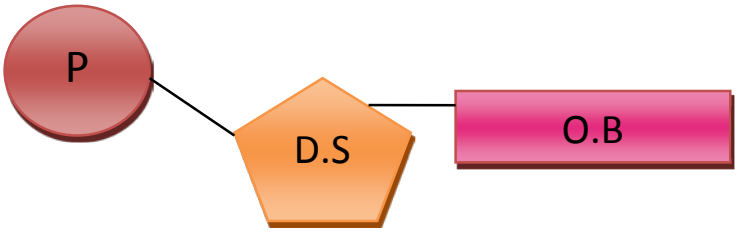
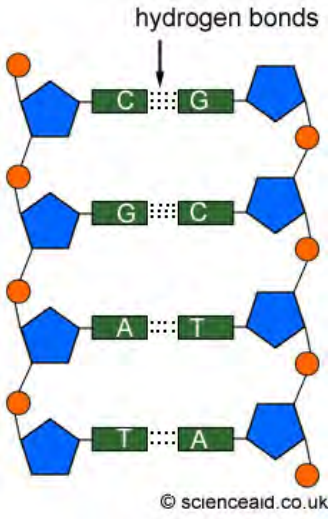
DNA and meiosis



Nucleotide structure:
- A sugar called deoxyribose.
- A phosphate group.
- An organic base belonging to one of two groups: (a) Single-ring: cytosine and thymine.
  (b) Double-ring: adenine and guanine.

The deoxyribose sugar, phosphate group and organic bases are a result of condensation reactions to give a **mononucleotide**.
Two nucleotides combine to form a **dinucleotide.**
The continuous linking of monucleotides forms a long chain known as a **polynucleotide.**

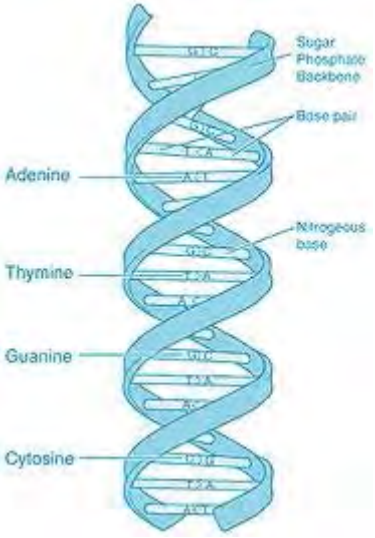
DNA structure:
In 1953, Watson and Crick worked out the structure of DNA.
DNA is made of two strings of nucleotides each of which is extremely long. They are joined by hydrogen bonds formed between bases.



Pairing of bases
The organic bases contain nitrogen and are of two types.
Those with a double-ring structure have longer molecules than those with a single-ring structure.
- Adenine always pairs with thymine by two hydrogen bonds.
- Guanine always pairs with cytosine by three hydrogen bonds.

Adenine is said to be complementary to thymine and guanine is said to be complementary to cytosine.

The function of DNA
DNA is adapted to carry out its functions in a number of ways:
- It is very stable and can pass to generations without change.
- Its two separate strands are joined only with hydrogen bonds which allow them to separate during replication.
- It is a large molecule and carries an immense amount of information.
- By having the base pairs in the helical cylinder the information is protected from being corrupted.



The triplet code

What is a gene?

Genes are sections of DNA that contain the coded info for making polypeptides.
The coded information is in the form of a specific sequence of bases.
Polypeptides combine to make proteins and so genes determine the proteins of an organism.
As enzymes control chemical reactions they are responsible for an organism's developments and activities.

The triplet code

Scientist suggested that there must be a minimum of three bases that coded for each amino acid.

- Only 20 amino acids regularly occur in proteins.
- Each amino acid must have its own code of bases.
- Only four bases are present in DNA.
- If each based coded for a different amino acid, only four amino acids could be coded for.
- Using a pair of bases, 16 codes are possible.
- Three bases produce 64 codes.

Further experiments have revealed the following features of the triplet code:

- A few amino acids have only a single triplet code.

- The remaining amino acids have 2-6 triplet codes each

- The code is known as a degenerate code.

- The triplet code is always read in one direction.

- The start of a sequence is always the same triplet code.

- Three triplet codes do not code for any amino acid and are known as stop codes.

- The code is non-overlapping.

- The code is universal.

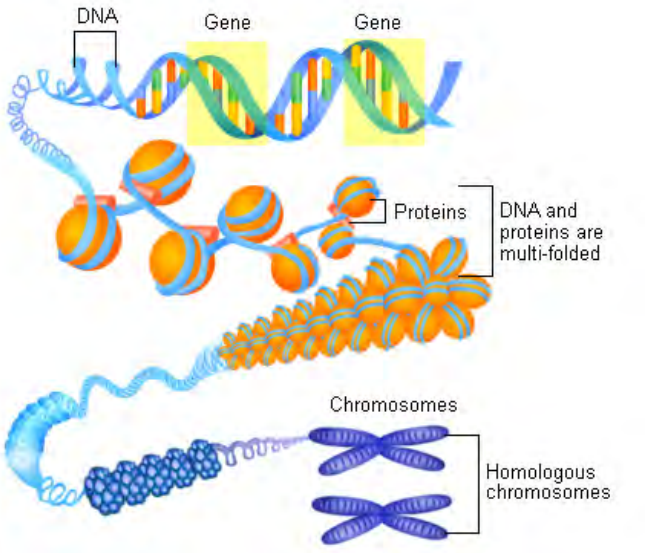
DNA and chromosomes

- In prokaryotic cells, such as bacteria, the DNA molecules are smaller; they form a circle and are not associated with protein molecules. They therefore do not have chromosomes.

- In eukaryotic cells, the DNA molecules are larger; they form a line and occur in association with proteins to form chromosomes.

Chromosome structure

- Only visible as distinct structure when a cell is dividing. The rest of the time they are widely dispersed throughout the nucleus.
- When visible they appear as two threads joined at a single point.
- Each thread is called a chromatid.
- The DNA in chromosomes is held in position by proteins.
- The length of DNA is highly coiled and folded.



The DNA is coiled and the looped and further coiled before being packed into the chromosome.

The number of chromosomes varies from one species to another. For example humans have 46 chromosomes whereas, potato pants have 78. In almost all species there is an even number of chromosomes in the cells of adults this is because they occur as homologous pairs.

Homologous chromosomes:

Sexually produced organisms are the result of the fusion of a sperm and egg. One of each pair is derived from the chromosomes provided by the mother and the other derived from the chromosomes provided by the father. These are known as homologous pairs and the total number is referred to as the diploid number.

During meiosis halving the number of chromosomes is done in a manner which ensures each daughter cell receives one chromosome from each homologous pair.

What is an allele?

Each gene exists of two, or occasionally more different forms. Each of these forms is called an allele. Each individual inherits one from each parent.
Any differences in the base sequence of an allele may result in a different sequence of amino acids being coded for.

Meiosis and genetic variation

The division of the nucleus of cells occurs in one of two ways:
- **Mitosis** produces 2 daughter nuclei with the same number of chromosomes as the parent cell and as each other.
- **Meiosis** produces 4 daughter nuclei, each with half the number of chromosomes as the parent cell.

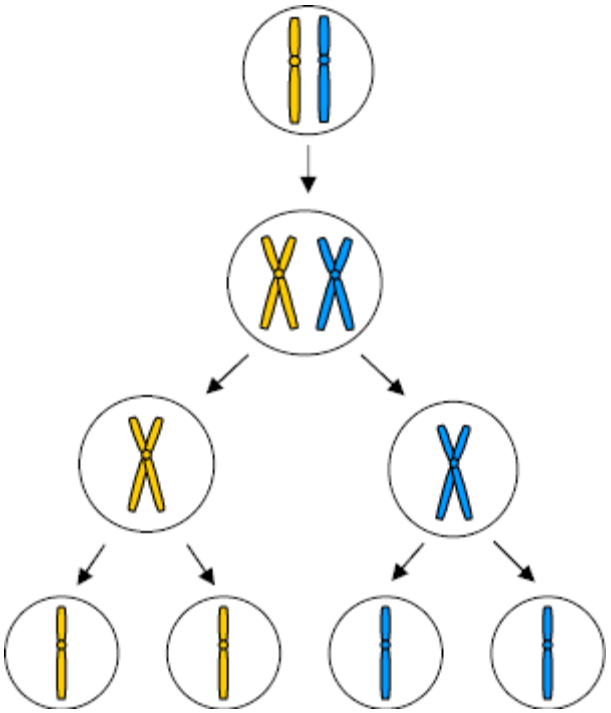
Why is meiosis necessary?

In sexual reproduction two gametes fuse to give rise to new offspring. If each gamete has a full set of chromosomes then the cell they produce has double the number.
This doubling of the number of chromosomes would continue at each generation.
In order to maintain a constant number of chromosomes in the adults the number must be halved at some stage.

The process of meiosis

Meiosis involves two nuclear divisions that normally occur one after the other:

1) In the **first division** the homologous chromosomes pair up and their chromatids wrap around each other. Equivalent portions of these chromatids may be exchanged in a process called **crossing over**. By the end of this stage the homologous pairs have separated with one chromosome from each pair going into one of the two daughter cells.
2) In the **second meiotic division** the chromatids move apart. At the end 4 cells have been formed.



Independent segregation of homologous chromosomes

During meiosis 1, each chromosome lines up along its homologous partner. When these homologous pairs arrange themselves in line they do it randomly. Which one of the pair goes into the daughter cell and with which one of the pairs depends on how they are lined up.
Since they are lined up randomly the combination of chromosomes that goes into the daughter cell is also random. This is called independent segregation.

Crossing over:

- The chromatids of each pair twist around each other.
- During this tensions are created and portions break off.
- These portions rejoin with chromatids of its homologous partner.
- The equivalent portions are exchanged.
- A new genetic combination is produced.