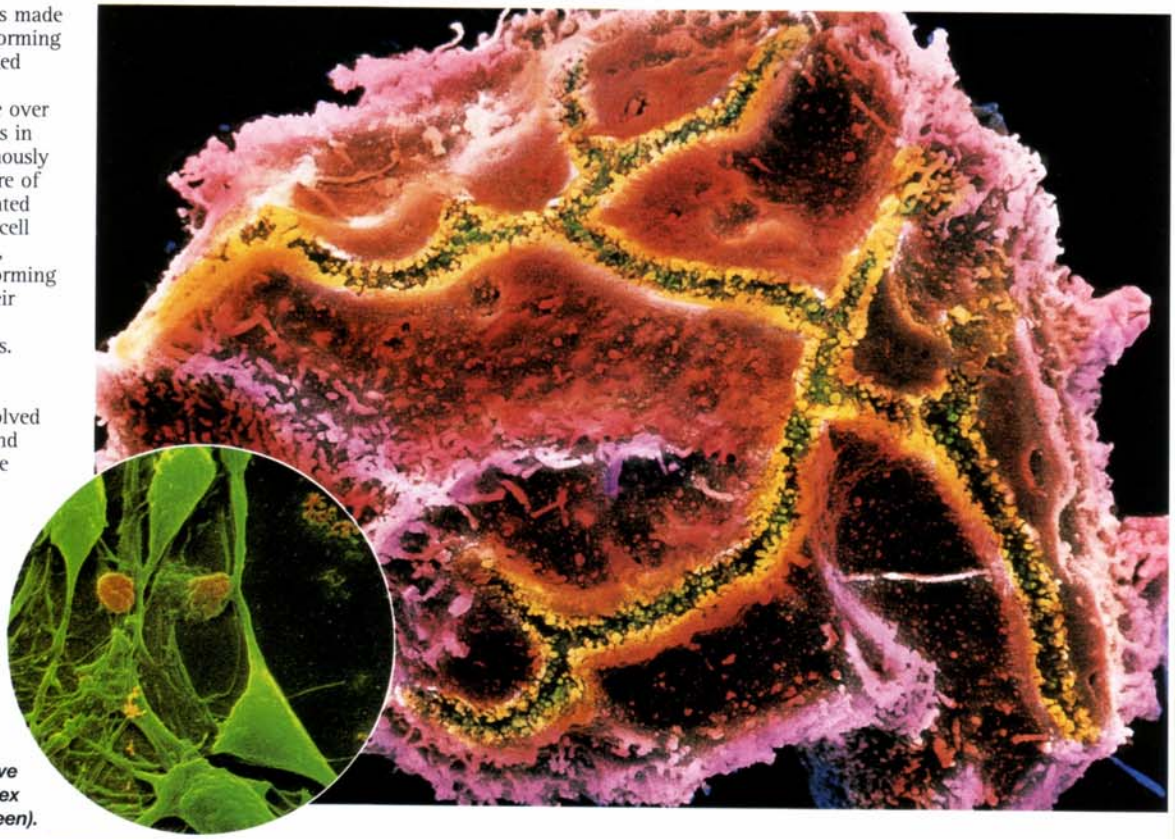
How cells work

All the living tissue in the body is made up of cells – microscopic membrane-bounded compartments filled with a concentrated solution of chemicals. Cells are the smallest living unit in the body.

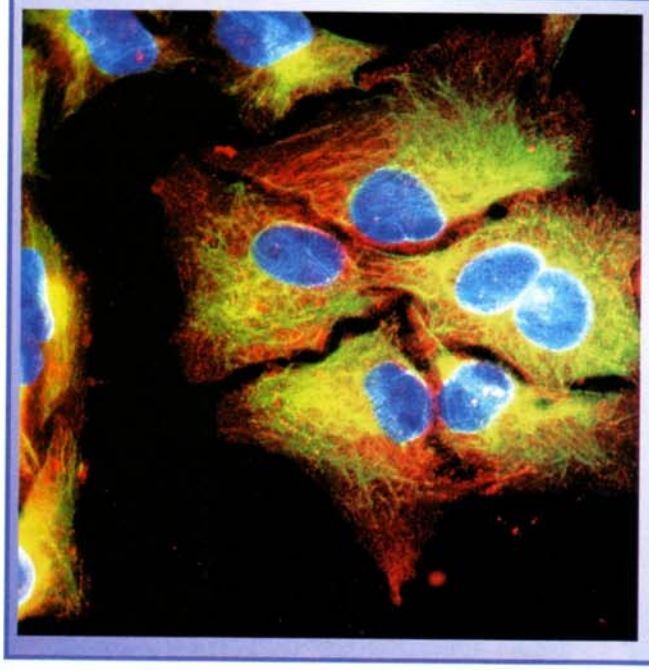
Every tissue in the body is made up of groups of cells performing specialized functions, linked by intricate systems of communication. There are over 200 different types of cells in the body. Although enormously complex, the final structure of the human body is generated by a limited repertoire of cell activities. Most cells grow, divide and die while performing functions particular to their tissue type, such as the contraction of muscle cells.

Typically, cells contain structural elements called organelles, which are involved in the cell's metabolism and life cycle. This includes the uptake of nutrients, cell division and synthesis of proteins – the molecules responsible for most of the cell's enzymatic, metabolic and structural functions.



A hepatocyte is seen on a micrograph (far right). This is a specialized liver cell that performs several functions. Neurones – nerve cells – of the cerebral cortex are shown in the inset (green).

Immortal cells



HeLa cells, unlike normal cells, continue to divide indefinitely. They have been used in research worldwide because they are so easily cultured.

Most cells, when grown in a laboratory, can divide only about 50 times before they die. Immortal cells are cells that can be grown in Petri dishes indefinitely, and such cells are extremely useful in research.

In 1951, Henrietta Lacks, a 31-year-old American woman, was found to have a small lesion on her cervix, and a biopsy was taken to determine if the cells were malignant (cancerous). The sample of cells sent to the laboratory were indeed malignant, and despite treatment, she died eight months later from cervical cancer.

The sample of cells ended up in the laboratory of George Gey, a pioneer of tissue culture, and after working with the cells for several weeks, he concluded that they divided faster than any cells he had ever seen before.

The cells, now called HeLa cells, proved to be robust and immortal, and because they grow so rapidly and reliably, they were eventually made available to other researchers and have been used extensively in biological research ever since. The polio vaccine was developed in under a year thanks to their use.

Unfortunately, HeLa cells have the ability to contaminate and subvert other cells growing in the same laboratory, and there were instances of experiments performed on one particular type of cell, unknowingly being performed on HeLa cells instead.

HeLa cells are still maintained in laboratory cultures. Such colonies have been maintained for the 40 years since the tumour they were cultured from was removed from Henrietta Lacks' cervix.

Structure of a cell

The cell structure can be divided into the outer membrane, the DNA-containing nucleus and the structures called organelles within the cell. Each component of a cell has a specific function, such as energy production, storage or the synthesis of proteins.

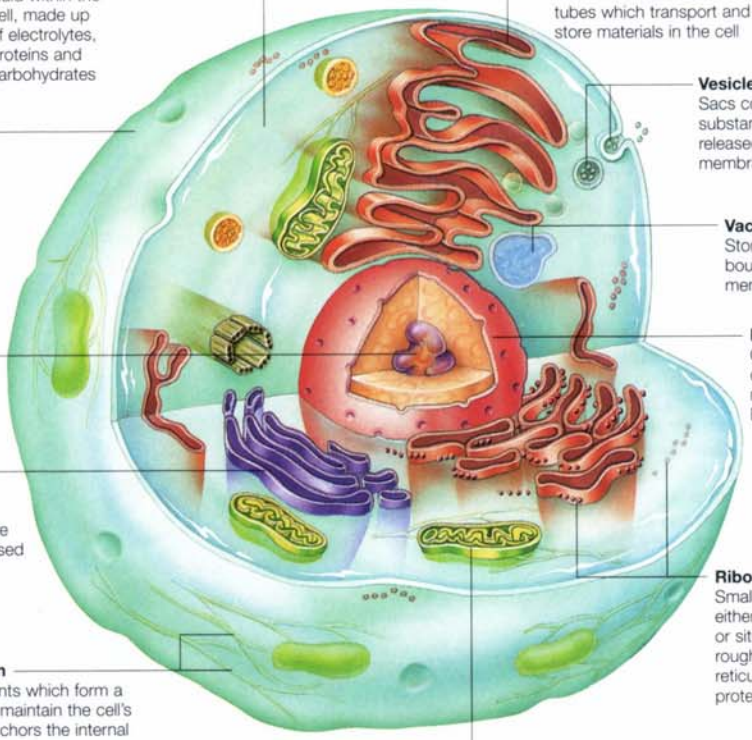
THE PLASMA MEMBRANE

The plasma membrane surrounds each cell and separates it from its external environment, which includes other cells. Contained inside the membrane is a solution of proteins, electrolytes and carbohydrates called the cytosol, as well as membrane-bound subcellular structures called organelles. Spanning across the membrane are proteins responsible for communication with the external environment and for transport of nutrients and waste.

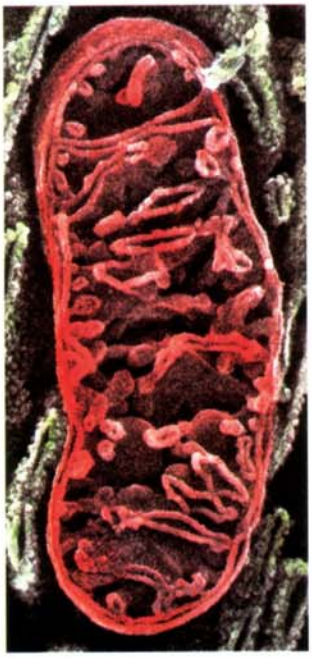
THE NUCLEUS

The nucleus is in the centre of the cell, and contains the cell's DNA arranged into chromosomes, as well as structural proteins for coiling and protecting the DNA. The nucleus is surrounded by a membrane with large pores in it, allowing for movement of molecules between the nucleus and the cytosol, while retaining the chromosomes inside the nucleus.

The shape of each type of cell varies according to function. Many organelles found in most cells are seen in this cut-away.



Inside the cell – the cytoplasm



The cytoplasm is the inner contents of the cell, not including the nucleus, which is made up of fluid (the cytosol) and large numbers of organelles. The organelles include:

■ **Mitochondria**
Responsible for energy production. Nutrients in the form of sugars and fats are broken down in the presence of oxygen to make ATP (adenosine triphosphate), a source of energy used by a cell.

■ **Ribosomes**
Ribosomes carry out the production of proteins, using the blueprint recorded in the genetic material of the cell.

■ **Endoplasmic reticulum**
This is a vast network of tubes, sacs and sheets of membrane that runs throughout the cell. It allows for the transport and storage of molecules.

■ **Golgi apparatus**
The Golgi apparatus is a stack of flattened sacs, critical in the modification, packaging and sorting of large molecules in the cell.

■ **Vesicles and vacuoles**
Vesicles are membrane-bounded areas within a cell for specialized processes or storage. Vacuoles appear as 'holes' under the microscope, and are typically regions of storage or digestion surrounded by a membrane.

■ **Cytoskeleton**
The cytoskeleton is the fine meshwork of protein filaments used to maintain the cell's shape, to anchor components in place and to provide a basis for the cell's movements.

A single mitochondrion is seen coloured pink in this high-powered micrograph. These are the 'powerhouses' of the cell, where respiration occurs.

This electron micrograph shows a section through the rough endoplasmic reticulum of an animal cell (red lines). Attached to the surface are ribosomes.