National Genetics and Genomics Education Centre

Cell division and the cell cycle

One of the options open to a cell is to divide (others are to differentiate, die or simply continue in its present state performing its proper function).

There are two forms of cell division:

- **Mitosis** is the way in which most cells divide. It produces two genetically identical copies of the original cell, each containing an exact copy of the DNA that was present in the original cell. All the cells of your body, with the exception of egg or sperm cells, have been produced by repeated mitosis from the original fertilised egg cell.
- **Meiosis** is a specialised form of cell division that is used only to produce egg or sperm cells. Compared to mitosis, there are two key differences in the result of meiosis.
    1. Each ovum or sperm cell contains only one of each pair of chromosomes present in the original cell. The ovum (unfertilised egg) and the sperm each contribute half the DNA of the fertilised egg.
    2. The products of meiosis are not genetically identical. Each ovum or sperm contains a unique and different assortment of the DNA of the original cell, so ensuring that every child (apart from identical twins) is different.

A cell that is going to divide (by mitosis or meiosis) passes through four stages:

1. It sets the biochemical stage for division by accumulating all the raw materials and enzyme systems it will need to make two cells from the original cell. A series of safety checks are performed, like the checks before a plane takes off. These 'checkpoints' prevent further progress until everything is ready for the next stage – in particular that there is no unrepaired damage to the cell's DNA.
2. It replicates its DNA (makes a second copy of all its DNA).
3. Another series of checks prevents further progress until all the DNA has been correctly replicated.
4. The visible part of cell division: chromosomes become visable when the DNA condenses. Each chromosome at this stage has two copies of the particular DNA that it contains, as a result of the DNA replication. In mitosis chromosomes are lined up and the two copies pulled apart to opposite ends of the cell, so that each end has an exact copy of the original DNA. Meiosis, in contrast, is designed to produce genetic variation between individual eggs and sperm and to ensure that eggs and sperm have only one of each pair of chromosomes.

In a population of repeatedly dividing cells, the cells go through the four stages over and over again, in a process called the **cell cycle**. This is often represented as a circular graph, like a baseball track that the cell goes round and round (*Fig. 1 The cell cycle*). The four stages are given names: **G1**, the first gap (nothing visible is going on, although there is a great deal of biochemical activity), **S** (DNA synthesis), **G2**, the second gap, and **M** (mitosis). They vary in relative and absolute duration. If cells divide when they shouldn't, the result may be a tumour. Understanding how the cell cycle is controlled is a key part of understanding what goes wrong in cancer.

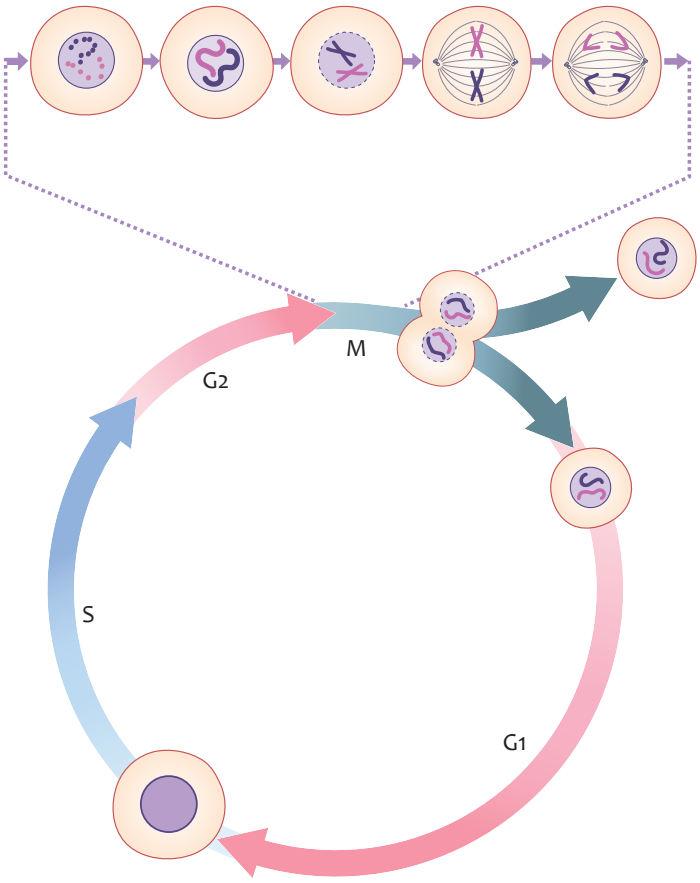

Fig. 1 The cell cycle