

The cell cycle

"Omnis cellula e cellula" was the conclusion that Rudolf Virchow came to in 1855. His conclusion, "every cell originates from another existing cell" is still valid today.

Cell division takes place as long as an organism is growing or when it renews at least some of its cells. During cell division, the parent cell produces two genetically identical daughter cells. The production of cells, therefore, depends on the cells' ability¹ to divide. Many cells that are capable² of division, and thus of reproduction, can be found in the dividing tissues (meristematic tissue) of plants, in embryos, the skin, the epithelium of the intestine³ and in bone marrow⁴. Approximately 100 million cells divide per minute in an adult human.

Following cell division, the newly formed daughter cells have the same content as the parent cell. The nucleus and the cell organelles have to be divided equally between the daughter cells. Cell division thus requires the division of the nucleus (mitosis) and the even distribution of the cell organelles and the cytoplasm (cytokinesis).

This process is carefully prepared during interphase, the longest period of the cell cycle. It's a period of intensive work, of intensive metabolism⁵ in which the chromatin isn't condensed⁶. The interphase is divided into three parts. During S(ynthesis)-phase the amount of chromatin, of DNA doubles. This means that each chromosome that consisted of one chromatid consists of two identical chromatids after the S-phase.

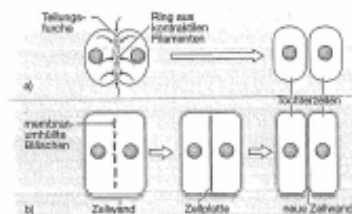


During G_1 -phase (G = gap) before the S-phase and G_2 -phase after the S-phase the cells grow and proteins necessary for division and growth are produced.

During mitosis the nucleus divides and the sister chromatids of each chromatid are transported to the opposite cell poles.

After the division of the nucleus the real division of the cell, cytokinesis, takes place.

In animal cells a ring of contractile⁷ protein fibres⁸ pulls the membrane inwards till the two daughter cells are fully separated. In plant cells small vesicles⁹ containing¹⁰ material for a new cell wall move to the centre of the original cell and build up a new cell wall.



The constantly recurring sequence of interphase and cell division including mitosis is called the cell cycle. It only stops when the cells differentiate and "work" as specialised tissue cells (G_0 -phase) or die.

Regulation and control of cellular division is of major importance for a multi-cellular organism. But what controls and regulates the cell cycle?

Nutrients¹¹ play an important role. If certain nutrients are missing, cell division doesn't take place. But even if all nutrients are available, certain growth factors are needed. Such a growth factor is produced if there is for example a wound and leads to cell divisions to close the wound. A high concentration of cells at a certain place represses¹² cell division whereas a low amount¹³ of cells leads to an increase¹⁴ in cell division.

During the cell cycle certain check points have to be passed. One check point is at the end of G_1 -phase. The cell can only move on to the synthesis of DNA if it is big enough, otherwise it leaves the cycle at this point. Another check point is at the end of G_2 -phase. Special proteins (enzymes) are responsible for these controls. They are inactive and get activated by certain regulating molecules which are built in the foregoing phase. Then, the enzymes can start the next step.

Cell division doesn't go on endlessly. The number of cell divisions depends on the species but the older the organism becomes, the slower is the cell cycle until cell division stops completely.

Tasks:

- 1) Create an arrow diagram that shows the main steps of the cell cycle.
- 2) Explain how the cell cycle is controlled and regulated. Hypothesise what is different in tumor cells.

1 ability Fähigkeit	2 capable fähig	3 epithelium of the intestine Darmschleimhaut	4 bone marrow Knochenmark
5 metabolism Stoffwechsel	6 to condense verdichten	7 contractile zusammenziehbar	8 a fibre Faser
9 vesicle Bläschen	10 to contain enthalten	11 nutrients Nährstoffe	12 to repress unterdrücken
13 amount Menge	14 increase Anstieg		

- 3) Watch the film about mitosis. Then find the correct order for the text parts describing the different phases of mitosis.
- 4) Use the pipe cleaners and the thread to show the different phases of mitosis.
First decide which material could present which part of the nucleus. Use the text passages on your worksheet for help.
Don't look at the images on your worksheet. Only use them to check your results.
- 5) Don't look at the text now. Describe the images showing the phases of mitosis in your own words.