

Replication of DNA

Every living cell, plant or animal, from bacteria to man, contains DNA in which is stored all the information necessary to drive the replication of the cell when this becomes necessary. In the simple case of single-celled bacteria, the whole length of the DNA molecule has to be replicated exactly. Mistakes would cause the program to “crash” and the cell would die.

For the sake of simplicity, replication of the DNA in the bacterium *Escherichia coli* will be described.

This involves the unzipping of the DNA spiral and the building up of new complementary strands on each separate original strand.

After this the cell can divide into two identical “daughter” cells.

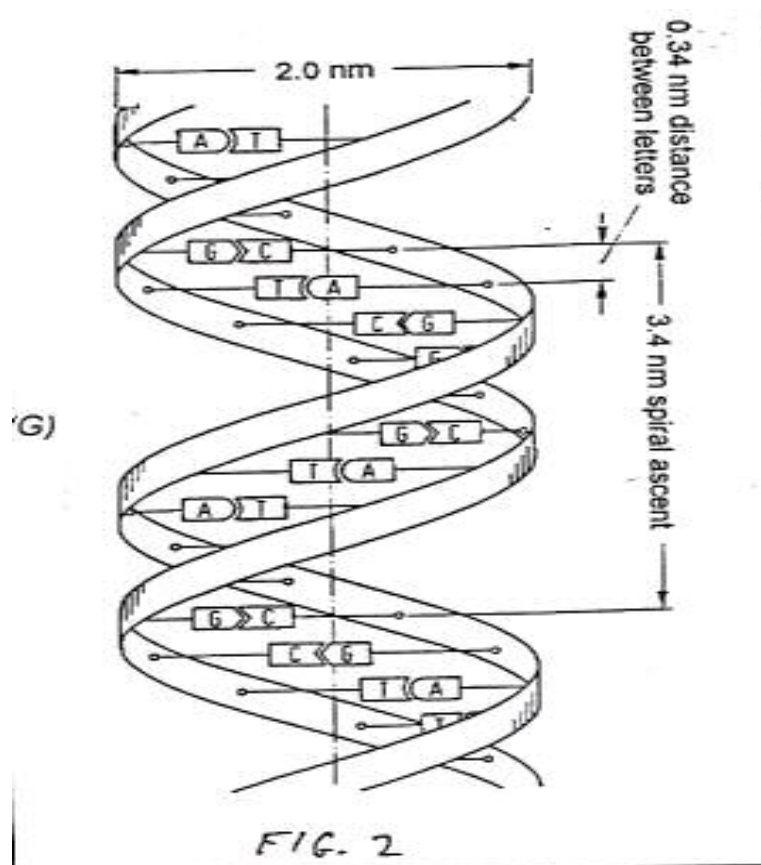
What is DNA?

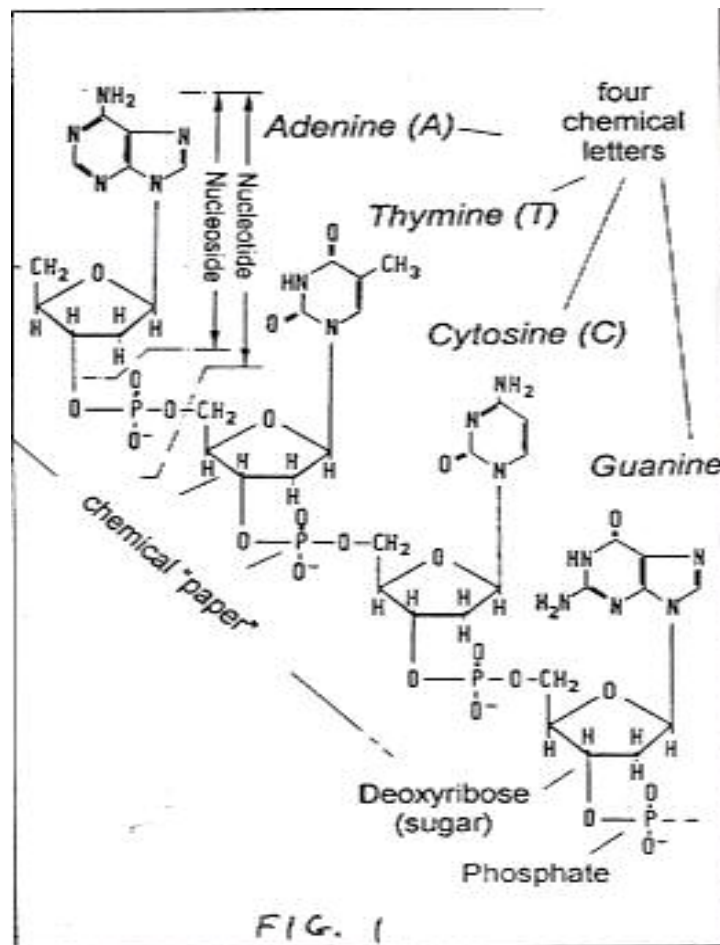
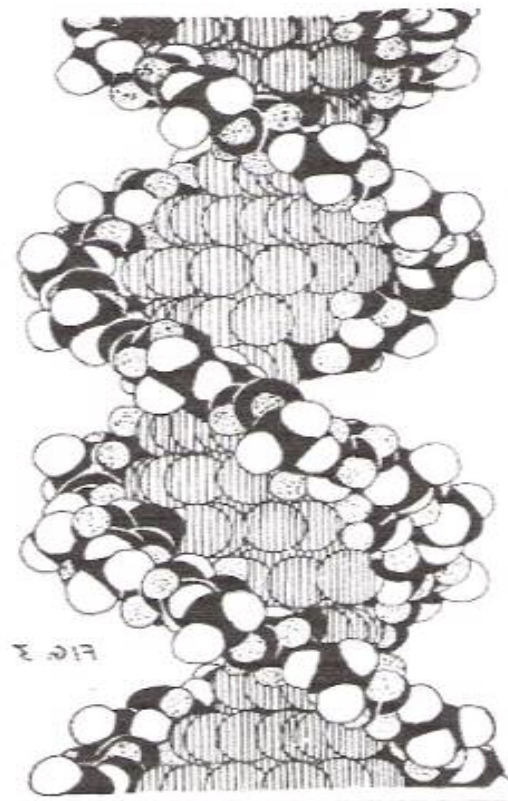
Nucleic acids occur in nuclei of cells in the form of long molecular chains called DNA. These molecules consist of two chains wound around one another as a spiral, and in this state they are stabilized by weak, electrostatic internal bonds called *hydrogen bonds*.

The components of DNA are simple, in fact there are just FOUR units called nucleic acid BASES, and we can represent them like an alphabet of four letters. They are (don't worry about the chemical names):

A for Adenine, T for Thymine, C for Cytosine and G for Guanine

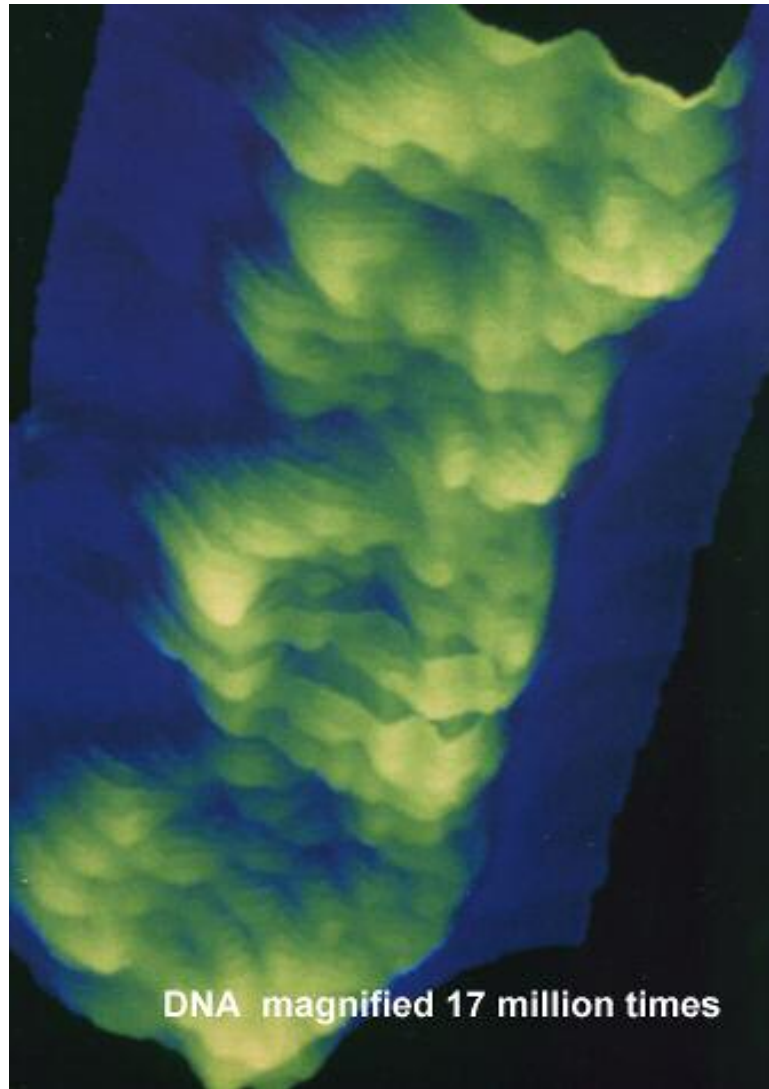
Note that A is always paired with T and C with G.





The DNA Coding

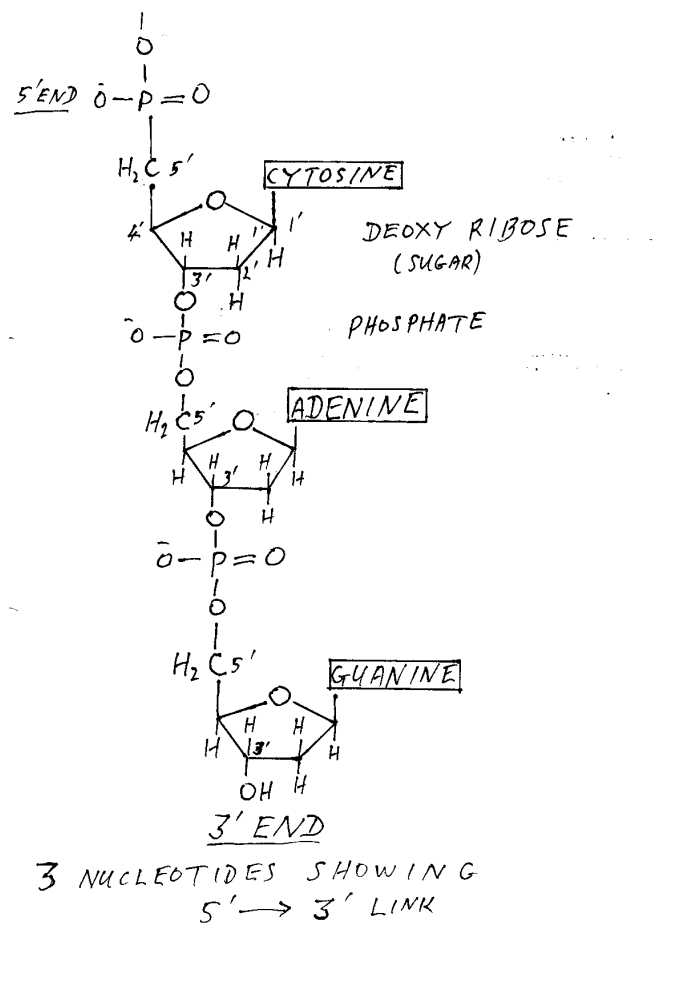
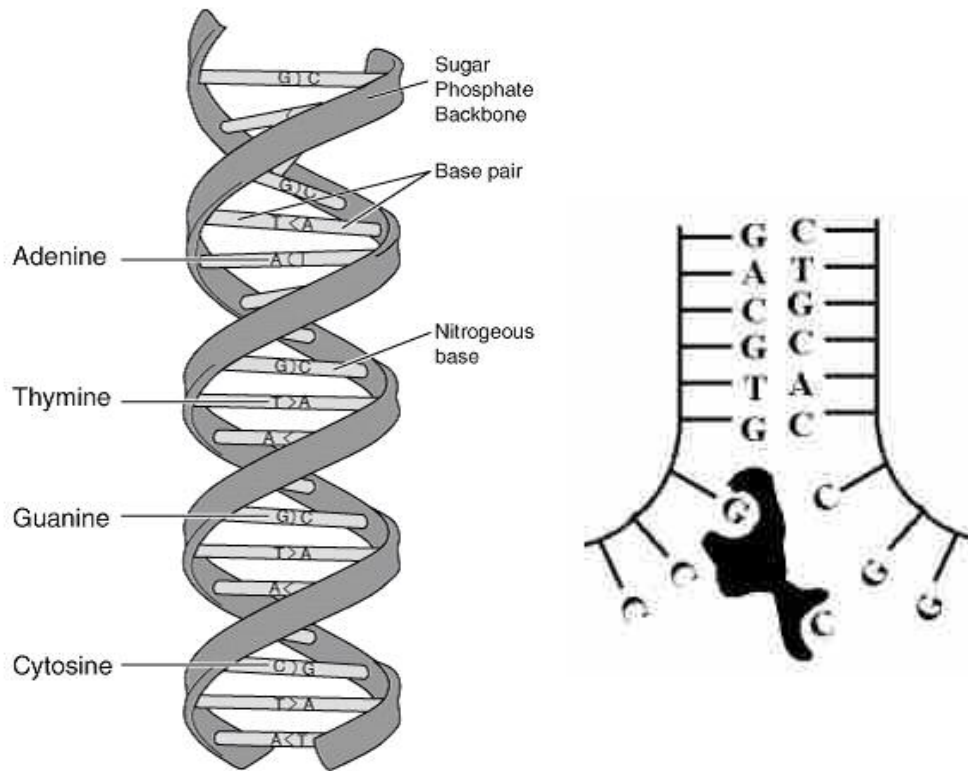
How is information coded on DNA? The four bases are like 4 letters, and the order of linkage of these is used as a code and read by the protein synthesizing machinery in every cell to make proteins. The code is universal for all organisms, plant and animal.

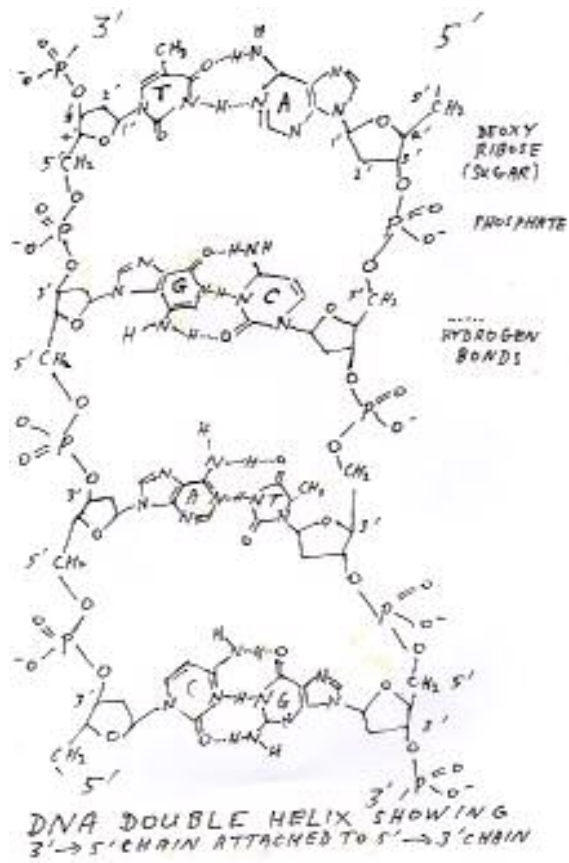


Mechanism of Replication

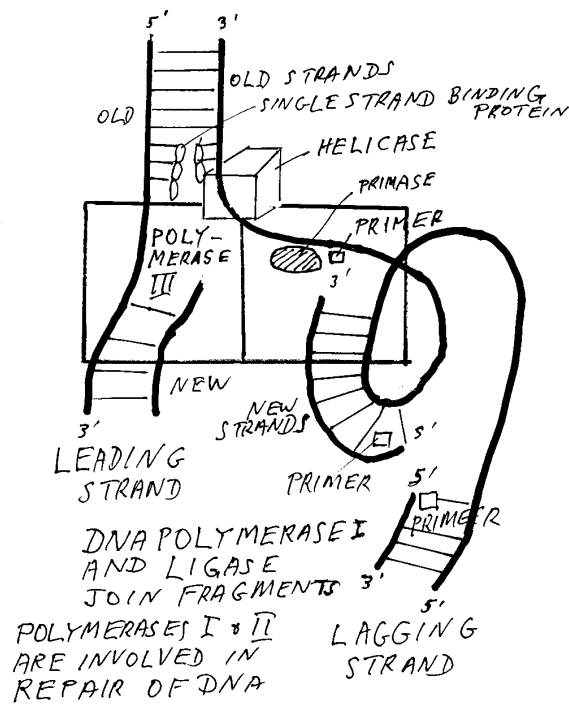
All this is done by special enzymes, the most important of which is DNA Polymerase, a huge enzyme, molecular weight 600,000 with 10 subunits, i.e. an assemblage of parts all working together.

DNA Polymerase has parts that unzip the DNA spiral by means of a ratchet lever, forward stitches a copy of one strand and backstitches the other, then proof reads the copy, correcting errors at the same time. It has been described as like a *tiny sewing machine* composed of protein parts.





MECHANISM OF REPLICATION OF LEADING AND LAGGING STRANDS DURING DNA REPLICATION



E. coli has about 4.4 million DNA base pairs or “letters” which would take 42 minutes to replicate at 1000 “letters” per second. In actual fact the organism reproduces itself in only 20 minutes. This means that replication takes place at more than one starting point.

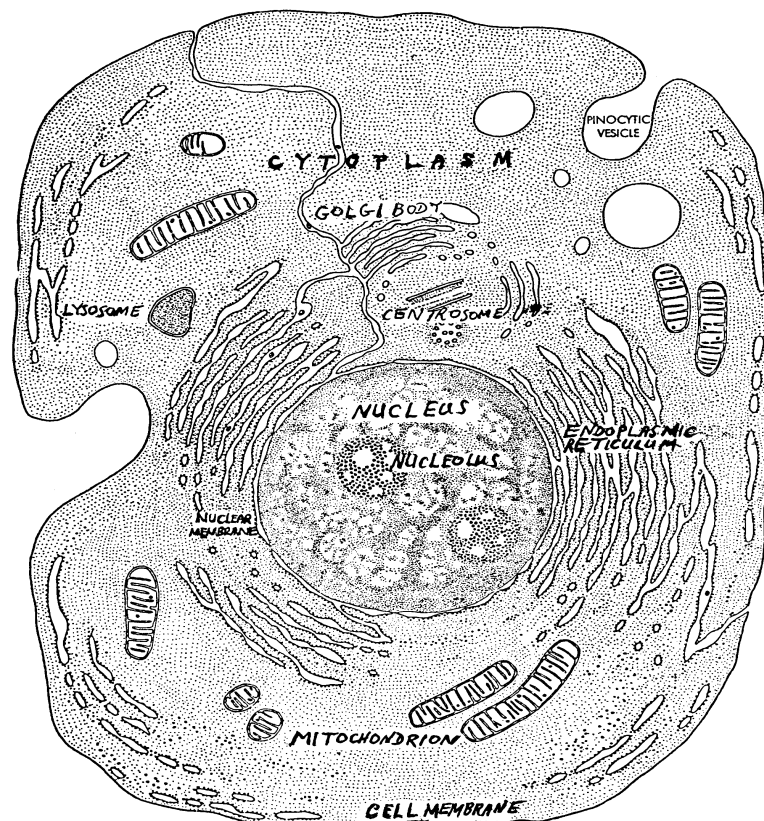
The accuracy of DNA replication is one error in a billion nucleotides or better. It is comparable to a typist making only one mistake in a lifetime of work! In humans there are about 50 enzymes that are known to be involved in DNA repair. Defects in these repair systems lead to diseases such as cancer.

An important gene is the p53 tumour suppressor gene which plays a critical role in cell-cycle regulation, causing a cell to stop growing if the DNA is damaged, and triggers the repair process. If the cell cannot be repaired, it is destroyed. These repair mechanisms oppose evolution, since this depends on mistakes getting through all these repair mechanisms.

There are at least 18 different proteins involved in the molecular machinery used in the replication of the DNA of *E. coli*. The replication of the DNA of more complicated cells is much more sophisticated.

The human genome contains 3000 million DNA “letters” and the replication takes place at about 100 “letters” per second. Since replication takes 8 hours, there must be 10 to 100 thousand starting points for replication.

DIAGRAM OF A TYPICAL CELL



"Impossible Beginning"

Cell Division: Mitosis

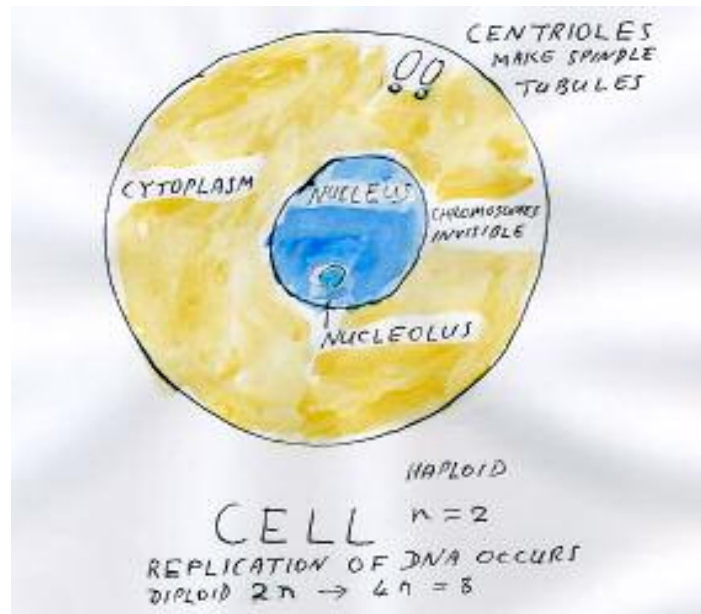
The basic number of 23 distinct chromosomes is called the haploid number or n , so that in a normal body cell there are $2n$. This is called the diploid number: in man there are 46. When the cell replicates, all 46 divide, and, before division there are $4n$ chromosomes, and the number $2n$ is restored after division.

For simplicity's sake, we are going to consider a haploid number of just 2 chromosomes.

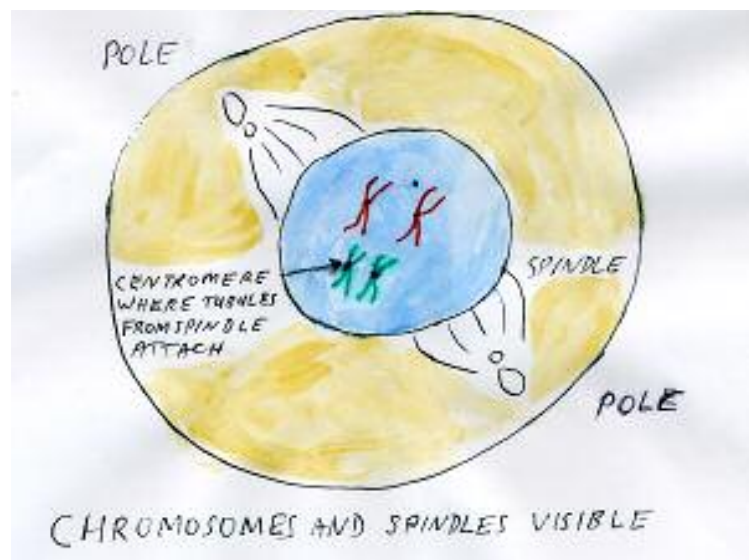
Typical cell in its resting state.

Chromosomes not visible, but the number is $2n$.

Replication of DNA occurs, and the number is now $4n$.

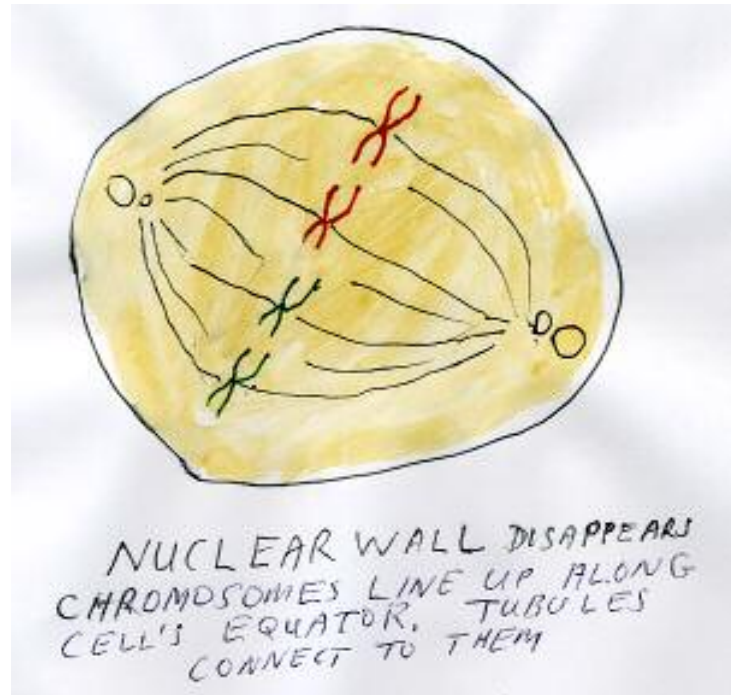


Chromosomes and spindles appear.

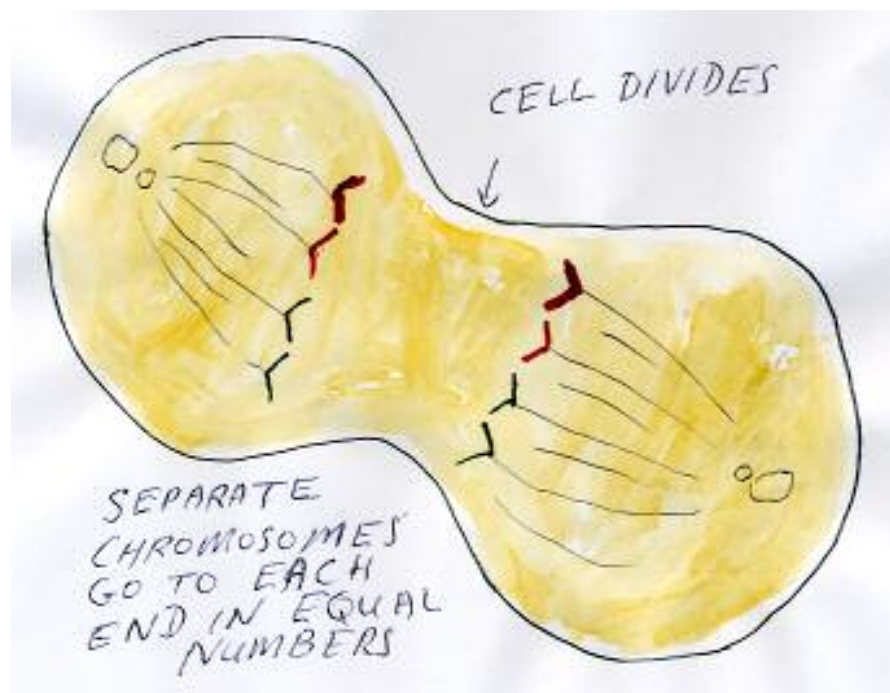


Chromosomes now $4n$, go to equator of cell.

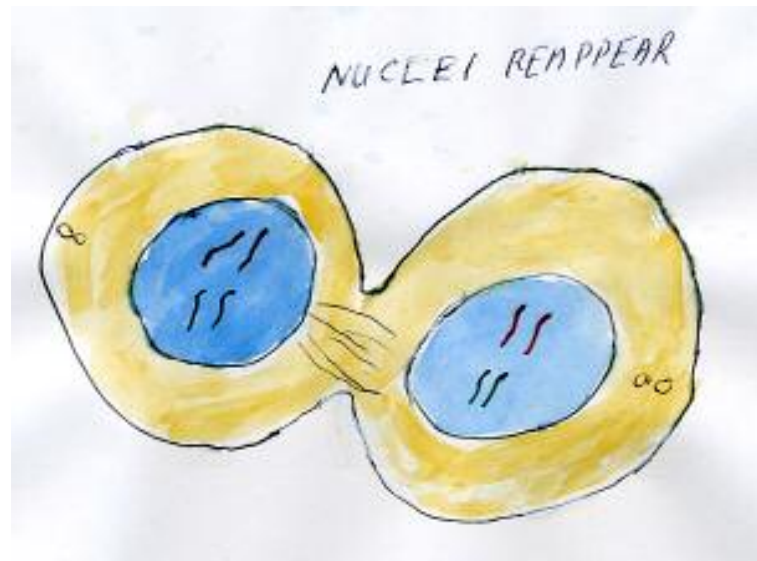
Nuclear wall disappears.



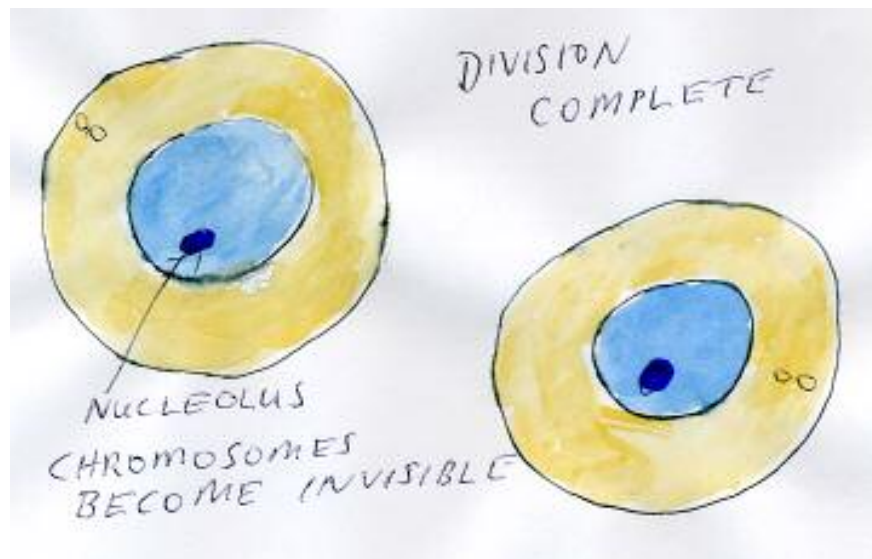
Separate Chromosomes are pulled to ends of cell.



Nuclei reappear.
Number of
chromosomes back
to $2n$



Division complete.
Chromosomes
become invisible.
Nucleolus reappears.



Cell Division: Meiosis

In Meiosis, there is an extra step of cell division without any replication of DNA. Thus the number of chromosomes is reduced from $2n$ (the normal number in body cells) to n , the haploid number. This only occurs in the formation of cells forming the sex cells or gametes. When the sperm and ovum cells combine to form a fertilized ovum or zygote, the number of chromosomes is again restored to $2n$.

I have only described these processes very superficially. In fact they are a masterpiece of exquisitely coordinated biochemical engineering. All the stages have to be exactly timed in the right sequence.

Cells typically require about 16 hours to divide, and only about an hour is needed for the actual cell division. The preparation for this takes all the rest of the time.

These complicated processes show all the hallmarks of intricate design involving very complicated series of events. All would have to be in place for the process to work at all. How could all this come about by chance? Surely this is the strongest evidence for a Creator-Designer.

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